LARGE ANIMAL PROCEEDINGS

June 4–6, 2023

2023 ANNUAL CONFERENCE

KANSAS STATE UNIVERSITY | College of Veterinary Medicine

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A Regulatory Update on Food Animal Drugs

Mike Apley, DVM, PhD, DACVCP, Kansas State University

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Michael D Apley, DVM, PhD, DACVCAP

The last of the over-the-counter (OTC) antibiotics

June 11th, 2023 is the target date for the end of availability of OTC antibiotics. The most widely used antibiotics which will be affected are procaine penicillin G, procaine/benzathine penicillin G, and 200 mg/ml oxytetracycline. A quick search for Guidance for Industry (GFI) #263 will get you the document itself as well as an FDA question and answer document. The Q and A document has a link to the list of the drugs affected by this change. Existing products with OTC labels may be sold and used following June 23rd; they do not have to be withdrawn or relabeled. On and after June 11th, all product entering the market place must have the new labels.

Your biggest change will be deciding on what you will accept for a VCPR to sell or authorize the purchase of these antibiotics when new clients approach you for purchase or a prescription. The Animal Medicinal Drug Use Clarification Act (AMDUCA) regulations define a VCPR in 21CFR part 430 as follows:[1]

> "(1) A veterinarian has assumed the responsibility for making medical judgments regarding the health of (an) animal(s) and the need for medical treatment, and the client (the owner of the animal or animals or other caretaker) has agreed to follow the instructions of the veterinarian;
>
> (2) There is sufficient knowledge of the animal(s) by the veterinarian to initiate at least a general or preliminary diagnosis of the medical condition of the animal(s); and
>
> (3) The practicing veterinarian is readily available for followup in case of adverse reactions or failure of the regimen of therapy. Such a relationship can exist only when the veterinarian has recently seen and is personally acquainted with the keeping and care of the animal(s) by virtue of examination of the animal(s), and/or by medically appropriate and timely visits to the premises where the animal(s) are kept."

While some other states have defined a period within which the veterinarian must have visited the production site, Kansas has not enacted such a time requirement.

Reimplanting

July 1, 2023 is the implementation date for changes in our ability to reimplant cattle within a production phase. On May 12, 2023 a letter and a question and answer document were released by the FDA Center for Veterinary Medicine (CVM). The letter and Q and A document may be easily accessed by searching "FDA reimplanting". The reader is referred to these documents for clarification on the different production phases in cattle production as defined by the FDA CVM.

Labels for implant products can be quickly searched at AnimalDrugs@FDA. On that site you may search by product name or ingredient. Once you have searched, click on the application # on the left, then scroll down to the proprietary section and click on the blue highlighted proprietary name for which you wish to evaluate the label.

Generics

The requirements for approval of a generic drug by the FDA Center for Veterinary Medicine (FDA CVM) are often the subject of confusion and misinformation. For purposes of clarity and brevity, this article focuses on the requirements for approving a generic injectable product for use in food animals, intended as a general overview of the generic drug approval process. As in any complicated process, there are many "ifs, ands, and buts" which may affect any particular approval.

Pioneer (NADA) Drug Approvals

It is first necessary to understand the approval requirements for the original drug product, often referred to as the "pioneer" version of the drug. While we usually say a drug is approved by the FDA, the FDA CVM actually approves the New Animal Drug Application (NADA), made up of 7 required technical sections. The science and practices associated with terms such as good manufacturing practices (GMPs), good clinical practices (GCPs), and good laboratory practices (GLPs) are integral to successful completion of the sections. The FDA CVM then prepares a Freedom of Information (FOI) summary in cooperation with the sponsor; this is a public document which summarizes the studies and conclusions for each of the technical sections. The technical sections for a pioneer NADA are as follows, as listed in FDA Guidance for Industry (GFI) #132, dated May 2018. Quoted text are excerpts taken directly from GFI #132.

1. Chemistry, Manufacturing, and Controls (CMC)
    a. "This section contains complete information regarding the manufacture of the new animal drug active ingredient and the new animal drug product. It includes information on personnel, facilities, components and composition, manufacturing procedures, analytical specifications and methods, control procedures, stability, containers and closures, Good Manufacturing Practice (GMP) compliance, and many other aspects of the chemistry and manufacturing processes (21 CFR 514.1(b)(4) and (5))."
2. Effectiveness
    a. "This section contains full reports of all studies that show whether or not the new animal drug is effective for its intended use (21 CFR 514.1(b)(8)(i)). This section includes studies conducted by or on behalf of the sponsor or available to the sponsor by right of reference… This section includes any additional pertinent information that is known about the effectiveness of the drug at the time the technical section is submitted."
3. Target Animal Safety
    a. "This section contains full reports of all studies required by FDA to demonstrate whether or not the new animal drug is safe to the target species (21 CFR 514.1(b)(8)(i)) This section also contains any studies or references relevant to the safety of humans that administer or may come into direct contact with the new animal drug (user safety)..."
4. Human Food Safety
    a. "This section is submitted only for applications for new animal drugs intended for use in species that are used for human food (food-producing animals). This section includes a description of practicable methods for determining the quantity, if any, of the new animal drug in or on food, and any substance formed in or on food because of its use, and the proposed tolerance or withdrawal period or other use restrictions to ensure that the proposed use of the drug will be safe (21 CFR 514.1(b)(7)). This section

should also contain any data relating to residue toxicology (including the impact of residues of antimicrobials on human intestinal microflora), residue chemistry, and, if the new animal drug is an antimicrobial, microbial food safety…"

5. Environmental impact
    a. This section (21 CFR 514.1(b)(14)) contains either an environmental assessment (EA) under 21 CFR 25.40, or a request for categorical exclusion under 21 CFR 25.30
6. Labeling
7. All other information

To describe the process as complex and resource-intensive is an understatement.

<u>Generic (ANADA) Drug Approvals</u>

Once the pioneer drug is off patent, or in some cases after expiration of an additional marketing exclusivity period, the FDA is granted authority by the Generic Animal Drug and Patent Term Restoration Act of 1988 to approve Abbreviated New Animal Drug Applications (ANADAs) for generic copies of the pioneer drug. Approval of the ANADA requires the acceptance of 6 technical sections by the FDA CVM. A public FOI document is also prepared.

1. Labeling
    a. This must be similar to the Pioneer drug (also referred to as the Reference Listed New Animal Drug, or RLNAD).
2. Chemistry, Manufacturing, and Controls
    a. The section has the same requirements as for the pioneer product or any approved drug.
3. Human food safety
    a. "In the instances where human food safety information is required, the division responsible for the evaluation of this information will advise the sponsor as to the requirements that must be met." Human food safety information is required for all drugs intended for use in food animals.
4. Environmental Impact
    a. This section is the same as for the RLNAD.
5. Bioequivalence
    a. "This section contains full reports of all studies that show the generic new animal drug is bioequivalent to the reference listed new animal drug or all information submitted in support of a waiver from the requirement to demonstrate in-vivo bioequivalence."
6. Patent and Marketing Exclusivity
    a. "This section includes the appropriate patent certification or statement (see 21 CFR 314.94(a)(12)). It also contains an appropriate statement with regard to the current marketing exclusivity status of the reference listed new animal drug."

Notice that the technical sections for effectiveness and target animal safety are not required for generic ANADA applications. Bioequivalence studies bridge the generic product to the pioneer product, which was proven to be safe and effective. Technical sections unique to the generic drug approval procedure are Bioequivalence and Patent and Marketing Exclusivity.

All generic products must demonstrate bioequivalence. For products where this is accomplished through approval of a biowaiver such as an injectable solution, bioequivalence may be demonstrated by

a comparison of the generic formulation to the pioneer on the basis of relevant physiochemical properties. If there are any changes in the generic product which affect bioavailability, the biowaiver will be denied.

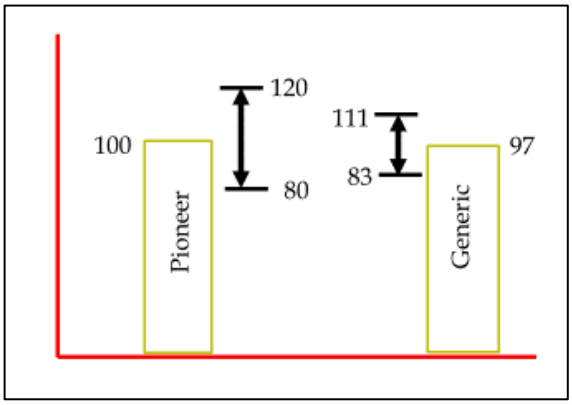
When a biowaiver is not granted, then a bioequivalence study is required. We will use a pharmacokinetic (blood concentration) study as an example, but in some cases alternatives to this type of bioequivalence study may be used, such as a pharmacologic end-point study or clinical end-point study.

For a typical pharmacokinetic bioequivalence study, both the pioneer and proposed generic drug are given to each of multiple animals in a "cross-over" study design where each animal in the study receives both products with a "wash out" period observed between the two drugs. When the plasma concentration data are analyzed, the focus is on two parameters; these are the maximum achieved plasma concentration (Cmax) and the area under the plasma concentration curve as plotted on a chart (AUC). The Cmax gives an indication of the rate (speed) of absorption of each product and the AUC gives an indication of the extent (how much) of drug absorption over the observed time period.

This next part about the analysis of these values is very important because it is a source of one of the myths about generic products. A 90% statistical confidence interval is constructed around the average Cmax and AUC values for the proposed generic product. This means that given the variability observed in the study, there is a 90% probability that the true average of the value lies with this range. The outer limits of this confidence interval must generally fall within -20% and +20% of the average value for the pioneer product (+ 25% if the values are log transformed). Let's use the example below to clarify this approach.

In our example (Figure 1), the pioneer product maximum concentration in the plasma (Cmax) average across all study animals was 100. Calculating the+/- 20% range around the pioneer Cmax results in a range of 80-120. In this same example, the average for the proposed generic product is 97, with a 90% confidence interval for the true average of ± 14 (83 to 111). This product would meet bioequivalence standards for Cmax, ; the outer bounds of the 90% confidence interval fall within ± 20% of the pioneer product average.

Figure 1: An example of a bioequivalence analysis



The same process would be repeated for Area Under the Concentration curve (AUC). The standards must be met for both Cmax and AUC in order for a proposed generic product to demonstrate bioequivalence.

Generic Myths

A generic product can have as little as 80% of the concentration of the pioneer product. First, the ±20% range is about statistical analysis of plasma concentration values, not drug concentration in the product. Secondly, to meet the requirements within the variability encountered in a study, the values for the generic drug must be quite close to the pioneer product values so that the outer boundaries of the 90% confidence interval fall within the prescribed range around the pioneer product average (generally +/- 20%).

Generic products have wider manufacturing tolerances than pioneer products. The FDA applies the same CMC requirements to generic and pioneer drugs.

Compounded and generic products are essentially the same thing. You now understand the FDA CVM approval process for generic products. Compounded products do not have a similar approval process and are not reviewed by FDA prior to marketing. Any assurances as to the quality of compounded products are provided by the compounder and their processes. This includes information like compounded product strength and expiration.

You can access multiple information sources, including the FOI, for products approved by the FDA Center for Veterinary Medicine at Animal Drugs @ FDA.

Thank you to Dr. Ian Hendricks of the FDA/CVM Division of Generic Animal Drugs for his presentation "FDA/CVM Demonstrating Bioequivalence" which was valuable in preparing this article.

For additional information.

FDA Center for Veterinary Medicine Guidance for Industry #35. Bioequivalence Guidance. (2006)

FDA Center for Veterinary Medicine Guidance for Industry #132. Administrative Applications and the Phased Review Process. (2018)

FDA Center for Veterinary Medicine Draft Guidance for Industry #171. Demonstrating Bioequivalence for Soluble Powder Oral Dosage Form Products for Type A Medicated Articles Manufactured from Active Pharmaceutical Ingredients Considered to be Soluble in Aqueous Media. (2019)

Ponazuril, diclazuril, and toltrazuril

This is the text of a joint informational document from the American Association of Bovine Practitioners and the American Association of Swine Veterinarians on the use of ponazuril, diclazuril, and toltrazuril in swine and cattle.

"Questions have been raised regarding the use of compounded ponazuril, diclazuril, and toltrazuril medications being offered by compounding pharmacies. In some cases, these products are being offered directly to the public.

Ponazuril, diclazuril, and toltrazuril are not approved for food animal use in the United States. Information on drug labels approved by the Food and Drug Administration Center for Veterinary Medicine (FDA CVM) may be found at Animal Drugs @ FDA.[2] On that site, drugs may be searched by proprietary name, established drug name, or by FDA New Animal Drug Application (NADA) approval number or Abbreviated New Animal Drug Application (ANADA) approval number.

The law permits compounding of an animal drug when the source(s) of the active ingredient(s) for compounding is/are the finished FDA-approved drug(s) and not a bulk drug substance. The FDA CVM defines "Bulk Drug Substance" and "Active Pharmaceutical Ingredient" (API) in a footnote in Guidance for Industry #256.[3]

> FDA regulations define "bulk drug substance" and "active pharmaceutical ingredient" as "any substance that is intended for incorporation into a finished drug product and is intended to furnish pharmacological activity or other direct effect in the diagnosis, cure, mitigation, treatment, or prevention of disease, or to affect the structure or any function of the body."

Bulk API may be legally used for production of the FDA-approved product by the approved manufacturer. In this case, the source of the bulk API has been approved and is inspected by the FDA.

The extralabel use provisions of the Federal Food, Drug, and Cosmetic Act (FD&C Act) permit the compounding of animal drugs made from FDA-approved animal or human drugs, provided the conditions for legal extralabel use described in the FD&C Act and FDA's extralabel use regulations are met.[1,4] The use of a drug compounded from bulk API is not permitted in any food animal under the AMDUCA regulations, except in the case of specific antidotes as noted in FDA CVM Guidance for Industry (GFI) #256 and listed on FDA's website.[3,5] Therefore, when compounded from bulk API, ponazuril, diclazuril, and toltrazuril products are specifically prohibited for use in food animals.

<u>Compound specific discussions:</u>

- **Ponazuril**
    - There is an FDA approved equine ponazuril paste labeled for the treatment of equine protozoal myeloencephalitis (NADA #141-188). This drug is not prohibited for food animal use in the United States and is therefore able to be considered for extralabel drug use (ELDU) within a valid Veterinary-Client-Patient relationship (VCPR) under the Animal Medicinal Drug Use Clarification Act (AMDUCA) regulations.[6]
    - Compounding using the FDA-approved ponazuril product may be considered under the AMDUCA regulations by a veterinarian within a VCPR. The use of compounded ponazuril originating from bulk API in food animals is illegal under any circumstances.
- **Diclazuril**
    - There is an equine diclazuril oral pellet approved for the treatment of equine protozoal myeloencephalitis (NADA #141-268) and a medicated feed for broiler chickens and growing turkeys approved for prevention of coccidiosis (NADA #140-951). The equine

oral pellet is an alfalfa-based pellet designed for administration by adding to the feed of horses. Under 21CFR part 530.11, the extralabel use of an approved new animal drug or human drug in or on an animal feed is an extralabel use that is not permitted and results in the drug being deemed unsafe.[7] Similarly, any ELDU of the chicken and turkey medicated feed is strictly prohibited in food animals.

    - The use of compounded diclazuril originating from a bulk API in food animals is illegal under any circumstances.

- **Toltrazuril**
    - There is no FDA approved toltrazuril product in the United States. Therefore, toltrazuril is illegal to use in food animals in the United States in any form.

These drugs may be approved for food animal use in other countries. However, drugs approved in other jurisdictions may not be legally imported and used in food animals in the United States, regardless of their labels in other countries.

Guidance on compounding from bulk drugs should be sought from Food and Drug Administration Center for Veterinary Medicine (FDA CVM) Guidance for Industry (GFI) #256.[3] The FDA CVM may be contacted with questions at AskCVM@fda.hhs.gov."

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5. FDA/CVM. List of Bulk Drug Substances for Compounding Drugs for Use in Food-Producing Animals or Free-Ranging Wildlife Species In: Medicine FaDACfV, ed. https://www.fda.gov/animal-veterinary/animal-drug-compounding/list-bulk-drug-substances-compounding-drugs-use-food-producing-animals-or-free-ranging-wildlife, 2022.
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7. FDA. 21 CFR part 530.11 Food and Drug Administration, Department of Health and Human Services, Subchapter E - Animal Drugs, Feeds and Related Products, Part 530 - Extralabel Drug Use in Animals. Subpart B - Rules and Provisions for Extralabel Uses of Drugs in Animals. Sec. 530.11 Limitations. . https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?fr=530.11

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Novel Strategy to Mitigate Stress and It's Deleterious Consequences in Cattle

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Appeasing pheromone use in animal production: a review

Summary:

Key-words: cattle, calming, behavior, pheromone

Mammalian pheromones control innate social behavior and acutely regulate hormone levels [1]. Pheromones are compounds secreted by one animal that have an effect on the physiology or behavior of other animal of the same species. Sensory systems that mediate touch, vision, taste, hearing, and smell activate neutral circuits in the brain; olfactory circuits that process pheromones are highly efficient, targeting brain regions of the limbic system that coordinate behavioral and endocrine responses in few synapses [1].

Appeasing pheromone benefits in animal production

- *Improvement of welfare and productivity of weaned animals*

Stress can negatively impact young animals faster than adult animals. Pigs experience biological stress such as physiological, environmental, and social challenges when weaned from the sow [2]. Stress-related problems are very common in pigs and lead to decrease their welfare, impaired performances and increased vulnerability to infections at any stages of life of the animal. Antibiotics are frequently used in weaned pigs to reduce the undesirable effects of weaning[3]; however, public health concern about the use of antibiotics have driven researchers to study natural alternatives to facilitate the adaptation to new environment, uphold the homoeostasis of individual to help to prevent the negative consequences of stressful situations, less disease and lower antibiotic use. Besides the changes in diet, and physical and thermal environments, the post-weaning environments lack in familiar maternal odors, comforting semiochemicals including pheromones that further contribute to growth lag and health challenges experienced by the young pig at post-weaning [3].

The idea to supplement environments with biologically meaningful odors that are deficient the post-weaning environment lead McGlone and Anderson [4] to investigate the effect of a

synthetic maternal pheromone on feeding behavior and performance of weanling pigs. The synthetic pheromone contained lipid-soluble compounds found in skin secretions of sows was described by Pageat (2001) in the patent US Pat. No. 6,169,113.

The exposure of the synthetic pheromone to weanling pigs (either on the feeder or their snout) applied topically once at weaning had significant effects on their behavior and performance of weaned pigs. Average daily gain (ADG) and feed:gain ratio were improved by application of the putative synthetic pheromone either directly on the feeder or when painted on the pigs' snouts. Exposed piglets spent less time fighting, less time lying down, less time drinking and spent more time in the feeder The synthetic pheromone applied topically once at weaning had significant effects on the behavior and performance of weaned pigs, such as stimulation of apparent feeding behaviors, reduction of fighting and apparent drinking behaviors, and improvement of average daily gain (ADG) and feed:gain ratio[4]. Similar study showed that a pig appeasing pheromone applied in environment was effective in reducing aggression and stress response of young and adult pigs [5].

Lastly, but not least, aggressive behavior is inherent in farm animals as the environment is generally constrained and optimized and induces regular changes in the composition of social groups. Aggressive behavior is normal behavior, but it should be minimized and negative consequences prevented. Aggression is indeed present in many pig farms and may lead to welfare impairments and even carcass depreciation.

Positive results were also observed when a natural rabbit nipple-searching pheromone (2-methyl-2-butenal (2M2B) generally sold as a food-grade flavoring agent was applied to the feeder at weaning. Interestingly, since is believed that pheromones are species specific, piglets that had 2M2B applied to their feeder at weaning had greater feed intake and greater weight gain than piglets in the control group who did not have this odor or flavor placed in the post-weaning environment [3].

Weaning is a stressor inherent to beef cattle management, alternatives to alleviate the stress elicited by the weaning process are warranted to promote calf performance and welfare in cow–

calf [6]. The use of appeasing pheromone is considered an important strategy to enhance cattle welfare and productivity upon stressful procedures.

Schubach et al. [6, 7] corroborated that bovine appeasing substance (BAS) administration to beef calves upon weaning alleviated adrenocortical and acute-phase protein responses and improved feed intake and efficiency, resulting in improved performance during a 42-d post weaning period. Calves that were treated with BAS had reduced cortisol concentrations in hair from the tail-switch on day 14 and overall reduced circulating haptoglobin concentrations when compared to calves that were not treated with BAS at weaning. Importantly, the differences on hair cortisol and haptoglobin were more noticeable 15 days upon treatment. Additional administration of BAS, such as every 14 days, were warranted to extend its benefits [6]. In general, BAS administration to beef calves at weaning alleviated stress-induced physiological reactions, improved temperament, enhanced humoral immunity, and appeared to have accelerated adaptation to novel management and environment [7].

The administration of BAS improve performance and consequently reduce the costs related to interventions of pre-weaning dairy calves [8]. Bovine appeasing substance has been described as a feasible alternative to improve health and performance of the dairy cattle herd and decrease disease occurrence [8].

- *Improvement of performance in feedlots*

Feedlot receiving is one of the most critical phases within the beef production cycle[9], when cattle are exposed to several stress and health challenges that impact their welfare and productivity. In addition, improvements in feed efficiency of beef cattle have the potential to increase producer profitability and simultaneously lower the environmental footprint of beef production [10]. Hence, management strategies to minimize stress and enhance performance and immunity of receiving cattle are warranted.

Therefore, Colombo and his group evaluated the impacts of administering a bovine appeasing substance (BAS) at feedlot entry to receiving cattle [9]. Upon arrival, the steers were assigned to receive 5 mL of BAS or placebo (DE Solvent) topically applied on their nuchal skin

area. Steers were assessed daily for bovine respiratory disease (BRD) signs, and feed intake was recorded from each pen daily. Treated steers enhanced body weight gain in 45-d period by improving feed efficiency. On the other hand, overall incidence of BRD in this experiment was substantial and similar between treatments. Still, interestingly, signs of BRD were detected earlier in BAS steers. Early detection of BRD enhances the efficiency of the antimicrobial treatment corroborating the greater proportion of BAS steers that regained health after the first and did not required a second antimicrobial treatment. In general, improvements of performance of feedlot cattle has been reported when BAS is administrated to animals prior to stressful events, such as weaning and transportation [11-13].

- *Enhancement of meat quality*

As mentioned previously, in the animal production industry, weaning and transport, are well known to have strong detrimental impact in beef cattle health and performance. The physiological stress responses involve the secretion of "stress hormones" such as cortisol and catecholamines (i.e. adrenaline and noradrenaline). Adrenaline is known to cover a key-role in determining the quality of meat. In livestock species, certain preslaughter conditions boost the probability to obtain meat with altered ultimate pH [14].

Available findings reported that the stress during pre-slaughter has effect by reducing pH as well as on meat quality. Moreover, it was demonstrated a negative correlation between the stress level during preslaughter and beef meat physical parameters [15].

Therefore, Cappellozza et al. [11] investigated studied the effect of BAS administration at immediately prior to transport to slaughter on meat pH levels in the post-mortem period, as a indictor of potential meat quality. Generally, beef meat with pH above 6.0 denotes a problem in quality, being also negative for human intake, and determines reduced economic returns [16].

In the current study[11], prior transportation, animals were weighted and received BAS (BAS; n=422) or water (CON; n=413) topically applied to the nuchal skin area of each animal. Meat pH was determined from the 12th rib 48 hours post-mortem. Animals having a meat pH > 5.80 were classified as higher-risks for having dark, firm, and dry (DFD) and was further evaluated

herein. Animals receiving BAS had reduced meat pH vs. their CON cohorts (5.75 vs. 5.82). Also, the risk of dark, firm, and dry (DFD%) cuts was greater ($P < 0.0001$) for CON vs. BAS when pH > 5.80 (42.2 vs. 26.2). In this study, BAS administration to animals prior to transport to slaughter decreased the risk if occurrence of DFD cuts, and maintained the pH at levels below the threshold considered as critical for DFD occurrence.

- *Modulation of immune transcript expression*

Immunomodulation, is the process that involves the use of therapy to modify the immune response, often to prevent tissue damage resulting from an excessive response. It is widely known that under stress the immune system's ability to fight off antigens is reduced. The stress hormone corticosteroid can suppress the effectiveness of the immune system. Appeasing pheromone is an alternative approach to improve bovine health and reduce risk to develop respiratory infections. Positive effects including increased performance and improved early detection of BRD signs were reported in dairy cattle as well as beef cattle[9].

In a recent study, 265 young Charolais bulls aged 317 days were sorted at arrival at the fattening facility and treated with doramectin anthelmintic (Dectomax, Elanco, Sèvres, France), vaccinated once with a vaccine containing modified-live bovine viral diarrhea virus (BVDV) and bovine respiratory syncytial virus (BRSV) (Rispoval RS-BVD, Pfizer, Paris, France), and then weighed [17]. Two treatment groups were then randomly constituted. The pheromone group consisted of 159 young bulls in 14 batches and the control group consisted of 106 young bulls in 9 batches. For a given fattening unit, batches of pheromone and control group had comparable mean weight and included young bulls with similar conformations and from the same farms of origin. Similarly, to previous findings, Hevert et al. found that more respiratory clinical signs were observed in bulls who received the pheromone treatment on Day 8 than in bulls who did not, while it was the opposite on Day 30 [17]. It was identified an increased expression of interleukin 8 transcripts associated with the expression of immune molecules involved in the recruitment of immune cells. Consequently, appeasing pheromones with their capacity to reduce stress and thus

their ability to preserve the functions of the immune system may be an important addition to the proposed reduction the use of antimicrobial substances.

- *Improvement of dairy cow performance*

The effects of a synthetic analogue of the BAP was assessed in dairy cows during the first turning out from tie-stalls to confined lowland pastures [18]. The treatment was administrated every 7 days for 28 days, and milk samples were collected in the same time points. Daily milk production (kg/day) was higher in the treated group compared to control group. In addition, somatic cells count was higher in the control group. Differences in milk composition was not found between groups, except to urea content. Urea (mg/dl) was higher in control group, which suggests a better metabolic balance in the group treated with pheromone. The researchers concluded that: "The use of BAP appears to modulate adaptation in ways that may improve dairy cow performance in the context of changes in management routines".

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LARGE ANIMAL PROCEEDINGS

June 4–6, 2023

Ins & Outs of the USDA Veterinary Medical Loan Repayment & Veterinary Services Grant Programs

Brian Lubbers, DVM, PhD, DACVCP, Kansas State University
Brad White, DVM, MS, Kansas State University

KANSAS STATE UNIVERSITY | College of Veterinary Medicine

2023 Annual Conference for Veterinarians Proceedings

Ins & Outs of the USDA Veterinary Medical Loan Repayment and Veterinary Services Grant Programs

Brian V. Lubbers, DVM, PhD, DACVCP / Bradley J. White, DVM, MS

Veterinary Medical Loan Repayment Program Overview

The Veterinary Medical Loan Repayment Program (VMLRP) was authorized by the National Veterinary Medical Services Act to assist qualified veterinarians by offsetting veterinary medical educational debt in exchange for providing services in specific veterinary shortage situations. Detailed information regarding the VMLRP can be found on the USDA National Institute of Food and Agriculture (NIFA) website[1]; this presentation will serve to familiarize the audience with the basics of this loan repayment program.

To initiate the VMLRP cycle, NIFA solicits shortage nominations from state animal health officials (SAHOs). Each state is allocated a maximum number of shortage areas based on livestock sales data and total land area. For example, in fiscal years 2023-2025, the state of Kansas may nominate up to 7 shortage areas per year under the VMLRP program. The SAHO shortage nomination includes the following information:

- Shortage situation location
- Shortage situation type
    - Type I – 80% FTE Food Animal Practice (any location)
    - Type II – at least 30% FTE Food Animal Practice (rural area)
    - Type III – at least 49% FTE Public Practice
- Must serve & May serve animal species
- Importance / Objectives of the veterinarian filling the shortage area
- Veterinary medical activities to be conducted in the shortage area
- Recruiting / Retention efforts for the shortage area
- Consequences of not securing veterinary presence in the shortage area

Once veterinary shortage areas are reviewed and approved, the nominations are posted to the NIFA website and are opened to applications from veterinarians. A complete VMLRP application includes the applicant information form, professional narrative, 3 recommendation letters, loan information forms and an intent of employment signed by the hiring official. Each applicant may only apply to one (1) designated shortage area in a given year. To be eligible, the applicant must:

- Have a DVM from an AVMA-accredited institution
- Have minimum qualifying educational debt [$15,000]
- Secure employment or establish/maintain a veterinary practice in the given shortage area
- Have no other veterinary service obligations
- Not have federal judgment liens against their property from federal debt

Shortage situation applications undergo a competitive review process. If a VMLRP award is made, the applicant is contractually obligated to serve in that shortage area for three (3) years with loan repayment up to $25,000 per year with an additional tax allowance of 39% made on behalf of the

awardee. VMLRP payments are made directly to the loan servicer on a quarterly basis following verification of service and documentation of previous payment received by the lender. At the conclusion of the original service term, if an applicant has remaining eligible debt and they continue to serve in the original shortage area, they may apply to the VMLRP program as a renewal applicant. Renewal applications apply even if the shortage area is not re-nominated for VMLRP consideration, but they undergo the same competitive review. If a renewal award is made, the contract may be for an additional 1, 2 or 3 years depending on the remaining eligible debt of the applicant.

VMLRP summary statistics

In 2021 (most recent published report), 129 new applications and 15 renewal applications were reviewed with 78 awards made (54% award rate – 52% for new applicants, 73% for renewals).

Kansas State University – College of Veterinary Medicine graduates were very competitive in the 2021 VMLRP cycle. Overall, there were 9 new applications submitted by KSU alumni, with 3 awards made (out of 67 total new awards). KSU-CVM graduates also submitted 3 renewal applications, with all 3 being awarded (out of a total of 11 renewal awards nationally).

Application success rates were highest for veterinarians 4 -6 years post-graduation (59% award rate), followed closely by veterinarians with 1-3 years of experience (57% award rate) and applicants with less than 1 year of practice experience (55%).

Tips for writing a competitive application (Dr. Lubbers' suggestions)

1. Make sure you have submitted all application materials

Incomplete applications don't make it through the administrative review. Start the application process early and make sure you understand exactly what needs to be submitted. If you don't understand something, email the USDA at vmlrp@usda.gov

2. Read the nomination for the specific shortage area for which you are applying

One of the most important criteria that review panels will consider when reading your application is the strength of "match" between the applicant and the need. Specifically, what has the SAHO listed in the Objectives and Activities sections of the nomination form and how do you intend to meet those needs? For example, if the SAHO describes the importance of establishing VCPRs with small ruminant clients for oversight of VFDs and providing health certificates and you only describe your interest in swine production in your application, you have not submitted a competitive application. The nomination form also serves as the basis for your service contract, so understanding what is needed will help you determine if it is reasonable for you to complete your service.

3. Be specific (and passionate)

Specific details in your professional narrative generally make for a more competitive application. Applications written with a vision and a specific plan to achieve that vision are often strongly considered. Have a business plan? Great, describe it. Love rural life? Awesome, put it in your application.

Your application is judged against applications for every shortage situation throughout the United States, you have to convince the review panel why you are the best investment of funding resources.

Veterinary Services Grant Program

The Veterinary Services Grant Program (VSGP) is operated by the USDA and has two funding opportunities: the Education, Extension, and Training (EET) and Rural Practice Enhancement (RPE). Each program has specific requirements which can be found in the request for proposals[2]. This website also offers an online training webinar and more information about applying for the program. The goal of this portion of the presentation is to describe the RPE program and provide information for applications for this section of the VSGP.

The goal of the RPE program as stated on the USDA website is to "ultimately bolster the capacity of private clinics that provide food/large animal veterinary services in designated veterinarian shortage situations". Specific projects should address needs in their area and how the proposal will enhance the practice's ability to meet the shortage needs. Individuals or practices that operate a veterinary clinic in a rural and designated shortage area are eligible to apply. The RPE is awarded to the practice which is different from the VMLRP which is awarded to the individual that applied.

Specific terms for funding are listed in the request for applications, and for FY2023 maximum award is for $125,000 for up to 36 months. Fundable activities include purchasing equipment for care of food animals, some practice operational costs (there are limitations), establishing mobile facilities, and supporting exposure of students in grades 11 to 12 on career opportunities. The grant does not support building facilities, expansion or remodeling. For questions on if the potential item is eligible for grant funding contact the USDA program representative. Previously funded RPE projects are listed on the website and this can be valuable information to review when preparing a proposal.

The RPE practice must be in a designated shortage area and the shortage areas can be found on the USDA website as they change annually. Each shortage area should include a description of the specific need for that location. Applications should include the shortage area in the title and ideally have a map of the practice area with an overlay of the shortage area to clearly illustrate how much of the shortage situation will be addressed by the practice.

The request for applications contains valuable information regarding preparation of the proposal. Carefully follow the instructions in this document to insure eligibility and have the greatest chance for funding. Each application is reviewed by a peer panel and scoring is based on both expertise and experience of the practice and the technical merit of the proposal. Components of the RPE application include project overview/summary, project narrative, senior person profile, budget, budget justification, and data management plan. Each section has specific guidelines that must be followed to have an eligible application.

When writing a proposal be sure to allow enough time to complete all components of the application. A few tips include:

- Create a clear, concise objective to specifically meet the shortage in your area
- Use a business plan approach including describing the strategy and how this will address the shortage
- Include how the grant will lead to long-term success
- Tell a compelling story

The VSGP RPE program is an opportunity to receive funding for rural practices in eligible USDA designated shortage areas. If you are considering applying focus on the request for applications for specific details in the proposal.

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LARGE ANIMAL PROCEEDINGS

June 4–6, 2023

Frequency of Pulmonary Lesions in Feedlot Mortalities

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KANSAS STATE UNIVERSITY | College of Veterinary Medicine

KSU June Conference Proceedings

Frequency of Pulmonary Lesions in Feedlot Mortalities

Paige H. Schmidt and Brad J. White

Bronchopneumonia (BP) is the most common cause of morbidity and mortality among feedlot cattle, which leads to severe economical and production losses. Through continued focus on BP management, and proper therapeutics, there is seemingly a lack of research when it comes to other respiratory diseases, and pathological lesions in various organ systems, as cattle progress to slaughter. Necropsy is a vitally important, and irreplaceable procedure in bovine medicine, where it is useful for the diagnosis of disease in individual animals. The use of this procedure in feedyards is sporadic and limited. Post-mortem examination in cases of respiratory disease must not only focus on the respiratory system, but also for lesions in other corresponding organs. Currently, most mortality diagnoses are limited to one disease syndrome, and the frequency of concurrent disease or other pathological syndromes is poorly documented. The study objective was to utilize gross necropsy to determine the frequency of pulmonary lesions associated with three major diagnoses: acute interstitial pneumonia (AIP), bronchopneumonia (BP), and bronchopneumonia with an interstitial pattern (BIP). We assessed the accuracy of recognizing AIP, BP, and BIP gross respiratory lesions to corresponding histopathological samples and if there was consistency between diagnosis throughout the four lung samples collected. Primary focus was placed on the respiratory system, however, all major organ systems were evaluated and considered for mortality contribution.

Full systemic necropsies were conducted in groups of two veterinary technicians with one technician performing the postmortem examination and determining the pathological gross lesions. Postmortem diagnoses based on gross findings were confirmed by a veterinarian. All necropsies were documented, and photographs were collected. Necropsies were performed on feedyard mortalities, with minimal autolysis, from June – July 2022 at six Kansas feedyards. Four hundred and two systemic necropsies were performed, with the majority of cattle being native origin and black-hided. Additionally, 2/3 of the cattle were heifers which aligned with the live cattle enrollment.

Gross pathological pulmonary lesions were categorized into four areas: BP, AIP, BIP, and Undifferentiated. Diagnosis of BP was based on a variety of characteristics reported in previous research including lung consolidation, interlobular fibrinous material, pulmonary abscesses, firm/rubbery texture of lungs by palpation, and apparent bacterial infections. Cattle diagnosed with AIP lesions had diffuse, overinflated lung lobes, intralobular edema and emphysema, and pulmonary lobules varied in color from light pink to dark red leaving a “checkerboard” appearance which has been described in previous research. Lung lesions that expressed characteristics of both bronchopneumonia and an interstitial pattern were diagnosed with a respiratory lesion of BIP. Gross pathological lesions for BIP typically included a diagnosis of BP in the cranioventral lung lobes and a diagnosis of interstitial pneumonia in the caudodorsal regions of the lungs. A line of demarcation was often noted between the two pathological processes within the lungs. Respiratory lesions that did not meet the above criteria (AIP, BP, or BIP) were

recorded and documented but categorized as an Undifferentiated pulmonary lesion for the purpose of this study (i.e. Embolic pneumonia).

Due to resource allocations, lung samples were collected from the first 9-11 mortalities at each feedyard each week. Regardless of the number of mortalities and postmortem diagnoses, a maximum of 11 samples were taken from one feedyard in a week. Pulmonary histopathology samples were collected as a 1 cm x 1 cm square from four areas of the lung: right cranioventral, left cranioventral, right caudodorsal and left caudodorsal lung lobes. If applicable, samples were obtained at the junction between grossly diseased and non-diseased lung tissue. Lung samples were processed and digitalized for histopathology evaluation.

Using gross diagnosis, BP represented 36.6% of cases with AIP and BIP representing 10.0% and 35.8%, respectively. Histopathological diagnosis had similar findings; BP represented 32.3% of cases, with AIP and BIP pneumonia representing 12.2% and 36.0%, respectively. The two diagnostic modalities tended to be associated (*p*-VALUE = 0.06).

Further organ evaluation concluded:

- 87% of cases had 2 or more concurrent lesions.
- On average there were 2.8 lesions per mortality.
- 6.6% of cases contain liver abscesses.
- Heart lesions were associated with having a greater left and right ventricular lumen.
- 40.2% of heifers necropsied were lactating, with a strong association for heifers greater than 30 days on feed.

Results from this study indicated that pulmonary lesions are frequent in deceased feedlot cattle with BP and BIP representing the two most common syndromes. The BIP diagnosis has been infrequently acknowledged as a specific pulmonary lesion, but an improved understanding of this syndrome may play a role in identifying improved prevention and control measures. Refining mortality diagnostics and creating more specific descriptions of pulmonary lesions at death can facilitate better understanding of pathologic processes and appropriate therapeutic interventions. In addition, full systemic necropsies are necessary to obtain a full overview of the lesions and disease processes present at the time of death in feedlot mortalities.

Additional Authors:
Abigail Finley, Eduarda M. Bortoluzzi, Brandon E. Depenbusch, Maddie Mancke, Rachel E. Brown, Makenna Jensen, Phillip A. Lancaster, and Robert L. Larson

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LARGE ANIMAL PROCEEDINGS

June 4–6, 2023

Penile Lesions Resulting in Bull BSE Failure & Options for Resolution

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KANSAS STATE UNIVERSITY | College of Veterinary Medicine

Penile Lesions resulting in bull BSE failure and options for resolution.

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Clinical Professor, KSU-VHC Livestock Services Section

Objectives and Summary

Acute injuries often go unnoticed at the time of occurrence and may not be detected until the time of BSE. Common congenital and structural lesions also present during extension at exam. Collectively, bull genital problems are challenging situations requiring us to make an accurate assessment of the problem, institute appropriate case management, and frequently reassess each situation individually. Regarding genital problems common in young bulls, there are not always clear criteria for culling at initial BSE and not all bulls predictably respond to therapy if attempted. Breeding injuries are also difficult to advise clients wanting to treat on the potential for future soundness after management. This presentation will include the problems we face in young and old bulls, examination and assessment guidelines for intervention (or Not), and management tools for treatment when indicated.

Goals:

* Diagnose Genital problems in Young and Older Bulls at BSE.

* Treatment goals for acute injury are to decrease inflammation and edema, eliminate infection, and prevent additional trauma while reassessing for potential posthioplasty when healed. Majority will heal without the need for surgery.

* Considerations of common problems in young bulls…. Frenula and papillomas.

Pudendal Nerve block for maintaining penile exposure

The Pudendal nerve block is a technique of anesthetizing the internal pudendal, caudal rectal, and pelvic splanchnic nerves. This allows relaxation of the retractor penis muscle by blocking these motor fibers. Sensory nerve fibers supplying the penile and prepucial mucosa are not sufficiently blocked for surgical anesthesia, therefore a local dermal block or penile ring block are needed for surgery in that area. The primary action of the pudendal block is to allow and retain exposure of the penis for surgery when general anesthesia is not utilized for surgery. As with other local anesthetics, the effects of the block will last a couple of hours, therefore a retaining bandage may need to be applied to retain the penis in the sheath until tone returns.

Equipment needed for the procedure will be a 5 to 6 inch spinal needle or long catheter stylet**.** About 20 to 25 ml of 2% lidocaine per side (40 to 50 ml total) will be deposited around the nerves. Disinfect the perianal region with antiseptic and alcohol, a tail tie is optional. Rectally palpate the sacrosciatic ligament and sciatic foramen within the pelvis on one side about wrist to mid forearm anterior to the anus. The internal pudendal artery should be appreciated at the ventral aspect of the sacrosciatic foramen to be avoided when the needle is passed peri-rectally toward the nerves. Pass the needle peri-anal and peri-rectal with one hand while the other remains within the rectum to be able to appreciate the depth of the needle and avoid entering the rectum.(figures 1 and 2) Deposit 15-25 mls

of 2% lidocaine at this depth in approximately a 2-3 cm diffusion dorsal and ventral. Repeat the procedure on the other side.

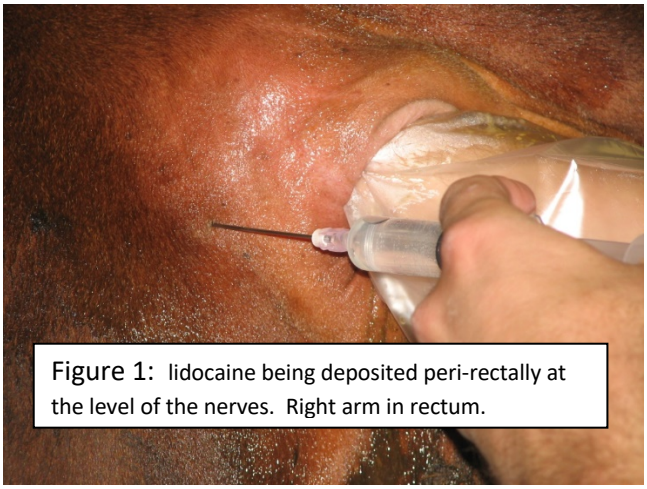


Figure 1: lidocaine being deposited peri-rectally at the level of the nerves. Right arm in rectum.

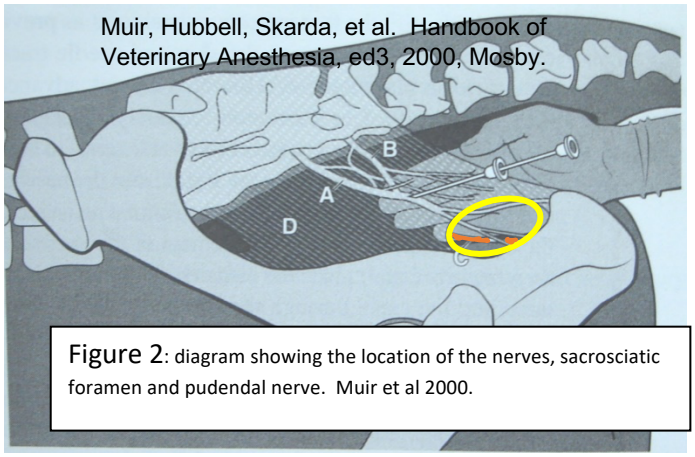


Figure 2: diagram showing the location of the nerves, sacrosciatic foramen and pudendal nerve. Muir et al 2000.

Relaxation of the penis should be evident within 5 minutes if the block was successful. It will persist for a couple of hours, so the exposed penis should be protected with a retainer pessary bandage until the bull can retract the penis. Remember this block is good for motor nerve blockade but not sufficient sensory for surgery.

Young Bull Pre-breeding Genital Problems

Persistent Frenulum

Persistent Frenulum is detected in young bulls during initial breeding soundness examination. If left undetected, it can serve as a risk factor for injury as the young bull attempts to breed. Hence the importance of observing extension during BSE. At birth the penis is attached diffusely to the preputial mucosa. The attachment begins breaking down after the first month of life and the penis should normally be free by 1 year of age. The separation process is mediated by testosterone and sexual maturation. Failure to completely separate is considered a heritable condition and delayed maturity. Mostly likely, this trait is autosomal recessive and bulls having this problem should only be used for service in commercial herds if surgical correction is attempted.[1](Steffen et al, 1997)

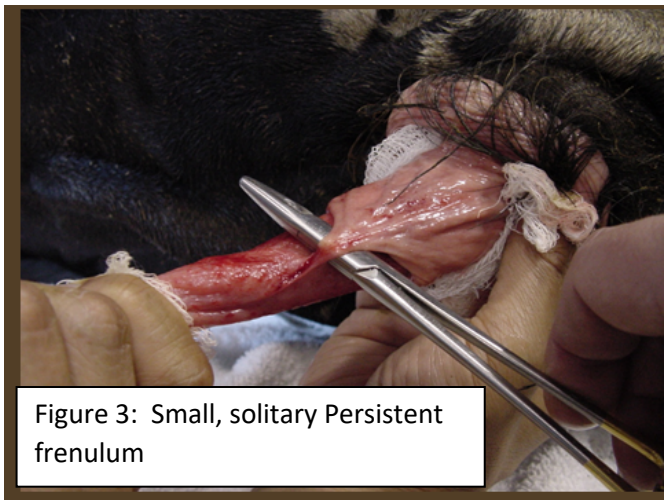


Figure 3: Small, solitary Persistent frenulum

Considerations on orientation of the frenula should also be taken into account when deciding to treat. Isolated bands of tissue can be crushed with hemostats and separated or ligated for removal. (Figure 3) Frenula can have a robust blood supply in some instances. All bulls should be rechecked two weeks later to assure healing and that other lesions, ie fibropapilloma, has not developed. Some persistence is diffuse (Figure 4) and can be manually separated with reasonable pressure. Note the size and appearance of the penis and if it appears grossly underdeveloped (hypospadias), the bull should be eliminated as a satisfactory breeder. Some frenula attach intimately with the entire glans penis. Frenula in this orientation are robust and could prevent normal copulation by removing the function of the glans in locating and penetrating the female. The author chooses to cull these bulls as I cannot safely remove the frenulum from the glans without significant scar tissue/fistula formation and I cannot be confident in his pasture breeding soundness.

Figure 4: Diffuse failure to detach. Appears similar to Velcro.

Papilloma/Fibropapilloma

Penile warts, caused by Bovine Papilloma Virus (BPV), are common in young bulls up to 2 years of age. In what appears to be an age related immunity, most will be able to clear the mass(es) by 15-18months. Some will be unable to clear them regardless of age. There are over 10 types of BPV, with BPV-1 being the type with tissue tropism for the penis. BPV-1 is fibro-papilloma with a tendency to invade the dermis and sub-dermis BPV-1 is also the only cross species papilloma virus, infecting horses and involved with sarcoids.(Nasir,Campo; 2008) Fibro-papillomas are the most concerning as they invade the deeper tissues beyond the dermis. Vaccines will reduce the number of bulls experiencing warts in a population but provide inconsistent immunity at an individual level. With both commercial and autogenous vaccines, severity and number is reduced in vaccinated individuals, yet adjunct therapy in conjunction with manual removal has proven inconsistent. Using Amplimune™, a mycobacterium cell wall fraction immune-stimulant labeled for calves against early exposure to E. coli, is off-label with mere anecdotal evidence for efficacy.

Bulls must be free of warts to pass breeding soundness, limit transmission to cows, avoid damage to the bull penis, as well as just limiting fertility should bleeding at intromission occur. Manual removal may stimulate immunity during an inflammatory response. Location and orientation of the wart as well as individual response will determine outcome. Like the frenulum covering the glans penis, warts closely associated with the glans will result in scar tissue at removal. Invasive fibro-papillomas may extend into the corpus cavernosum penis, elastic tunics, and urethra, posing complications for removal. CO2 laser therapy is applied with some frequency by the author having many positive outcomes.(Figure 5) CO2 laser removal provides a more controlled debridement, less hemorrhage, and a base of tissue to hopefully stimulate an immune response. Multiple repeat sessions may be required and some bulls fail to respond.

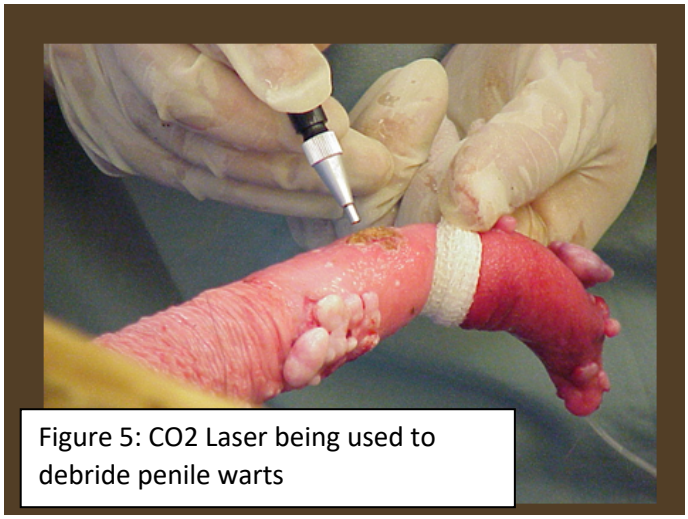
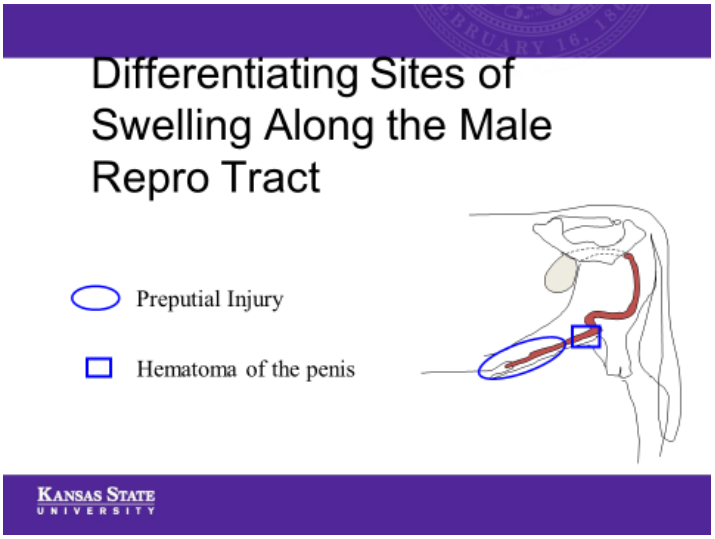


Figure 5: CO2 Laser being used to debride penile warts

Penile and Preputial Injury



<u>Preputial Trauma</u>

Preputial trauma can occur at breeding, environmental hazards, self-inflicted, or iatrogenic during collection or trichomoniasis testing. Only the latter causes are addressed acutely, lending opportunity for primary repair and early medical therapy. Most of the injuries that occur on pasture are discovered after the swelling becomes significant. Most of the time when the swelling is noticed, infection is already present and surgical options are off the table for immediate planning. When detected at routine BSE, try to determine if any potential trauma was noticed and when. Often detection at BSE is in the healed stage, however, timing is such that is surgery is performed, the bull will likely miss the upcoming breeding season due to healing time after surgery.

The goals of acute preputial trauma management are to 1) Reduce swelling and limit further trauma, 2) address infection, 3) retain exposed prepuce back into the sheath and 4) reassess for possible restrictive scar tissue. As with hematoma injuries, consider these bulls out for the season.

Prioritize medical management to quiet the injury and start the remodeling process. Surgery should only be considered once the acute injury has healed and infection is not present. Any scalpel application early would be limited to trimming granulation and necrotic tissue from an exposed prolapse to facilitate reduction and retention into the sheath. Avoid removing any tissue that could benefit healing in the end. The majority of preputial lacerations will heal appropriately without the need for posthioplasty. At BSE time, often a healed scar is all that is noticed and if restriction to extension is not evident, the bull should be an adequate breeder. If posthioplasty is needed the bull will need to have twice the amount of prepuce as free portion of penis after surgery for natural service. This is most important in breeds such as Angus with shorter preputial length. Here at KSU, I plan on acute medical management until the bull can retain the prepuce and then recheck in 60 days at the earliest. Most will be able to extend without restrictions.

If we detect a past injury at BSE, we try to fully extend the bull for assessment of the amount of scar tissue to remove. What if he can't extend? Then we discuss the unknown and make the decision on a case by case basis as to if he is worth the attempt knowing we may not be able to resolve the restriction after exploratory. For those that will need surgery we plan such that the surgery can take place and the bull will have a minimum of 60days postoperative before checking for soundness at that time and hopefully being healed for the next breeding season.

Prognosis on preputial scar revision is based largely on the ability to partially extend the penis to visualize the amount of scar tissue that will need resected. (Figure 6) If the penis cannot be exteriorized, we are unable to know how much restrictive tissue will be present and a greater amount of dissection through the exterior portion of prepuce will be required possibly causing additional restrictions. Ideally all scar tissue is dissected free from the lesion and healthy mucosa is re-apposed.(Figure 7) Meticulous hemostasis, cleanliness, and absorbable suture material in interrupted apposition should be the technique. Immediate post operative management to prevent prolapse of the surgical site in critical for success. If the wound prolapses and not immediately replaced, severe edema and dehiscence of the surgical site is likely. A pessary tube bandage should remain in place for 3-5 days, at which time it is removed and surgical site evaluated. A second pessary bandage is often placed and removed again at 3-5 days. Monitor for the ability to retain the penis within the sheath, at which time the bull can be kept on strict sexual rest for 45-60 days and rechecked.

Figure 6: Scar tissue to be resected is visualized

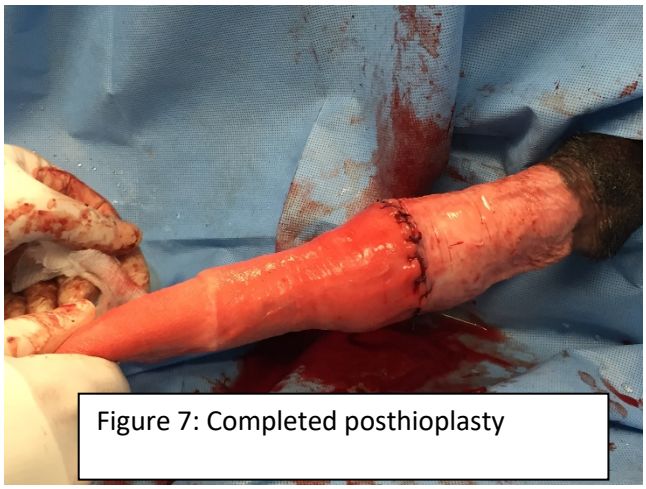


Figure 7: Completed posthioplasty

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LARGE ANIMAL PROCEEDINGS

June 4–6, 2023

Bovine Theileriosis: An Update

Gregg Hanzlicek, DVM, PhD, Kansas State University

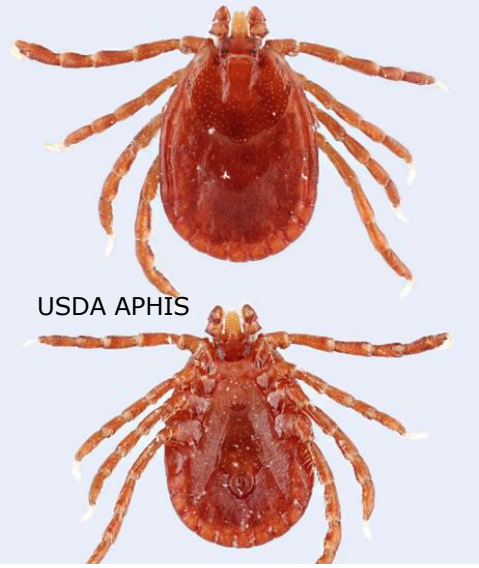
KANSAS STATE UNIVERSITY | College of Veterinary Medicine

Bovine Theileriosis: An update

Gregg A. Hanzlicek, DVM, PhD, PAS

The Asian Longhorned Tick (also called the cattle, bush, East Asian or scrub tick), scientific name *Haemaphysalis longicornis* has been in the U.S. since 2010. Although it is unknown, researchers believe entry into the U.S. likely occurred through the importation of cattle either from Japan or Australia.

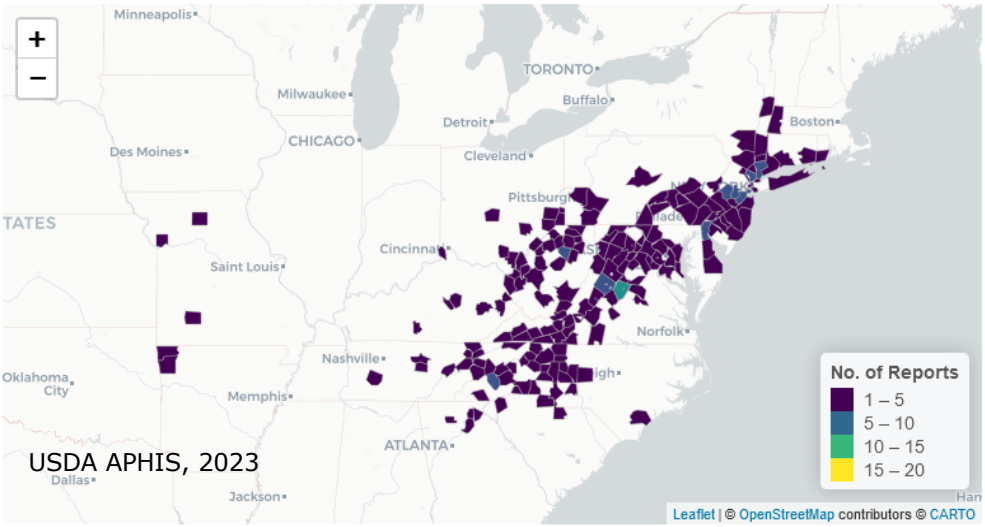
Ventral and dorsal view of the female *H. longicornis*.



USDA APHIS

It has been found in 18 states. To the author's knowledge it has not been found in Kansas, but it has been reported in western Arkansas and Missouri.

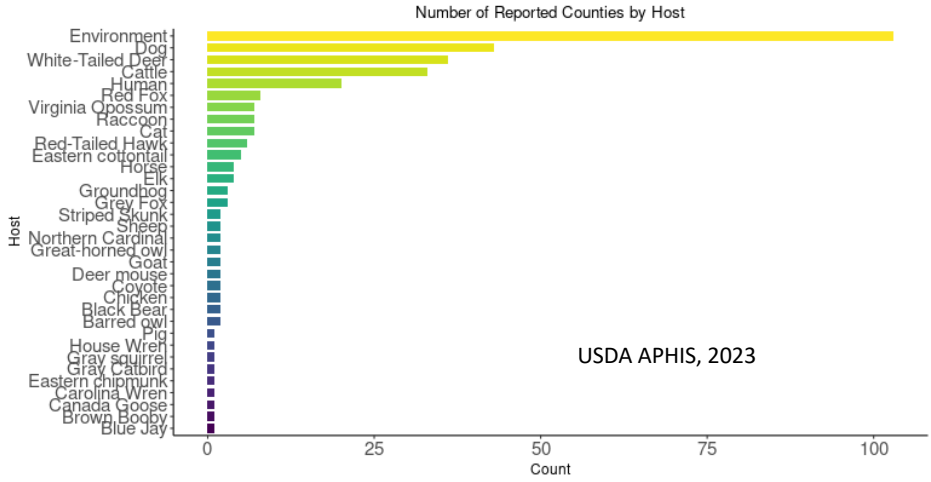
States and counties where *H. longicornis* have been identified.



USDA APHIS, 2023

This tick is somewhat unique because it is parthenogenic; males are not needed for offspring production. To the author's knowledge, male *H. longicornis* ticks have not been found in the U.S. After feeding to repletion, females fall off the animal and proceed to lay more than 1,000 to 2,000 eggs.

The Longhorned tick can be found on most domestic animals including dogs, cats, horses, cattle, sheep, and goats, and on a variety of wild animals including cervids, several bird species, raccoons, and opossums.



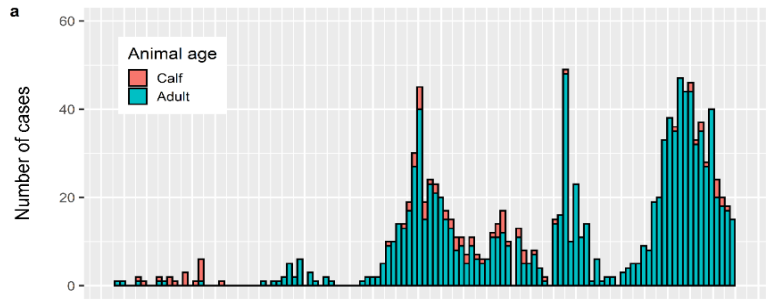
Longhorned ticks are not believed to be a carrier of *Borrelia burgdorferi* (Lyme disease), *Anaplasma marginale* (Bovine anaplasmosis), *Anaplasma phagocytophilum* (Canine anaplasmosis). Experimentally, this tick has been able to carry *Rickettsia rickettsia* (Rocky Mountain spotted fever).

H. longicornis can affect the health of bovines in two ways: 1) because the number of ticks on a single animal can be large, blood-loss anemia can occur. 2) through the transmission of *Theileria orientalis* which results in RBC infection and subsequent splenic removal resulting in anemia similar to *A. marginale.*

All other known U.S. tick species are not known to carry *T. orientalis*, although some researchers believe black flies, stable flies, sucking lice, and needles may transmit this disease.

There are eleven *T. orientalis* genotypes in the U.S. and the world, only Ikeda and Chitose are thought to be pathogenic in cattle.

The prepatent period is reported as low as 10 days to 30-45 days. Clinical signs include, anemia, abortion, fever, weakness, icterus, death, chronic poor-performance, reduction in milk production. All ages of animals are at risk of infection. Unlike other blood borne diseases (anaplasmosis) *T. orientalis* clinical signs are commonly observed in young calves. The histogram below is from an outbreak in Australia, indicating that number of young calves that expressed clinical signs.



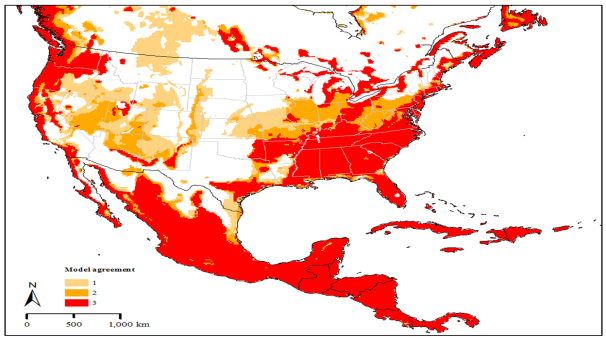
Mortalities are relatively low in most cases; most animals recover and become life-long carriers. Reoccurring clinical signs are rare but have been reported in carrier animals during times of stress such as late gestation, lactation, and transport.

T. orientalis appears to be resistant to most common antimicrobials. One antimicrobial, available in New Zealand has been shown to be effective. It is not available in the U.S. and most other countries. Veterinarians from Australia and New Zealand who have been involved in *T. orientalis* outbreaks for many years, report that blood transfusions are the best treatment when practical.

T. orientalis control is based on controlling *H. longicornis* through acaracides. Although most products are effective in preventing heavy tick infestations, they do not prevent all infestations. Research has shown that one *H. longicornis* tick is capable of transmitting *T. orientalis* resulting in disease.

That *H. longicornis* appears to be necessary in the maintenance of *T. orientalis*, what areas of the U.S. can be expected to become infested? Depending on the life-stage these ticks can be found in geographical areas with ambient temperatures between 52 and 100° Fahrenheit. Several models have been composed to predict where *H. longicornis* will likely be able to survive.

Potential spatial distribution of *H. longicornis*. The darker areas indicate more agreement among models.



Results from another research model indicating the most likely geographical areas to find *H. longicornis.*

Other considerations when investigating cases of anemia include, A. marginale, Lepto sp., autoimmune disease (single cases)

Diagnostic options for *T. orientalis* are somewhat limited. In cases of suspected acute infections, microscopic examination of stained blood smears can be effective. KSVDL has developed a PCR that is sensitive and be used to identify both acute and carrier-state animals. It targets *A. marginale* and the two pathogenic *T. orientalis* genotypes. Unfortunately, there is no antibody (ELISA) test available in the U.S. for carrier-state determination.

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LARGE ANIMAL PROCEEDINGS

June 4–6, 2023

Update on Management of Calf Scours

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Practical evaluation of the critical neonate

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Neonatal calf scours (NCS) are a significant cause of preweaning mortality in beef calves. In the most recent summary of fecal samples submitted for PCR analysis at the Kansas State Veterinary Diagnostic Laboratory, rota, rota-corona and corona virus were the most common etiologies[1]. Viral diarrhea results in significant fluid and electrolyte derangements leading to dehydration, depressed mentation, anorexia, septicemia and death.

The basis for treatment of NCS is restoring hydration, correcting metabolic derangements and providing nutrition. In addition to life threatening dehydration and metabolic abnormalities, 1 out of 3 calves will develop neonatal septicemia[2]. Without laboratory diagnostics it can be difficult to accurately identify septicemic calves. Many of the clinical variables are indistinguishable between a non-septic and septic calf. However, initial physical examination of scouring calves can provide critical information to guide prognosis and refine therapy. It is important to accurately identify these calves because prognosis is poor, and treatment is often unrewarding. Lofstedt and others identified clinical criteria that increase the likelihood of a calf being septic[2]. Specifically, those calves with NCS that have a focal source of infection are at higher risk of being septicemic[2]. In a large retrospective analysis of calves with NCS, clinical factors in the first 48 hours associated with increased risk of non-survival included, cachexia, complicated umbilical infections, pneumonia, neurologic signs or abdominal emergencies[3]. The nature and severity of the underlying disease rather than the blood pH alone had a more important effect on survival[4].

Important physical exam findings in calves with NCS

- Absent palpebral – indicative of d-lactic acidosis
- % dehydration estimation in neonatal calves[5] = [eye ball recession (mm) x 1.6]
- Focal source of infection (umbilicus, joint, meningitis, pneumonia) associated with increased likelihood of septicemia[2]

General comments regarding IV fluid therapy[4]

- Dehydrated calves without a suckle need IV fluids
- IV fluids *superior route* of fluid administration for rapid resuscitation of dehydrated calves[6]
- Volume of fluid to correct dehydration: at least 3-5 L (8% dehydrated x 50kg BW)
- IV fluids should be warmed to body temperature

General principles of antibiotic therapy[7]

- Not all calves with NCS need antibiotics
- Calves with NCS and clinical signs of systemic disease warrant antibiotic therapy
- Antibiotic therapy is directed at decreasing number of coliform bacteria in the gastrointestinal system and prevent bacteremia

- % of calves with bacteremia higher in calves with failure of transfer of passive immunity
- Oral sulfonamides cannot be recommended for treating calves with NCS due to lack of efficacy studies
- Parenteral ampicillin likely to be effective in calves with NCS
- Enrofloxacin is not labeled for NCS in the United States and therefore is illegal when given solely for the treatment of NCS

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LARGE ANIMAL PROCEEDINGS

June 4–6, 2023

Developing a Customized Vaccination Protocol for each Cow-Calf Client

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Developing a customized vaccination protocol for each cow-calf client

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Abstract
Each beef cow-calf business is unique and deserves to have a customized vaccination and herd health protocol. The best way to develop this protocol is for the herd health veterinarian to ask numerous questions about the beef business. The first question I always ask is, "tell me about your current herd health protocol." Follow up questions may include, "what disease issues have you had in the past; how was the protocol developed; what is your goal for this plan?

Key words: vaccine, herd health, protocol, parasite, refugia

Introduction
Studies have shown that producers feel their herd is unique and they do not want a 'cookie cutter' protocol.[1] Design a protocol specifically for them.

Core vaccinations - calves
One of the first items to establish is what do you as the herd health veterinarian feel are 'core' vaccinations. Do calves receive vaccines for BRD at 2-3 months of age? What about Clostridial diseases? Most veterinarians would consider these two as core vaccines.

The BRD vaccines are available as modified live virus (MLV) and inactivated (killed) with the MLV vaccines available as intranasal (IN) or parenteral (SQ or IM). These choices of types and routes show the complexity of the issue. A herd in Kansas that calves in a barn in January should have a different protocol than one that calves in May on pasture.

Numerous studies conclude that using MLV vaccine in these young calves provides a more robust immune response compared to inactivated vaccine. Repeating these vaccines approximately 4 weeks before or at weaning is recommended.

With regard to the MLV options, Chamarro and Palomares published a meta-analysis in the Vet Clinics of North America and asked the question*, "Are modified-live virus intranasal and parenteral vaccines similarly effective for providing clinical protection against bovine respiratory disease in beef calves?"* [2]

They conclude from the studies that, "*There is limited, moderate-quality evidence that vaccination of beef calves with parenteral multivalent MLV vaccines is superior to IN MLV vaccines on reducing BRD-associated morbidity and mortality after experimental challenge with BVDV, BHV-1, or BRSV."* [2]

Vaccines that would be considered 'optional' may include "pinkeye" vaccines, *Manheimmia haemolytica, Pasteurella multocida, Histophilus somni,* among others.

Core vaccinations – cows and bulls
For the cowherd there is also controversy on what to use and when. Core vaccines for most would include IBR, BVD and Leptospirosis. MLV vaccines are labeled to be given at least 30 days prebreeding or they can be given when cows are pregnant IF the same MLV vaccine was used in the previous 12 months. If pregnant cows are given parenteral MLV IBR vaccine and they have not been previously vaccinated with the same product or have not been exposed to IBR, abortion due to the vaccine strain of IBR can occur.

When comparing using MLV vs. inactivated prebreeding, Perry *et. al.* showed "*a*t 56 days after AI, MLV animals (88.9 ± 2%) had decreased pregnancy success compared to both the Inactivated (93.2 ± 2%) and Control groups (92.5 ± 2%, P ≤ 0.01)*"*.[3]

Walz et. al. performed a 32-month long research study where 75 heifers were given MLV BRD vaccine or saline at weaning and prebreeding. The MLV vaccinated heifers were split into 2 groups where half received MLV, and the remainder received inactivated vaccine soon after pregnancy check. The following year at pregnancy check animals received the same vaccine (MLV or inactivated). All heifers were exposed to BVD PI steers 95-111 days after timed artificial insemination (TIA) and then inoculated with IBR virus IV 210 days after TAI. The conclusion was "*This research demonstrates efficacy of administering two pre-breeding doses of MLV vaccine with annual revaccination using CV vaccine to prevent fetal loss due to exposure to BVDV and BoHV-1."*[4]

If herds do not or are unable to vaccinate cows prebreeding, vaccination at the time of pregnancy examination with an inactivated vaccine seems to be a reasonable alternative.

Leptospirosis would be considered a core vaccine in many parts of the US. The questions would be whether to use the "HB" strain - *Leptospira borgpetersenii* serovar *hardjo* type hardjo-bovis.

Vaccines that would be considered 'optional' may include "pinkeye" vaccines and *Campylobacter fetus* among others*.* Many herd owners vaccinate cows in late gestation to enhance colostral immunity against pathogens such as Rotavirus, Coronavirus, E. coli and Clostridium perfringens type C.

Bulls receive vaccines similar to the cows less those given to enhance colostral immunity. Since footrot in bulls can be hugely impactful on their ability to breed cows while lame, many herd owners vaccinate bulls against *Fusobacterium necrophorum* when a breeding soundness examination (BSE) is performed.

Internal parasite control
During my 40-year veterinary career, I have seen numerous internal parasite control programs, some of which enhanced the development of resistance to our parasiticides. The development of refugia (untreated animals that should not have parasites resistant to some anthelmintics) in the herd has become much more accepted. While this paper is not meant to have 'the answer' to an internal parasite program, some conclusions can be made according to Navarre. "*A general recommendation for maintaining refugia in cow-calf operations is leave adult females 4 years of age and older untreated.*"[5] A colleague at Elanco used the phrase '*4 score and under 4'* for a starting place on which cows to treat for internal parasites, meaning cows with body condition score (BCS) 4/9 or lower and those under 4 years of age are dewormed. The goal is not to "kill all the worms" as many of us were taught in veterinary school, but to have internal parasites at a level where little to no economic losses occur.

I attended a talk on strategic deworming and the benefit of refugia recently. The speaker showed a picture of a pregnant, mature beef cow in BCS 5.5 with a tremendous 6-month-old calf weighing about 650# at side. He said, “whatever internal parasites are in that cow, I want them on my pasture”. That statement really resonated with me.

External parasite control

Controlling flies is a goal of many producers. The key is to not apply fly control products to the animals too early. Conversely, if a feed through product is used in the mineral, these need to be started 30 days before the expectation of flies in the spring.

The recommendation is to apply pour-ons, sprays and/or insecticide ear tags when there are approximately 200 horn flies per adult cow.[6] Horn flies bite the animal up to 30 times per day so 200 flies equate to over 300 bites/hour in an 18-hour period.[6] Our cattle deserve to be protected.

Face flies can spread pinkeye, so control of face flies is also paramount.

The most common error I see in prevention of lice infestations is treatment too early in the fall. Cattle need to have a winter haircoat for the products to work effectively. Treating in September when pregnancy checking in Kansas is likely too early. We want to treat for lice just as they become more active (colder ambient temperatures). Application is also a concern in some cases. The product needs to reach the skin and not be simply ‘sprayed’ on the animal. If the dose for an adult animal is 30ml, the ideal technique is to put 13 ml from the neck to the middle of the back, 13ml from the tailhead to the middle of the back (if you have a gap of 6-12 inches at the middle of that back, that is not a concern) and then put the remaining 4ml on the head. This allows the product to be closest to the sites where the lice live so they will come in contact with the product. Be sure to treat all animals in the group. One untreated escapee can reinfect the entire group.

Conclusion

Developing a vaccination protocol or more appropriately a total herd health program should be the goal of every producer and veterinarian. With so many choices available, having a yearly meeting between the herd owner/manager and the herd health veterinarian to discuss this important topic is critical.

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LARGE ANIMAL PROCEEDINGS

June 4–6, 2023

Reproductive Success is an Accumulation of Little Successes

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Reproductive success is an accumulation of little successes

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Abstract
Excellent reproductive efficiency can be achieved in a beef herd by using a multifaceted approach focusing on herd production and management issues. Numbers that would define reproductive efficiency for most herds would include a 90-95% pregnancy rate, less than 2% abortion rate with 65, 88 and 100% of the calves born by days 21, 42 and 65 of the calving season respectively.

Heritability of reproductive traits tends to be low and disease causing reproductive failure in beef herds is uncommon in many parts of North America. Heifer selection and development, nutrition and utilizing heterosis are some of the keys to success. Efficiency is not synonymous with maximums, but rather is more closely aligned to optimums. Recent research with cost control as the core of heifer development shows that heifers can be developed more efficiently than previously thought.

Introduction
Having a large percentage of beef calves born in a relatively short period of time will decrease labor, enhance marketing opportunities, improve herd health and enhance overall herd income. Herds with acceptable pregnancy rates and a short, defined calving season have achieved these results with a disciplined, deliberate plan for reproductive success.

Because beef cattle are raised across vastly different environments, specific definitions of reproductive efficiency can be quite varied. Specific questions and concerns for a given environment should be addressed with individuals who are deemed to be experts in these geographic locations. The universal concepts of reproductive efficiency are the focus of this paper.

The National Animal Health Monitoring System (NAHMS) data from 2007-2008 revealed that 91.5% of exposed females calved in each year.[1] While this number may seem to be acceptable for some regions of North America, when it is coupled with the fact that 34% of all herds had no defined calving season and only 50.4% of herds had calves born in three or fewer months, the numbers show reason for concern.[1] A well-managed herd should be able to achieve a 90-95% pregnancy rate with only a 1-2% abortion rate in 65 days.[2]

Reproductive concerns tend to be an accumulation of errors,[3] and solving these concerns is rewarding for both the herd owner and the veterinarian. Utilizing the techniques discussed in this paper should provide a template to preventing and/or solving reproductive concerns in a beef herd.

Heifers

Selection

Building a beef herd that excels in fertility should start with the selection of heifer calves that will breed early, calve yearly on schedule, and remain in the herd for 12 to 15 years. Since reproductive traits tend

to be of low heritability, (10% or lower) selection for fertility cannot be the primary focus of ensuring reproductive success.[4-6]

Heifers selected as potential replacements need to be able to thrive in their given environment. If a highly fertile, low maintenance herd is desired, females with excessive nutrient demands will not allow the herd to reach its goals. Extreme milk production, mature body weight and frame score must not compromise the overall goal of having a herd that excels in fertility as extremes in any or all can diminish herd fertility.

Recent work from Australia indicates that Angus heifers selected for low residual feed intake (RFI) calved 8.1 days later than high RFI females across two calving seasons.[7] Conversely, some other studies with similar parameters have shown no difference in fertility among females of differing RFI. While low RFI will improve the efficiency of our industry, we must be cautious not to use single-trait selection and suffer some unintended consequences.

Economics

Reproductive efficiency is about optimums and not maximums. The law of diminishing marginal returns states that "in all productive processes, adding more of one factor of production, while holding all others constant, will at some point yield lower per-unit returns".[8] Adding more costs, e.g., generally feed, to the *group* to get one or more or even all the heifers pregnant is generally not cost-effective when the initial pregnancy rate is already quite acceptable.

Recommended guidelines for heifer development have generally been to target a weight of 60%- 65% of mature body weight at the time of breeding. Recent work from Nebraska that targeted heifers to weigh 55%-60% of mature body weight at breeding showed a feed cost savings of $22 per heifer when heifers were bred at 53% vs. 58% of mature body weight.[9] Developing spring-born heifers to calve at 53% of mature body weight did not affect reproductive success, dystocia rate or calf performance compared to heifers at 58% of mature body weight. We must be aware, though, that targets are not always met, as was the case in this study. Heifers developed to weigh 53% of mature weight may in fact reach a weight below this target and cause reproductive rate to fall below an acceptable rate. Leaving some room for error seems to be a prudent tactic.

Heifers can be developed to gain steadily from weaning to breeding, or the growth rate can be variable across this time frame. The path to puberty is unimportant so long as the heifer attains puberty before breeding.[10-13]

Records from the American Angus Association in 2013 showed that the average seven-year-old cow weighed 1394 pounds so a heifer in this "average" herd needs to weigh 740 to 900 lbs at breeding if she is to weigh 53%-65% of her mature body weight.[14] While 1,394 pounds is the average weight of a registered Angus cow, this figure can be highly variable across herds in North America. For our example, we will use this weight as the mature weight of the cows.

If a heifer born on March 23 is weaned 190 days later on September 19 and weighs 475 lbs, a gain of 324 lbs is needed to reach the target breeding weight of 800 lbs — using 59% for example — by May 23 of the following year. This will give a calving date of March 1 the following year, which equates to calving at approximately 23 months of age. To gain 325 lbs over 246 days, a gain of 1.32 lbs per day is necessary. An example ration of 16 lbs hay and 4 lbs dry corn gluten with appropriate vitamins, and Rumensin minerals would cost $1.70 per head per day. A more cost-effective option would be to allow a 30-day

backgrounding ration where heifers gain 1.5 lbs (0.68 kg) per day followed by 60 days of grazing cornstalks (cost $0.00-$3.60 for 60 days) or stockpiled grass ($21.00 for 60 days). An expected gain of 0-30 lbs in this 60-day period would be reasonable.[15] Now the heifers have 155 days to gain 280 lbs (127 kg) and a growing ration containing a higher percentage of a co-product feed like corn gluten feed or distiller's grains with solubles would be a reasonable choice that would also cost less than the $1.70 per day ration listed above.

Crossbreeding

The major benefit of heterosis is in strengthening lowly heritable traits.[5,16] In a commercial herd, all potential replacement heifers should be crossbreeds, with no more than 75% of one breed making up the cross. Research at Montana State University in 1994 showed that crossbred cows had 1.2 years longer productive lives and weaned 74 lbs more calf/cow exposed each year compared to the straightbred cows. The financial benefit was nearly $70 per cow per year for the crossbred cows compared to their straightbred counterparts.[17] In 2023 dollars, the crossbred cow should return over !50/cow/year more than their straightbred herdmates.

DNA testing

Over the past few years, genomic testing of replacement females has become increasingly common with scores for reproductive traits like heifer pregnancy and stayability providing some insight into the genetic contribution of these traits.[18]

Breed Heifers Early

In most beef herds, getting nursing two-year-olds bred back is the biggest fertility challenge. As we examine herd nutrient needs, this female is still growing and requires additional energy and protein compared to a mature cow.[19] One technique is to breed heifers two to three weeks before the cow herd so that this high-risk group has additional days from calving to rebreeding. At times, the environmental stress that could be associated with earlier calving is not worth the benefit of the increased lag time before breeding, so this needs to be addressed before this recommendation is made.

Shortened Breeding Season for Heifers

A late calving heifer becomes a late calving cow or an open cow.[7,20-22] The way to keep this negative from happening is to not allow any heifers to calve late. If the cow breeding season is 65 days, the heifer season should be only 30 to 42 days. If the adult cows calve March 21 to May 25 and the heifers calve March 1 to April 11 (21 days ahead of cows and for only 40 days), even the last heifer to calve is exposed to the bulls from day 62 to 127 post-calving which should give the heifer an excellent chance to rebreed. If, however, a heifer calves on May 25, she is only exposed to the bull from day 18 to 82 post-calving. This will likely give her only one opportunity for rebreeding. Do not start with a problem, breed heifers for a shorter time than cows. Exposing about 10% more heifers to the bull should produce a similar number of pregnant heifers if breeding is reduced from 65 to 40 days.

Pregnancy Exam Heifers Early

Another advantage to breeding heifers for a reduced time is that these heifers can be pregnancy checked early so that all open heifers can move to the feedlot. If heifer breeding is from May 22 to July 1, they can be examined for pregnancy around August 10. In the Upper Midwestern and Great Plains regions of the U.S. most pastures are in the "summer slump" and a non-productive animal is better to be off the pasture and in the feedlot. The economics of having a heifer at 16 months of age and open is less favorable than having a bred heifer, but with current prices, it is still profitable to feed and sell the open heifer as a feedlot animal.

Herd Health

- Every herd owner needs a herd-health veterinarian to guide them on health decisions
- A proper vaccination protocol melded with biosecurity and a parasite control program is a must. The veterinarian must also be knowledgeable in the areas of nutrition or work with a nutrition consultant, as this is a key component of a healthy herd.

Nutrition

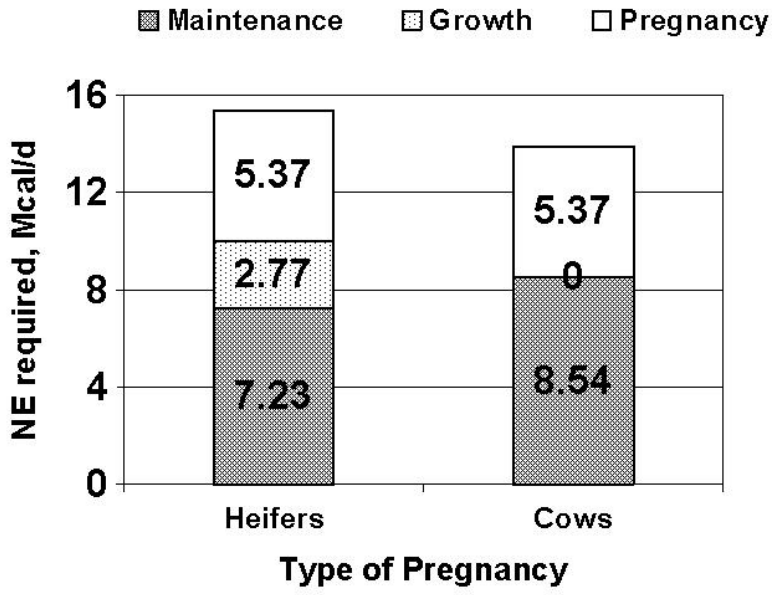
Priority of Energy Use by the Cow

Reproduction is a luxury to all animals, and females must intake enough energy or have enough energy reserves to initiate cyclicity. According to Short *et. al*, a cow needs to meet each of these needs before the next one is met[24]

1. Basal metabolism
2. Physical activities — including grazing
3. Growth
4. Supporting basic energy reserves
5. Maintaining an existing pregnancy
6. Milk production
7. Adding to energy reserves
8. Estrous cycling and initiating pregnancy
9. Storing excess energy

The list makes it very apparent that estrous cycling and initiating a pregnancy is not a high priority to the cow, and adequate nutrition must be supplied if the cow is going to maintain a yearly calving interval.

Table 1. Energy requirements during the last month of gestation in cow[19]



Body Condition Score

Body Condition Score (BCS) at calving is the single most important factor in rebreeding success.[9] Since heifers have an increased requirement for energy and protein compared to mature cows, heifers should calve in a BCS greater than cows.[19] Most studies show a BCS of 5.5 to 6.0 out of 9 is optimum for cows,[24, 25] so heifers should calve in BCS 6.5 to 7.0. This is especially true with the increased mature size and increased milk production of today's females. A study done from 1985-1987 showed that a BCS of 6.0 at calving was superior to BCS of 5.0 or 4.0 in terms of rebreeding success (96 vs. 80 vs. 56) in a 60-day breeding season.[25] The heifers in the study weighed 933 lbs (424 kg) for BCS 6.0 and 744 lbs (338kg) for BCS 4.0 so they were significantly lighter than a typical two-year-old today. In addition, the average expected progeny difference (EPD) for milk in the Angus breed was +2 in 1986 and in 2023 it is +27.[26] Other breeds have seen similar increases in milk production, and increased milk production demands increased energy intake and increased pre-calving BCS.

The most cost-effective time to add BCS to a cow is in the period immediately post-weaning. If cows are thin at weaning and calves are weaned at seven months of age or older, cows have little chance to regain BCS before the next calving season. This factor is compounded if the cows are under environmental stress during this time. If a cow that calves in March has her calf weaned in November in the northern half of North America, adding BCS from November to March is nearly impossible or very expensive. If instead these calves are weaned in September at 5.5 to 6 months of age, cows have time to regain BCS during a time of the year with little or no weather stress. Herd fertility will ultimately be improved because cows go into the winter and calve in a higher BCS. Herd profitability will also increase, as it is cheaper to feed the calf directly than to feed the cow to feed the calf.

Table 2. Relationship of body condition score (BCS) to beef cow performance and income[25]

BCS[a]	Preg rate %[b]	Calving interval, days	Wean age, days[c]	Calf ADG (lbs)[d]	Calf WW (lbs)[e]	Calf value, $/cwt.[f]	Gross income[g]	Cow income[h]
3	43	414	190	1.60	374	210	785	311
4	61	381	223	1.75	460	176	810	455
5	86	364	240	1.85	514	160	822	650
6	93	364	240	1.85	514	160	822	703

[a]Body Condition Score: scale of 1 (thin) to 9 (obese).
[b]Pregnancy rates averaged across trials in Texas, Oklahoma, and Florida when BCS was assessed at calving, breeding, and pregnancy testing.
[c]Weaning Age; 240 days for cows in BCS of 5 and 6 and decreases as calving intervals increase.
[d]Average daily gain.
[e]Adjusted weaning weight; calculated as calf age times calf gain plus birth weight (70 lb).
[f]Average price for similar weight calves April 28, 2017.
[g]Calculated as calf weight times calf price.
[h]Calculated as income/calf times pregnancy rate times 0.92 (% calves raised as those pregnant).

A common misconception is that heifers in BCS of 6.5 – 7 may have increased dystocia rates. In seven of nine trials where high-energy rations were compared to moderate and low-energy rations, dystocia rate was unchanged even though birth weights were altered in some experiments. In four of the five trials

where protein levels were varied, high-protein rations again did not increase dystocia rates. It appears that heifers need to calve in a BCS of >7 to decrease fertility and increase dystocia rates.[28]

While BCS at calving has the highest correlation to rebreeding success, heifers and cows must be fed a balanced ration post-calving if females are expected to become pregnant in a timely manner.

Micronutrient nutrition

Numerous studies have looked at the role of micronutrient deficiencies on herd reproductive status. While the roles of copper, selenium, manganese, Vitamin A and Vitamin E have been studied in herd reproductive problems, the results have been inconsistent. Recently a study of 771 cows in 39 herds in western Canada showed a significant ($P < 0.001$) association between serum copper concentrations and pregnancy status in cows less than 10 years of age. The strongest association with nonpregnancy was for cows with serum copper concentrations less than 0.40 ppm.[29]

Remedies for an Extended Calving Season

Even utilizing the recommendations for producing fertile, early calving heifers, herds with an extended calving season will need to either add a secondary calving season to the herd management plan or cut days from the single breeding season each year and cull all open cows. It is unrealistic to assume a producer can move from a 180-day calving season, where 25% of the calves are born in the first 21 days of the calving season, to a 65-day season in one year.

If a herd is in an area where two separate calving seasons are environmentally sustainable, this is an easy and quick fix to an extended calving season. For example, if a herd currently calves year-round and an April 15 to June 20 season is ideal, with a secondary season of August 15 to October 15 also acceptable, this extended season can be remedied in just over a year by timely pulling of the bulls, pregnancy testing cows, and culling all open females. I have developed a spreadsheet for use in the timing of various events and it can be downloaded from www.mwbeefcattle.com.

If the herd has only one time of year that is conducive to calving, the following strategies can be used:

- Keep significantly more heifers than the normal 8% to 20% replacement rate
- Select, develop and breed heifers as outlined earlier
- Cut 30 to 60 days off the breeding season each year until the herd is at the desired calving season. Sell all open cows.

For this system to work, the owner cannot have 'favorite' cows that are immune from culling.

Bulls

Fertile Bulls

Every bull should have a complete breeding soundness examination (BSE) before each breeding season. A spreadsheet developed by Texas A&M AgriLife Extension that is available on the AABP website BSE_Economics.xlsx (live.com) that assesses the cost-effectiveness of performing a BSE on beef bulls before the breeding season. With 560-lb feeder calves valued at $245.00 per cwt. and a cost of $75 for a BSE, the benefit-to-cost ratio for doing a BSE is $40.35:1 with a 10% improvement in fertility achieved by culling infertile bulls. So. the producer realizes a gain of $40.35 for every dollar spent on BSEs.

Numerous charts are available for producers to use when determining how many cows a fertile bull can service in a 65-day breeding season. While helpful, the numbers are difficult to remember. I proposed a rule of thumb in our practice over 30 years ago that recommends that a bull be placed with one cow per month of age of the bull up to 50. So, a 38-month-old bull should be able to service 38 cows in a 65-day

breeding season. Multiple bulls of similar age would also fit our criteria, so three bulls with ages of 25, 28 and 29 months would be able to service 82 cows in a 65-day breeding season.

There are breed differences regarding fertility and these need to be taken into consideration. A published research summary on the use of crossbred or composite sires showed that crossbred *Bos Taurus* x *Bos Taurus* bulls had calves born an average of 10 days earlier than comparable purebred bulls, while *Bos Taurus* x *Bos Indicus* bulls sired calves that were born 7.8 days earlier than the purebred bulls.[30]

Bull Exposure

Exposing females to a herd bull or surgically altered "teaser" bull 20 to 30 days before the start of the breeding season will induce an earlier estrus as compared to females without bull exposure.[31,32] If a herd bull is used and females get bred before the earliest desired service date, exposed females can be given an injection of prostaglandin the day the bulls are turned out. This will abort any females more than five days pregnant, and most should recycle soon after the injection.

Additional Reproductive Aids

Reproductive tract scoring: In herds with poorer than anticipated pregnancy rates in yearling heifers, the use of reproductive tract scoring (RTS) can be beneficial. Heifers should be palpated approximately 60 days before the anticipated breeding season so that if a larger than expected number of heifers are found to be in scores 1 to 3, appropriate management changes can be addressed. The goal is to have a majority of heifers at RTS 4 to 5 at the time of breeding.[33,34]

Reduced suckling: Once or twice-daily nursing[35] and 48-hour calf removal[36] are both short-term fixes to a potentially long-term problem. Each has been used to salvage a breeding season but should not become standard procedure (see "heifers, selection").

Ionophores: Feeding heifers monensin or lasalocid will increase the percent of heifers cycling before and during the breeding season and will improve feed efficiency in cows. Only monensin is approved for females after breeding and five trials confirm that feeding monensin decreases the postpartum interval an average of 18.8 days.[37]

Induction of estrus with hormones: It is the opinion of the author that "jump starting" heifers to induce them to cycle may be counterproductive. Do we have trials that show that anestrus heifers that were hormonally induced to cycle have equal stability as compared to heifers that had cycled naturally prior to the breeding season? If these induced heifers have fewer productive years due to lower inherent fertility, we are better served to have them be open as yearlings. Fertility is a lowly heritable trait, but most studies do show some degree of heritability.[4-6]

Conclusions

Assisting a herd owner in achieving reproductive efficiency is a long-term endeavor that will improve herd uniformity, marketing, health, and herd profitability while decreasing labor. If a herd has underperformed regarding herd fertility, a multifaceted, deliberate approach to improving nutrition, genetics, health, record keeping, and herd management is the key to success.

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LARGE ANIMAL PROCEEDINGS

June 4–6, 2023

How to Become More of an Asset to your Clients Through Consultation

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How to become more of an asset to your clients through consultation

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Abstract

Progressive, entrepreneurial beef and dairy producers demand a level of service that is well beyond that which is traditionally described on a list of clinical skills common to practicing veterinarians. It is also known that progressive, entrepreneurial, bovine herd health veterinarians desire to offer services to their clients that are more consultative in nature so that they can become an asset to the herd owner. To become a trusted partner to the beef and dairy producer, the veterinarian must know the goals of the owner and how to communicate recommendations for reaching those goals.

Keywords: Production medicine, Herd health, Consultation, Communication

Introduction

Traditional tasks of pregnancy checking cows, performing breeding soundness examinations on bulls, processing calves, Brucellosis vaccinating, DA surgeries, dystocias, and diagnosing and treating sick cattle have been the backbone of bovine veterinary practice for many years. If bovine veterinarians want to remain viable into the future, they must provide these services ***and*** add additional services that are beyond what we have relied upon for many years. This is no different from the shift in the mindset of the most progressive clients. Are these producers still in charge of every task on the farm or ranch, or have they trained others in the operation to do some of this labor so that they can spend more time working on the business to be more profitable? To perform more value-added services for producers, veterinarians must be more aware of their client's goals and priorities, and the veterinarian must ask the client for this information. After discussion of the client's goals and priorities, it is paramount that the herd health veterinarian develops a program for success that is tailored specifically to that cattle business. Our goal as the herd health veterinarian is to become indispensable to the client so that whenever they think "cattle", they think of us first. We may not know the answer to their question, but we want to be the first person that comes to mind because we have developed a trusted relationship where they know that if we do not know the answer, we will find it. In this relationship, we become the "coach" of the beef or dairy team and we assemble trusted advisors that will strengthen our relationship with all team members.

Growing your practice

If your goal is to grow your veterinary practice, what are ways you can do that? Some thoughts are that you could expand your practice radius, but the downside of this idea is more time driving and in most cases the mileage fee is not a significant profit center. If herds on the periphery of your practice radius are large enough that you spend most of the day at these farms, then this can be a viable strategy. You could add a haul-in facility and that would allow you to eliminate drive time, which would allow you to see more cases in a day. Many beef veterinarians have done this and find it especially beneficial for doing breeding soundness exams (BSEs) and seeing individual sick animal cases that can be safely brought into the clinic. Some clinics have trained or added a Registered Veterinary Technician that can perform tasks that are legal for them according to your state practice act. Another option is to offer additional services to the clients that are

already in your client base. The caveat to this approach is that you have to offer something that adds value to the producer's beef or dairy business. In addition, you must know that the client really needs this service.

The key to adding additional service to your existing clients is to always ask them their goals. Do we regularly do this? Dirks (2013) concluded that "Veterinarians that do not clearly seek the views of their clients, often do not fully engage in the advisory process." Their study showed that only 24% of the time did the veterinarian and producer set herd performance goals. Veterinarians who did not set goals indicated that they and the producer 'intuitively knew' what each wanted to achieve, and that the setting of these performance goals was considered 'too formal'. Veterinarians often could not identify a producer's main goal. During on-farm conversations, veterinarians did not actively seek to identify the producers' goals or problems, suggest a co-operative strategy, or summarize any advice given. These results should be an embarrassment to any veterinarian that does bovine work. The study also concluded that the veterinarian needs to actively seek out the goals of the producer because the producers did not readily volunteer this information. The awareness of the producer's goals is paramount to compliance by the producer and successful attainment of the producer's goals. If we want to become an asset to the producer, we must stop telling them what to do and instead seek to understand their top priorities for the improvement of their business. Focus on perceived benefits and remove or reduce barriers to successful implementation of a solution. Producers perceive the veterinarian as an appreciated, important, and frequently contacted information source. In this study, producers stated that they appreciated their veterinarian organizing 'producer study groups' to collaborate on specific health issues.

Our practice developed a total beef herd health program, and we invited the clients that were a part of that program to a 'year-end' meeting each January. The meeting consisted of a talk on a subject of importance to the group and concluded with a 'roundtable' discussion where the producers shared their successes and failures of the previous year. Many of the clients stated that it was the best meeting they attended all year. Producers learning from each other and being leaders in specific areas turned out to be one of our best ideas ever for sustaining and growing our beef cow-calf production medicine program.

Communication/creating demand for advice

The prevention of complex problems requires customized communication strategies as well as an integrated approach. Two factors of producer mindset are the most important behavioral determinants for improvement: believing there is a problem in the herd and belief in the effectiveness of management to solve that problem. These two keys become the template on how to initiate a production medicine program. The program needs to be customized to the specific livestock business and the owner must believe that some aspects of their business can be improved with input from the herd health veterinarian. It is imperative that the producer takes ownership of the thought that improvements can be made. To close the loop in production medicine consultation, the solution must be reasonable to accomplish, and the owner must validate the solution. The more the owner takes possession of the concern and the solution the more likely the change will happen. If the veterinarian identifies the concern and the producer feels that we are telling them what to do, the chance for success becomes minimal. Ask the producer their goals (ensure they share ownership of the concern), propose a solution and ask if the solution is reasonable. If a solution is unknown at the time, this is not a concern. Many problems will be complex in nature and will take time for the veterinarian to develop a plan to solve the problem. The key is to respond to the client in a reasonable timeframe to propose the solution. In my experience the veterinarian is thought of just as highly if they immediately know the solution or if it comes after some research.

Use open-ended questions such as "what are your short term and long-term goals for your agricultural business?" If there are multiple decision makers in the business, these goals need to be universally accepted. Be sure to ask the entire management team so that you can get buy-in from everyone on the

team. After the producer states the goals, the herd health veterinarian should ask, “How can our veterinary business help you achieve these goals?” It has been my experience that when you ask about goals and how your business can be an asset to your client’s business, you develop a stronger business relationship. Other businesses that deal with this producer are not asking these questions. The fact that we are asking them puts us in a stronger position to become an asset to the producer’s business.

It may seem obvious, but we have all seen countless examples of a producer not using a service of a veterinary clinic because they were unaware of the service, or the service did not exist. The most important step in creating demand for a veterinary service is to offer the service and let the producers know that the service is available. Newsletters, client education meetings, and speaking at local extension sponsored events are great ways to introduce a new service or market an existing, but underutilized service. If your clinic has a website, this can be a great way to announce new services. Adding timely client educational pieces to your website is another technique you can use to show that you are the veterinary clinic that has client education at the center of your business model. The goal is to raise producer awareness about the importance of a particular subject to stimulate demand for services that address the issue.

An improvement in communications skills will be necessary to become more of an advisor to beef and dairy producers. According to dairy producers, veterinarians have difficulties in being proactive advisors and applying essential communication. Jansen et. al. found that producers say that veterinarians are persistent in their curatively oriented, prescriptive, reactive expert role that prevails in veterinarian–farmer contacts. These producers’ advice is that veterinarians should take on the role of coach, sparring partner and facilitator instead of being merely a technical expert.

Just as veterinarians have different ways of learning and using information, so do producers. Communication strategies need to be customized to the specific learning style of each client. Producers may be segmented into information seekers, do-it-yourselfers, wait-and-seers, and reclusive traditionalists according to Jansen. While one beef producer may be quickly convinced to make a herd management change if informed, “you will save $5000/year by limit feeding your hay vs. supplying it *ad lib*”, another producer might decline because he does not see how the change is possible. While not every producer will heed the advice given, others that initially decline will make changes if you ask additional questions. Asking probing questions will provide a deeper understanding of an issue or topic.

Another key to the communication strategy is to utilize a team of experts, e.g., nutritionist, forage specialist, banker. These outside experts can bring a level of expertise that the veterinarian does not possess, and the veterinarian can then more thoroughly concentrate on areas of their expertise. Another advantage of having additional advisors is that the outside expert may repeat something that was mentioned by the herd health veterinarian in an earlier visit. This suggestion may be made in a similar or different way, but now it is seen or heard in a different light. Even though the advice may be ‘old’ to the client, the advice may be heard through ‘new ears’ and may now be taken. The goal is to help the producer achieve success and who gets the ‘credit’ for helping should not matter.

As a consultant, we must not be impatient when it comes to herd improvements. Even when a client identifies a need and we provide a solution, it may take years to implement the change. Herd concerns are generally long-term problems that may have taken years to develop. A problem that took years to develop will likely take months or years to be fully resolved.

Veterinary Business Plan

When your veterinary business commits to adding or expanding its consulting role, everyone on the veterinary team must be in alignment with this plan. While the entire team must embrace this philosophy, individuals on the team can and should have various levels of expertise. One of the benefits to having a

team in a veterinary business is that some members may be experts in fertility while others have more proficiency in nutrition or genetics.

If you, the veterinarian, are going to be giving financial advice, and bovine consulting nearly always has a financial component, you need to have a veterinary business plan. When I was in practice, my partner and I sat down every January and poured over our previous year's financial statements. We made a business plan for the upcoming year and took a more long-term view of where we thought the business was heading. This proved to be extremely valuable time spent for the health of our business.

Traits of the proper veterinary advisor or coach

Noordhuizen et. al. surveyed Dutch dairy producers and asked them to identify traits that would describe a proper veterinary advisor or coach. Their list included:

1. Understands entrepreneurship
2. Has empathy for producer; is not dominant
3. Is technically well skilled
4. Strong in communication
5. Invests in many contact moments
6. Has a practice business strategy
7. Knows behavioral economics principles
8. Is analytically skilled
9. Strong in choices of products and services
10. Has a commercial attitude
11. Shows great creativity
12. Separates advisory work from technical work at visits
13. Attends continuing professional training
14. Defines tailor-made products for the farm

As you analyze the list above, only four of the fourteen items are related to technical ability (3, 9, 13, 14) while ten of the fourteen are more related to communications, business, and consultation. Entrepreneurial producers want and expect a veterinarian that can help them reach their goals. Look at each trait on the list above and ask yourself, "Does this statement describe me and my practice?"

In the same survey, producers were asked, "What would you consider as weaknesses of your veterinarians?" Answers included:

1. Too dominant attitude in profession
2. Talks too much; listens too little
3. Rather poor communication skills
4. Does not follow structured protocols
5. Does not provide clear work instructions
6. Limited knowledge of cow nutrition
7. Limited knowledge of management
8. Limited knowledge of farm economics
9. Poor knowledge of entrepreneurship
10. Knows little about farm organization
11. Tells little about fields of expertise
12. Does not show what he contributes to farm
13. Is not proactive; waits too long before taking action
14. Does not offer on-site training

15. Too many changes in personnel in practice
16. Maybe not willing to invest in discussion

Look at this list and critically analyze yourself. Which of the above would clients say about you? Also, note that not one of the above lists says anything to do with the veterinarian's clinical skills. We are strong in these areas and our clients see this. Look at the list again and see where you need to improve.

A study of dairy farmers in Italy showed that producer's scores for their "ideal veterinarian" significantly differed from their herd veterinarian in several categories where a score of 1 was the lowest grade and 5 the highest one. (Table 1)

Table 1 Score means and statistical comparison of scores recorded for herd veterinarian vs. ideal veterinarian

Skill	Herd veterinarian	Ideal veterinarian
Exhaustive	3.43[a]	3.75[b]
Clear	3.63[a]	4.22[b]
Understandable	3.59[a]	4.27[b]
Practical	3.80[a]	4.40[b]
Useful	3.82[a]	4.29[b]
Proactive	2.99	n.e.
Satisfaction	3.56	n.e.

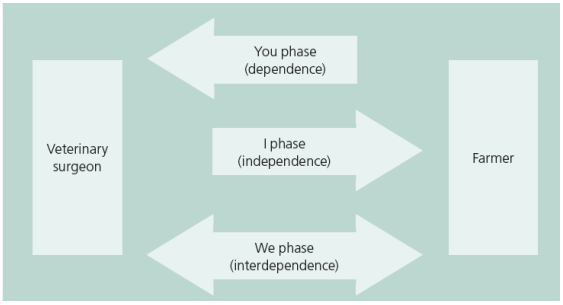
n.e. - not evaluated

In human medical studies, patient trust and good interpersonal relationships with the primary care physician are major predictors of patient satisfaction and loyalty to the physician. Patients need to trust the primary care physician to be satisfied and loyal. I am confident that this would also apply to veterinarians.

Relationship models

Different clients will demand different kinds of collaboration, depending on their own experience, knowledge and inclination to collaborate. This has been modeled into three different stages (Figure 1). In the 'You phase', the farmer is primarily dependent on the veterinarian and may trust the veterinarian to make decisions and define the objectives and action to be taken. The 'I phase' is characterized by a farmer acting largely independently, with the veterinarian being regarded as a provider of a certain means to an end. In the 'I phase' the farmer is in full control of the relationship and may use the veterinarian just as a technician, or possibly only as a writer of prescriptions and/or dispenser of medicines. Finally, the 'We phase' sees both the farmer and veterinarian collaborating to achieve common goals previously defined together.

Figure 1.



Entrepreneurial producers are willing to pay for advice, provided it is clear in advance what the benefit or profit will be. The consultation visit must be separate from the clinical visit. The client needs to clearly understand that they are paying for advice, not labor. Turn off your phone and give the client your full attention.

Roles of the Veterinarian

When veterinarians and dairy producers were surveyed in the UK, veterinarians considered 'optimizing milk production', 'decreasing overall cost' and 'being an independent adviser' as important roles, but these were not perceived as such by the farmers. In addition, when producers were asked what approach they wanted their veterinarian to have, their top two choices were 'a proactive person who identifies problems on the farm' and 'someone to give technical advice on all aspects of animal health'. When veterinarians were asked about how they present themselves to their dairy clients, their top response was 'a personal friend of the farmer style'. (Figure 2)

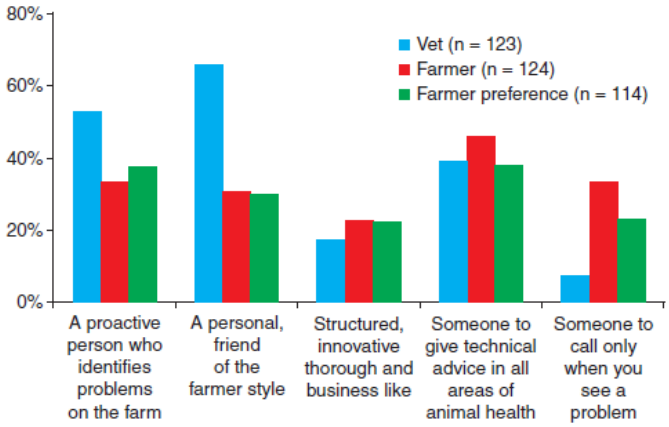


FIG 2: Frequency distribution of veterinarian and farmer responses to the question: 'How do you present yourself to your dairy clients?/What approach to you and your farm do you feel your veterinarian has?/What approach would you prefer your veterinarian to have?'

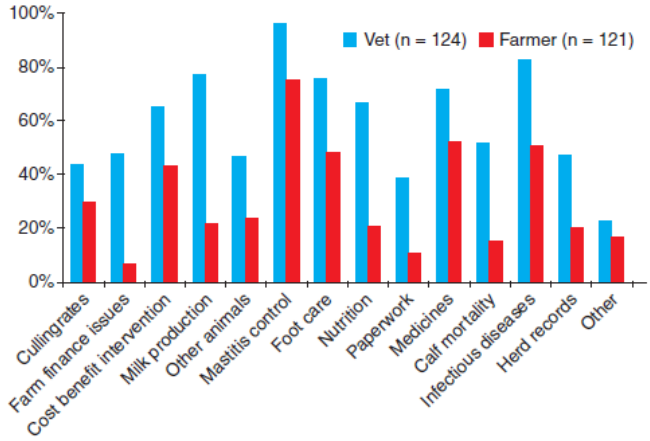


FIG 3: Frequency distribution of veterinarian and farmer responses to the question: 'During these visits to your dairy clients which topics of discussion recur?/During visits by the veterinarian, which topics of discussion recur?'

Most farm respondents (98 of 121; 81 percent) valued their discussions with their herd health veterinarian, and it was apparent from the relatively small proportion of veterinarians initiating a discussion on farm (33 of 125; 26 percent) that there is the opportunity for a more proactive approach from veterinarians.

Dairy veterinarians and producers in the UK were asked about recurrence of topics of discussion and in all 14 categories veterinarians thought the topic of discussion occurred more frequently than did the producers. (Figure 3) The point of this discrepancy is not to determine who is correct, but how to improve communication and listening skills. If two parties are having a discussion and they are interviewed later, the response of "was this discussed?" should be equal for both parties.

In the same study, consultation time was perceived as valuable by 78 percent of veterinarians and 81 percent of farmers who both agreed that 'discussions were good advice to put into practice'.

Practice culture and philosophy

If the veterinary business has minimally or has not embraced the consultative role, the shift in practice philosophy can still occur. To shift the culture of the practice, it will take buy-in from all team members. This also requires a program leader within the clinic that will lead this transformation. While all team members need not participate in the production medicine or herd health program, all members must see this 'thinking' work as valuable to both the producer and the veterinary business. Time for research and writing herd reports must be placed on the clinic schedule and interruptions of this scheduled time must be kept to a bare minimum. In time the veterinary team will realize that consultation time is just as important as clinical time.

How does a veterinary business change from a clinic that does not or minimally offers these production medicine programs? According to Jansen, the answer is simple; the most important way to create demand for a new veterinary service is to offer the new service. Ask your clients what they want, ask them their goals, and ask how you can help them achieve them. Ask, ask, ask. Do not tell them what to do. Do not think for them.

Action plan for effective consultation

1. Veterinarian establishes trust with producer.
2. Veterinarian asks producer their goals
3. Producer defines and refines the goals
4. Veterinarian asks producer for possible solutions
5. Veterinarian and producer discuss proposed solutions
6. Veterinarian and producer explore any unintended consequences
7. Veterinarian and producer agree on action plan
8. Veterinarian and producer agree on how to measure progress
9. Veterinarian and producer analyze results:
    a. Results are positive → move to next goal
    b. Results are negative → reexamine goal and possible solutions

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LARGE ANIMAL PROCEEDINGS

June 4–6, 2023

Open Forum on Workforce Issues

W Mark Hilton, DVM, PAS, DABVP (Beef Cattle)
Midwest Beef Cattle Consultants, LLC

KANSAS STATE UNIVERSITY | College of Veterinary Medicine

Open Forum on Workforce Issues

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In this session, Drs. Bob Larson, Brad White and Mark Hilton will lead a discussion of the attendees' thoughts on current workforce issues, specifically targeting recruitment and retention of veterinarians and veterinary technologists in rural practice.

LARGE ANIMAL PROCEEDINGS

June 4–6, 2023

Feeding Cows Consuming Dormant Low-Quality Forages: How, When, What?

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KANSAS STATE UNIVERSITY | College of Veterinary Medicine

Feeding Cows Consuming Dormant Low-Quality Forages: How, When, What?

Introduction

Nutrient intake and requirements are ever changing in beef cow production systems. Nutrient requirements of beef cows peak in early lactation and bottom out in mid gestation after weaning. Additionally, the nutritional value of forages changes throughout the growing season and does not always meet the nutrient requirements of the cow, particularly with fall-calving cows. Filling in the nutrient gaps without exceedingly high costs and utilizing body energy reserves when necessary is the key to feeding the beef cow.

Forage nutritive value

Protein content generally decreases, and acid/neutral detergent fiber (plant cell wall) generally increases from spring to winter in tallgrass prairie (Figure 1) resulting in less digestible forage that may not meet the energy and protein requirements of the cow. Additionally, calcium and phosphorus, along with other minerals, and vitamin A peak in spring/summer and are lower in fall and winter. This pattern is typical for all forage species even though the absolute values are different, except for cool-season forages that have abundant regrowth in the fall where protein, minerals, and vitamin content will increase, and detergent fiber content will decrease for a period. Based on the values reported in Figure 1, spring-calving beef cows would have adequate protein from May to July, vitamin A from May to November, and phosphorus would never be adequate to meet nutritional requirements.

Plant species have very different nutritive value at the same time of year even if they are of the same type (warm vs. cool-season). Figure 2 illustrates the differences in digestibility among 4 warm-season forage species as plants mature. In a mixed species pasture such as native prairie, there can be widely different nutritive value among forage species and thus some idea of the mix of forage species being consumed by cattle is important. Also, if harvested for hay it will be beneficial to understand the proportion of plants at different stages of maturity.

If this pattern of changes in nutritive value of forages was consistent, nutritional management of the cowherd would be simpler. However, as with cattle, there is biological variation in nutritive value of forages, both in terms of temporal differences and species differences. Figure 3 illustrates the changes throughout the growing season are not consistent among years in the same forage species. For example, if hay was typically harvested in late June, hay harvested in 1990 would meet the protein requirements of an early-lactation beef cow with 30 lb peak milk, hay harvested in 1991 would only meet the protein requirements of an early-lactation beef cow with 20 lb peak milk, and hay harvested in 1992 would only meet the protein requirements of an early-lactation beef cow with 10 lb peak milk. Most producers typically harvest hay at the same time of year every year, which can be problematic due to the interannual variation in forage nutritive value. Differences in weather conditions across years can have a profound effect on the rate of plant maturation, which leads to significant differences in nutritive value at the same time of year. Thus,

the best approach is to time the harvesting of hay with a particular stage of plant maturity – for grasses this is typically the boot stage of growth.

Forage intake

Not only does nutritive value of forage affect availability of energy and protein, but it also affects forage intake. As digestibility (total digestible nutrients; TDN) decreases the cow cannot consume as much forage (Table 1) because the forage digests slower in the rumen which slows down the passage of undigested material through the gastrointestinal tract. Thus, poor quality forage is a double-edged sward; the cow does not get as much nutritional value and she cannot consume as much forage because of lesser digestibility. The low protein content of more mature forage is a major contributor to the lesser digestibility. Forages with less than 7% crude protein content have less than adequate forage intake (Figure 4). The lack of protein available to the rumen microorganisms inhibits growth of bacteria thus decreasing digestion of the forage fiber/cell wall. By providing a protein supplement to poor quality forage, the rumen microorganisms can thrive thus increasing digestion and thus intake of forage.

Supplementing forage

Filling the nutrient gaps left by the base forage is the primary goal of supplementation strategies, but the best strategy is one that will fill the nutrient gap while maximizing utilization of the forage resource. There are 4 things to consider when designing a supplementation strategy: 1) type of carbohydrate, 2) type of protein, 3) how much to feed, and 4) how often to feed.

Feedstuffs can be classified by the type of carbohydrate – starch vs. fiber – which is important for meeting energy requirements and maximizing forage utilization in high-forage diets. Feedstuffs high in starch such as cereal grains are energy dense and can increase energy consumption with minimal intake. However, too much starch decreases forage digestion and if severe enough can result in no net increase in energy consumption. This is called a negative associative effect where the mixture of feedstuffs is less than additive of the nutrients supplied by either feedstuff alone. Starch intake has a dramatic negative associative effect on digestibility of poor-quality forages. The rapid digestion of starch by amylolytic (starch digesting) bacteria uses most of the available protein not leaving enough protein for the cellulolytic (fiber digesting) bacteria resulting in lesser forage digestion and intake of the poor-quality forage. Increasing the protein in the diet when feeding starch can partially, but not fully, compensate for the decreased forage digestion. In contrast, feedstuffs high in fiber such as forages and cereal grain by-products are not digested rapidly consuming the available protein in the rumen and, thus, do not have a negative associative effect. Supplementing poor quality forage with high quality forage can increase energy intake but requires more pounds of feed than using other high fiber energy sources. Cereal grain by-products such as corn distillers grains, wheat middlings, and soybean hulls are primarily the seed coat or hull left from grain processing and is composed of hemicelluloses and pectins that are highly

digestible. These feedstuffs have TDN values of 75 to 90% compared with high-quality alfalfa hay at 60% thus making them better choices for low cost energy supplementation.

Feedstuffs can also be classified based on the amount and type of protein – rumen degradable or undegradable – which is also important for maximizing forage utilization. Rumen degradable protein is protein that is digested in the rumen and used by the microorganisms to grow and digest carbohydrates, whereas, rumen undegradable protein passes through the rumen undigested of which some portion is digested in the lower gastrointestinal tract. Protein in forages is 80 to 90% rumen degradable and thus low protein content of forages is first restricting growth of rumen microorganisms and second restricting metabolizable protein to the animal. When supplemental protein is necessary, feedstuffs with high protein content are going to be the most economical such as soybean meal, cottonseed meal, or distillers grains. But these feedstuffs differ in the type of protein. Protein in cottonseed meal and soybean meal is 80 to 90% rumen degradable whereas protein in distillers grains is approximately 40% rumen degradable depending on the extent of heating during the drying process. Filling the gap in rumen degradable protein dramatically increases the digestion and intake of poor-quality forage having a positive associative effect where the mixture of feedstuffs is more than additive of the nutrients supplied by either feedstuff alone. Thus, highly rumen degradable protein feedstuffs are good choices to meet rumen microorganisms' requirement for protein and maximize forage digestion and intake.

Urea is an inexpensive source of rumen degradable protein to increase forage digestion but may have some limitations. Cellulolytic bacteria require branched-chain fatty acids which can only be made from deamination of amino acids, which are not provided in a non-protein nitrogen source like urea. Thus, supplemental rumen degradable protein should be a mixture of true protein and non-protein nitrogen sources to maximize forage digestion. Additionally, supplemental protein for young growing stock (calves, yearling heifers) should be composed of 100% true protein sources such as soybean meal and cottonseed meal. These young growing animals perform better when fed true protein rather than non-protein nitrogen sources.

Forage characteristics can influence the response to rumen degradable protein supplementation. The response to rumen degradable protein supplementation in medium-quality warm-season forage species is greater than in cool-season forage species (Figure 6). Additionally, the response to rumen degradable protein supplementation has a threshold of around 7% and increases with decreasing forage crude protein thereafter. Starch supplementation on the other hand decreases forage fiber digestion regardless of forage quality (Figure 7), but the effect is greater in low- than medium- and high-quality forage.

The amount of supplemental feed required is dependent on the size of the nutrient gap. Figure 5 provides a decision tree for designing a supplementation strategy for protein and/or energy supplementation and the target intake. An important aspect to determining the amount of supplemental feed required is an accurate estimate of cow weight. Preferably a scale is part of the cattle handling facility and documentation of cow weights are available. Another source of cow weight could be sale tickets from cull cows, but remember to adjust body weight for low body condition score if cull cows are thin.

The frequency of feeding is the last consideration. Preferably supplemental feed could be provided daily, but every other day or 3 times per week feeding of prorated amounts of a protein supplement has proven to be just as effective at increasing forage digestion as daily feeding. Large quantities of energy and protein supplements need to be provided daily in order not to cause large fluctuations in rumen function. However, we have fed the weekly amount of a high starch supplement at rates of 1% of body weight prorated for delivery 5 or 6 days per week in research studies without issue, although there is no available research to support this practice.

Nutrition of developing fetus

Fetal programming is the concept of external influences changing the intrauterine environment shaping the metabolism of the offspring such that animal health and performance are impacted later in life. The primary mechanism thought to alter metabolism is epigenetics which is the secondary changes in the DNA affecting gene expression. The primary changes in DNA are the nucleotide sequence inherited from the parents which is fixed at fertilization. However, epigenetics can be changed after fertilization of the egg by external factors such as nutrition.

Epigenetic changes involve changing the modifications to histones and cytosine bases in the DNA through addition or removal of methyl groups. Synthesis of methyl groups involves several nutrients - methionine, vitamin B12, folate (vitamin B9), and zinc. Methionine is activated allowing it to donate a methyl group to DNA.

Nutrient restriction of pregnant beef cows through feeding of low-quality forage has impacted almost all aspects of fetal development with negative effects on liver metabolism, feed digestion and nutrient absorption, reproductive efficiency, lactation potential, postnatal growth and carcass quality, and incidence of respiratory disease. The timing of nutrient restriction can affect the outcome on the offspring as fetal tissue development changes throughout gestation (Figure 8). Research on beef cows grazing low-quality forage in mid to late gestation indicates that protein restriction negatively impacts muscling and fat deposition with offspring having lesser postweaning rates of gain, smaller ribeye area, and lesser marbling score (Table 2). Additionally, heifers from protein restricted dams had lesser reproductive performance.

Additional studies indicate that overall maternal nutrient restriction (energy, protein, vitamins and minerals) during mid and late gestation also has long-term negative implications for progeny growth performance (weaning weight, feedlot ADG, carcass weight) and heifer reproductive performance (ovarian weight, calving percentage, percentage calving in first 21-d period). Nutrient restriction during the periconception period and early gestation also have negative effects on offspring performance, which is likely not an issue in spring-calving beef cows but has implications for fall-calving beef cows.

Many studies indicate that maternal nutrient restriction alters gene expression in skeletal muscle and adipose tissue as well as characteristics of these tissues such as muscle fiber number and adipocyte size. Although live animal performance measures were not reported in these studies, they support the idea that maternal nutrition has implication for molecular changes in fetal

development that can have long-term implications. Some research suggests that the insult of nutrient restriction is primarily a restriction in methionine supply as methionine is typically the first-limiting essential amino acid from rumen microbial protein, although overall effects of restrictions in metabolizable energy and protein cannot be ruled out. However, postnatal nutrition can result in metabolic imprinting of calves. The effects of maternal nutrient restriction on offspring performance are inconsistent across studies, which may be due to differences in postnatal nutrition of offspring. Additionally, there are other factors that affect the nutrient supply to the fetus (maternal heat stress, grazing endophyte-infected tall fescue) that could be confounding factors affecting studies involving dietary changes in nutrient intake. Therefore, our understanding of interactions among maternal nutrition, postnatal nutrition, and other factors is limited and thus specific maternal nutritional recommendations to enhance offspring performance are not available. The current best course of action is to focus on meeting cow nutrient requirements throughout gestation.

Conclusion

Differences in nutritive value of forage temporally and among plant species requires careful consideration when managing forage resources for maximum utilization and to meet the nutrient requirements of the beef cow through the fall and winter. Nutritional aspects of feedstuffs in the type of carbohydrate and protein provided are important to effectively fill nutrient gaps and maximize forage utilization. Due to the ability of ruminants to recycle blood nitrogen back to the rumen, less frequent feed delivery can help reduce labor and allow flexibility in management. The implications for maternal nutrition on offspring postnatal performance are many, but current knowledge limitations preclude recommendations to enhance offspring performance such that the current recommendation is to avoid negative effects through proper nutrition. Feeding the beef cow through the fall and winter starts with assessing forage nutritive value in comparison with nutrient requirements followed by evaluation of the available feedstuffs for supplementation.

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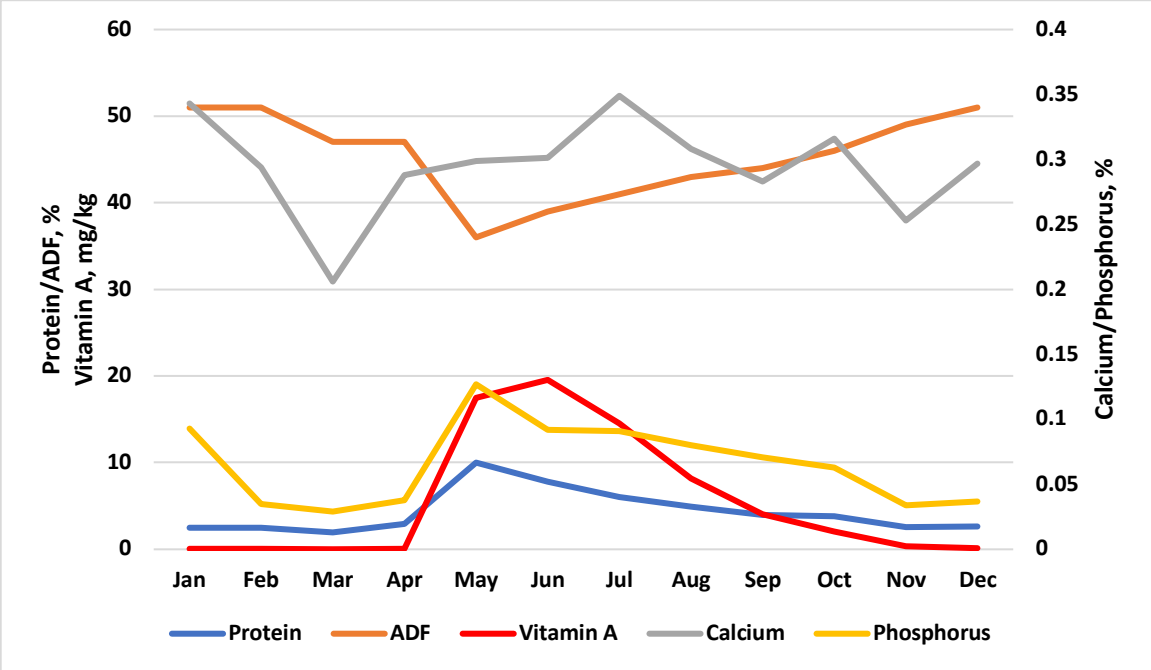

Figure 1. Changes in nutritive value of tallgrass prairie throughout the year. ADF = acid detergent fiber. Adapted from Waller et al., 1972 and Harmoney et al., 2002.

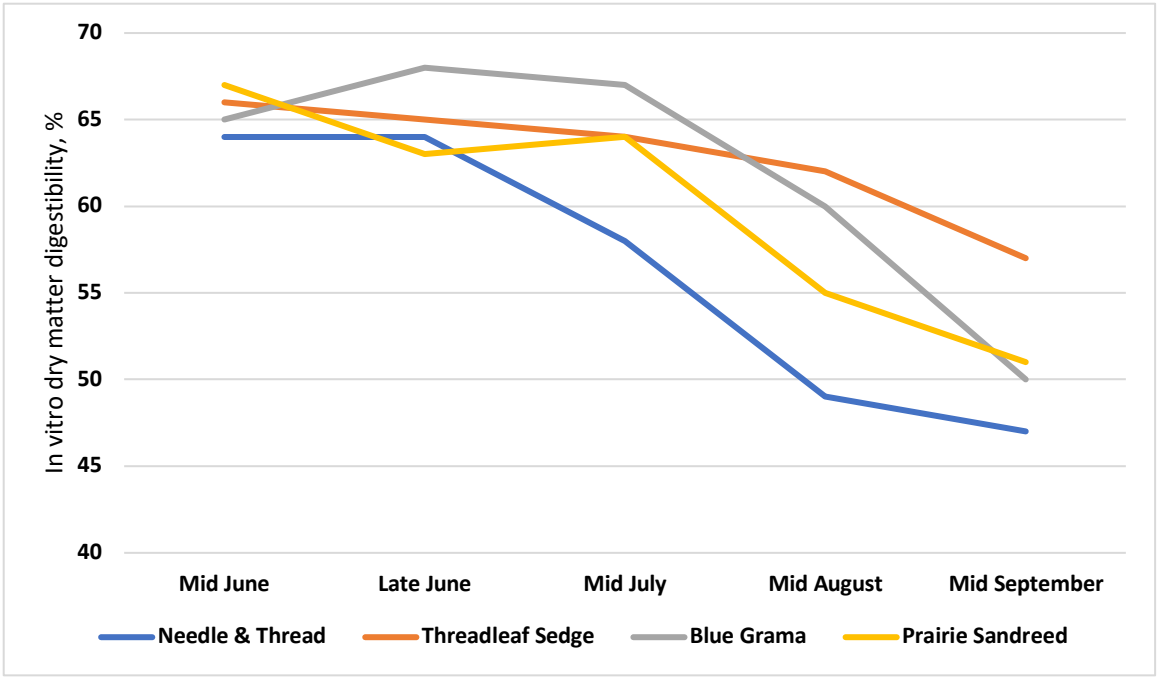

Figure 2. Changes in in vitro dry matter digestibility of 4 warm season grasses in South Dakota. Adapted from Cogswell and Kamstra 1976.

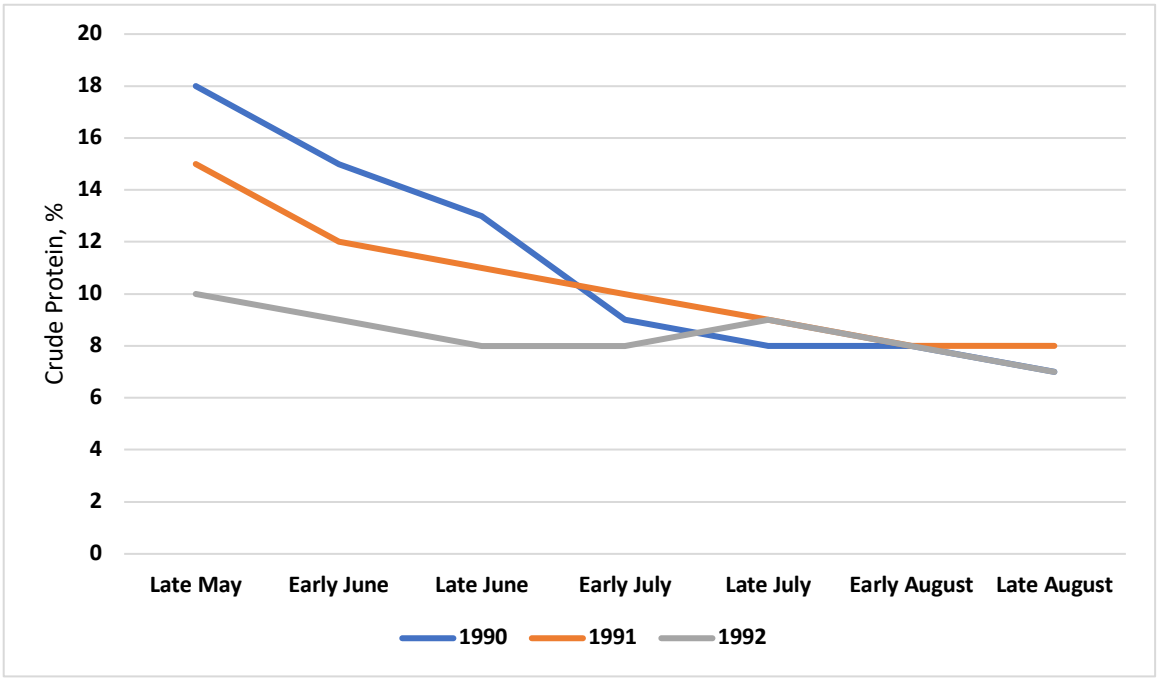

Figure 3. Changes in crude protein content in crested wheatgrass and Russian wildrye in South Dakota across 3 consecutive years. Adapted from Tusler et al., 1995.

Table 1. Forage intake guidelines for beef cows				
			Forage DMI Capacity, % BW	
Forage Type	TDN (%)	Example Forages	Dry Cow	Lactating Cow
Low quality	<52	Dry winter forage; mature grass hay; straw	1.8	2.2
Average quality	52-59	Dry summer/fall pasture; late-bloom legume hay; boot-stage and early-bloom grass hay	2.2	2.5
High quality	>59	Lush growing pasture; mid-bloom or earlier legume hay; pre-boot-stage grass hay	2.5	2.7
Adapted from Nutrient Requirements of Beef Cattle, 8th ed. (2016).				

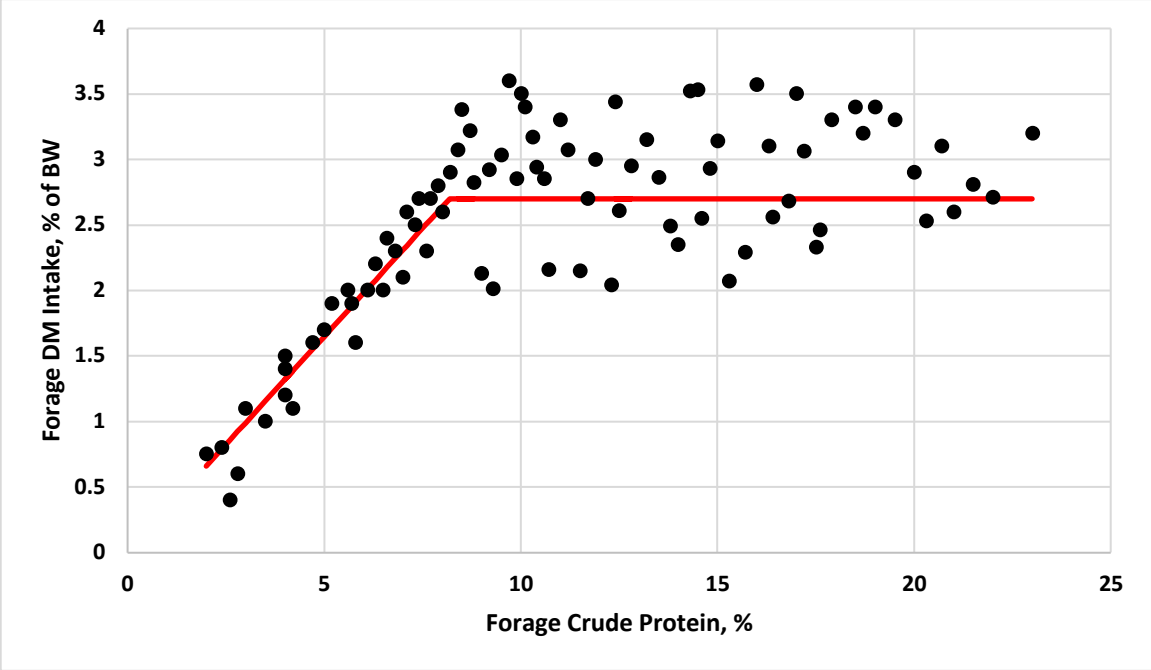

Figure 4. Effect of forage crude protein content on forage dry matter intake by beef cows. Adapted from Paterson et al., 2001.

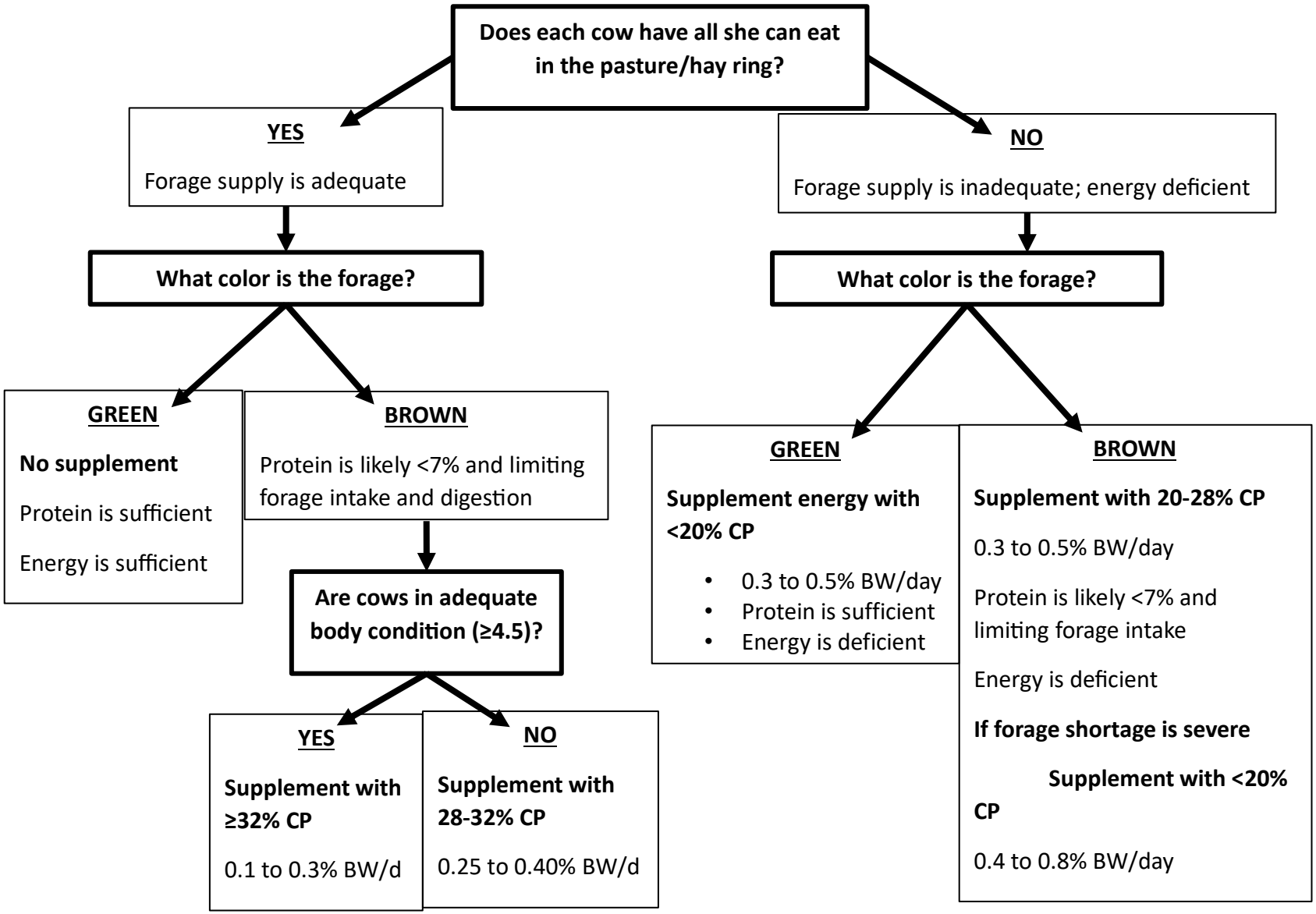

Figure 5. Schematic representing the decision tree for designing forage supplementation strategies.

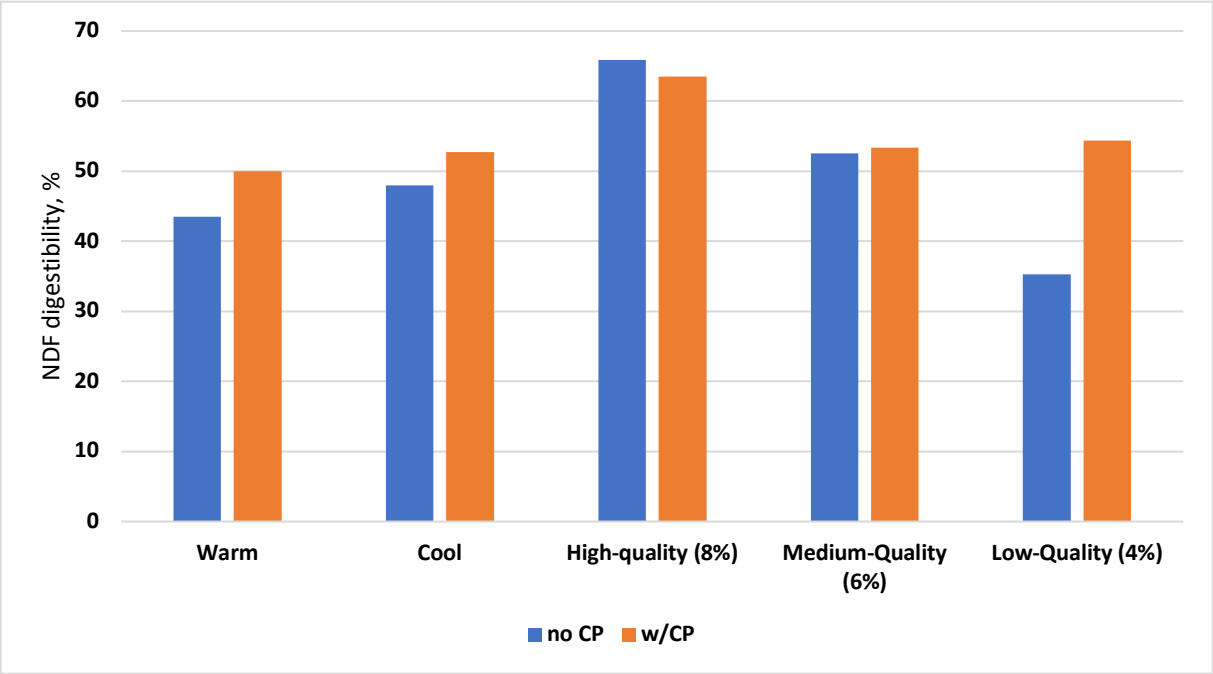

Figure 6. Effect of rumen degradable crude protein (CP) supplementation to steers consuming medium-quality warm or cool-season forage species and to high-, medium-, and low-quality forage on neutral detergent fiber (NDF) digestibility. Adapted from Bohnert et al., 2011 and Mathis et al., 2000.

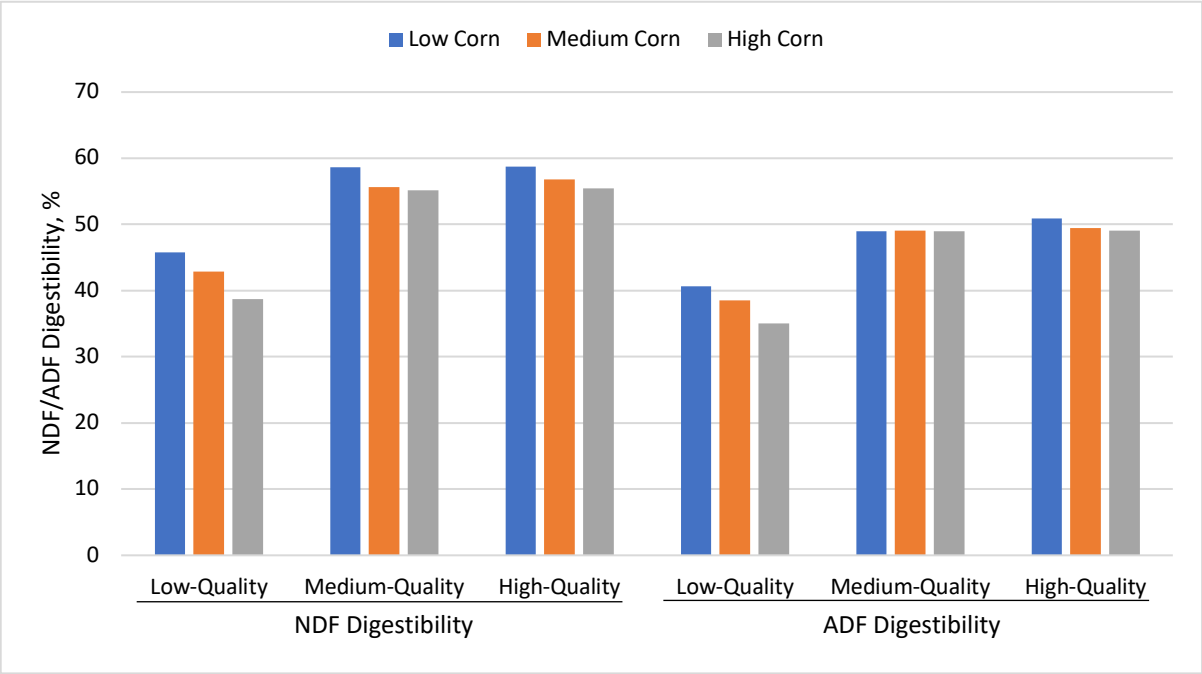

Figure 7. Neutral and acid detergent fiber digestibility of low (5% CP), medium (10% CP), and high (14% CP) quality forage when supplemented with increasing amounts of corn (0.25, 0.50, and 0.75% of BW). Adapted from Matejovsky and Sanson, 1995.

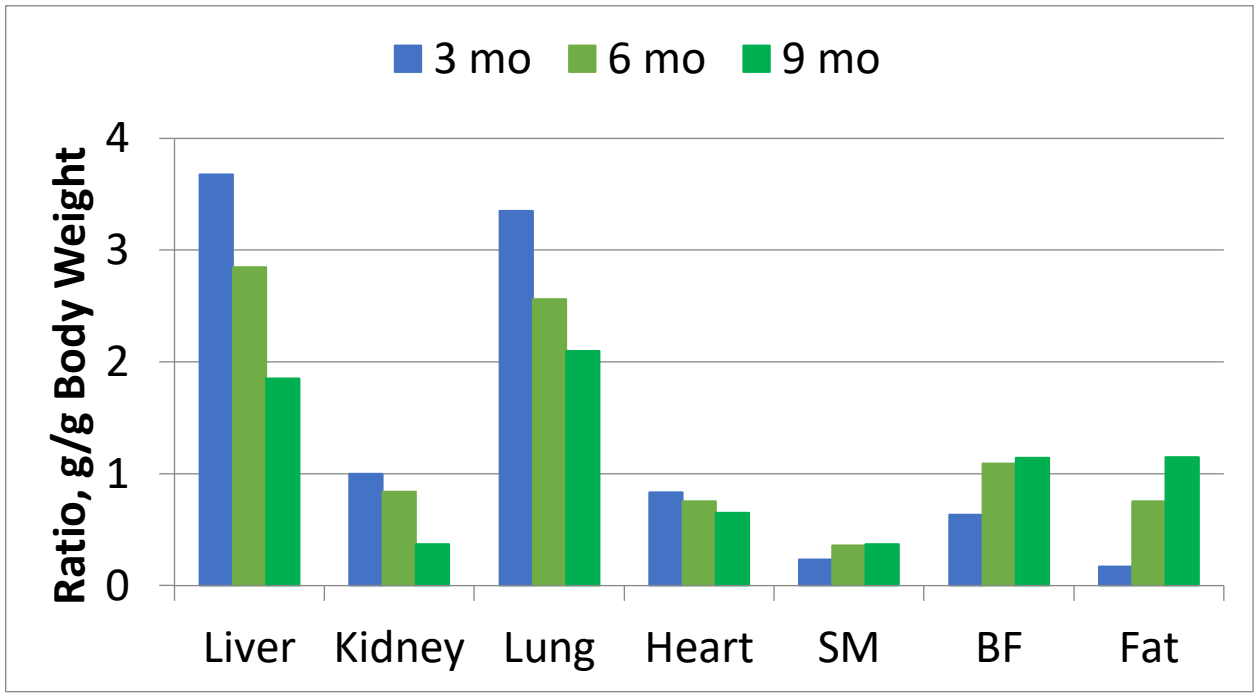

Figure 8. Ratio of tissue weight to fetal body weight of different bovine tissues in early, mid, and late gestation. SM = semitendinosus muscle; BF = biceps femoris muscle. Adapted from Mao et al., 2008.

Table 2. Effects of protein supplementation to gestating beef cows grazing dormant winter range in late gestation on offspring performance			
Item	No Protein	Protein	% Difference
Calf birth wt., lb	78	80	No difference
Calf weaning wt., lb	530	558	+5.3
Steer progeny			
Postweaning DMI, lb/d	23.0	24.3	+5.6
Postweaning ADG, lb/d[1]	3.66	3.77	+3.0
Hot carcass wt., lb	782	824	+5.4
Ribeye area, sq. in.[2]	9.88	10.75	+8.8
Marbling score[1]	457	503	+10.1
Heifer progeny			
Age at puberty, d[3]	370	355	-4.0
BW at puberty, lb[3]	281	279	No difference
Prebreeding BW, lb[4]	586	608	+3.8
Pregnant, %	79	92	+16.5
Calved 1st 21-d, %[4]	49	77	+57.1
Compilation of results from Martin et al., 2007; Larson et al., 2009; Funston et al., 2010; Maresca et al., 2019; Acton et al., 2020 [1]Only Larson et al., 2009 [2]Only Maresca et al., 2019 [3]Only Funston et al., 2010 [4]Only Martin et al., 2007			

LARGE ANIMAL PROCEEDINGS

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BLV Prevalence in North-East Kansas Beef Herds

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Evaluation of Herd and Within-Herd Prevalence of Bovine Leukemia Virus in Eastern Kansas Beef Cattle

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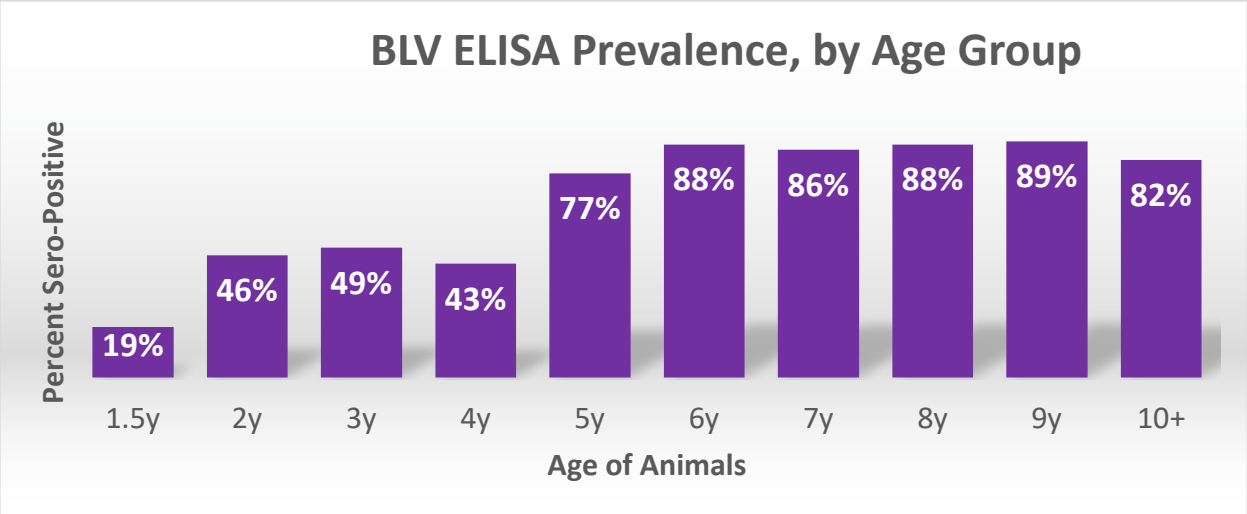
The last U.S. national beef Bovine Leukosis Virus (BLV) herd prevalence study occurred in 1997 by the USDA. This study found an AGID/ELISA herd- prevalence of 36.4% and an individual animal prevalence of 7.73% of animals tested in the Northcentral U.S. which included the state of Kansas. Kansas State University and Michigan State University, in a collaborative effort, performed a BLV herd and with-in-herd prevalence study of beef cattle in Eastern Kansas in the fall of 2021.

Beginning September 27, 2021 and concluding November 5, 2021, convenience blood samples were collected for BLV screening from cattle that presented to Kansas State University for routine herd/pregnancy checks. Whole herd BLV ELISA screening (IDEXX gp-51) was performed on 2,845 animals from 43 herds owned by 20 different producers spanning 13 counties in Eastern Kansas. All animals that had a positive BLV ELISA test were submitted for BLV qPCR testing (SS1) to measure proviral load. Metadata collected on sampled animals was age, breed, BCS, and pregnancy status.

41/43 herds had at least one ELISA positive animal, a 95% herd prevalence. 55% of all cattle tested were found to be ELISA positive. ELISA individual prevalence was associated with the age of the animal tested, with the probability of being BLV ELISA-positive being less likely for primiparous cow when compared to both young cows (second-parity and third parity) and mature cows. Mature cows were more likely to be BLV ELISA positive than either primiparous or young cows.



Percent BLV ELISA Positive animals per age group

BLV is an oncogenic deltaretrovirus that uses its own reverse transcriptase to create a viral DNA molecule that is incorporated into the host cell's DNA. This DNA is termed a provirus. There has been much work done in the dairy industry to create ways to quantify the amount of proviral DNA present in an infected animal, proviral load (PVL). It is thought that animals with high PVL's have a greater risk for transmitting the disease than animals with low PVL's. One challenge with interpreting PVL is that there has not been a standardization in the way that it is quantitated. There are no PVL thresholds that have been established to use as guidelines when trying to interpret if an animal has a high or low PVL. Neither has a PVL level been established

in defining whether an animal has a high or low likelihood for transmitting the disease to an uninfected animal. In this study, we used the qPCR SS1 by CentralStar Laboratories in Lansing, MI. This test uses a ratio of proviral DNA to host cell DNA to quantify the amount of proviral DNA present in an animal. Although this would suggest a certain number of leukocytes infected by the virus, it is important to realize that some leukocytes might carry 3-5 proviral copies, so a ratio of 1:1 should not be interpreted as every leukocyte being infected with BLV. In this study, 53.6% of the BLV ELISA positive animals were found to be harboring proviral DNA. There are detection limits to the BLV PCR tests available, and it is currently accepted that BLV ELISA positive- BLV PCR negative animals are still harboring provirus but have a PVL too low to detect.

In this study, we compared pregnancy rates to both the BLV ELISA and BLV PCR status of the cows tested. No negative effects to pregnancy or the timing of pregnancy were seen due to being either BLV ELISA or BLV PCR positive. We also did not find any negative association with pregnancy status and PVL levels within the BLV infected cattle population in this study.

Animals infected with BLV are only viremic for a short period of time after the initial exposure to a BLV infected leukocyte, so it is unlikely that this disease is spread via free viral transmission. It is accepted that the transfer of leukocytes infected with provirus is the most likely route for transmission. Many researchers have investigated different routes of leukocyte transmission in dairy cattle: insect vectors, surgical equipment contaminated by blood, reuse of needles and rectal sleeves, milk/colostrum, and close contact between animals. Through this research, there has been a lot of conflicting results that have made the transmission of BLV difficult to understand. The dairy industry has also recognized that within the Holstein breed, certain lines of cattle have a genetic predisposition for becoming infected with BLV. Due to the prior perception that BLV is primarily a dairy cow disease, we are only beginning to research the routes of transmission and genetic predisposition in beef cattle.

It is recognized that <5 % of BLV infected cattle develop lymphoma, but it is unknown if there are other health or economic consequences to becoming infected by this virus. It is also unknown if there is any zoonotic potential for this virus.

There are over twenty countries in Europe who have been successful in their efforts to eradicate this disease by aggressive BLV ELISA testing and culling. This would be an economic challenge for many of the beef herds in this study given the fact that over half the herds participating in this study would have to depopulate over 70% of their herds. One strategy in BLV eradication that has been used in the US dairy industry is to set a percentage of BLV positive animals to cull yearly and to then cull that number of animals from the highest PVL cows within the herd. In theory, this would result in reduced disease transmission and ultimately eradication through years of implementation. This strategy does not come without challenges. Without a firm understanding of how this virus is transmitted, eradication will be difficult to achieve if neighboring herds are not committed to the same strategy.

With so many unknowns about BLV and its potential negative effects to the beef industry, it is difficult to provide sound advice to producers. All we can do as veterinarians is to use the knowledge that we have currently, and give the best advice that we can until we know more about this virus. We know that the BLV prevalence in beef herds participating in this study are much higher than previous estimates. It is accepted that this is a disease that is spread through the transmission of infected leukocytes, so any management decision to prevent leukocyte transmission is not going to hurt our chances of decreasing BLV transmission: changing needles between animals, changing rectal sleeves when we recognize there is blood contamination on them, cleaning surgical and AI equipment, etc. We know that the younger animals in this study were at a lower prevalence than the older animals. I would suggest managing animals in groups according to age rather than mixing different age groups together. BLV ELISA is a terrific screening tool for BLV within a herd, but if the ELISA prevalence is too high to make culling

decisions from its results, proviral load testing might be an avenue to create a more targeted culling strategy.