STATE OF BEEF

Increasing Production Efficiency

November 7-8, 2018

North Platte

Proceedings

The State of Beef Conference
"Improving Production Efficiency"

November 7 and 8, 2018
Sandhills Convention Center
Quality Inn and Suites
North Platte, Nebraska

Coordinators

Karla Jenkins
Cow-calf and Range Management Specialist
UNL Panhandle Research and Extension Center, Scottsbluff
(308) 632-1245
kjenkins2@unl.edu

Rick Funston
Reproductive Physiologist
UNL West Central Research and Extension Center, North Platte
(308) 696-6703
rfunston2@unl.edu

Travis Mulliniks
Range Nutritionist
UNL West Central Research and Extension Center, North Platte
(308) 696-6707
travis.mulliniks@unl.edu

Randy Saner
Beef Systems Extension Educator
Nebraska Extension, North Platte
(308) 532-2683
rsaner2@unl.edu

Matt Spangler
Beef Genetics Extension Specialist
UNL Animal Science, Lincoln
(402) 472-6489
mspangler2@unl.edu

The State of Beef Conference
"Improving Production Efficiency"

November 7 and 8, 2018
Sandhills Convention Center
Quality Inn and Suites
North Platte, Nebraska

THANK YOU TO THESE BUSINESSES FOR MAKING STATE OF BEEF POSSIBLE

BREAK SPONSORS

ABS GLOBAL
BOEHRINGER INGELHEIM ANIMAL HEALTH

ADDITIONAL SPONSORS

AGRI AFFILIATES, INC.
FARM CREDIT SERVICES OF AMERICA
GENEX BEEF
MERCK ANIMAL HEALTH
MULTIMIN USA
PRAIRIE STATES SEED
REPROSCAN TECHNOLOGIES
USDA-NASS
WARD LABORATORIES

The State of Beef Conference

"Increasing Production Efficiency"
November 7 and 8, 2018
North Platte, Nebraska

Schedule and Proceedings Contents

WEDNESDAY, NOVEMBER 7

8:45 CT Vendor Booths Open

Morning Moderator: Karla Jenkins, UNL Panhandle Research and Extension Center

10:00 MARKET OUTLOOK

Jim Robb, Livestock Marketing Information Center 5

10:40 COW SIZE AND EFFICIENCY

Travis Mulliniks, UNL West Central Research and Extension Center 7

11:20 REPRODUCTIVE MANAGEMENT

Rick Funston, UNL West Central Research and Extension Center 13

Noon Lunch and Visit Vendors

Afternoon Moderator: Randy Saner, Nebraska Extension in Lincoln, Logan, and McPherson Counties

1:20 INTERNAL AND EXTERNAL PARASITES

Dave Boxler, UNL West Central Research and Extension Center 31

2:00 ANIMAL BREEDING PROGRAMS TO SUPPORT AN EVER-CHANGING WORLD

Tom Rathje, DNA Genetics LLC 39

2:40 Break and Visit Vendors

3:00 ALTERNATIVE ENTERPRISES FOR THE COW-CALF PRODUCER

Burke Teichert, Consultant 41

4:00 ALTERNATIVE ENTERPRISES PANEL 49

Moderator: Burke Teichert

Panel Members: Logan Pribbeno, Wineglass Ranch, Imperial

Sarah Sortum, Switzer Ranch, Burwell

Vern Terrell, Terrell Farms LLC, Hay Springs

5:20 Wrap-up

5:35 Cash Bar, Social, Visit Vendors

6:15 Dinner

7:00 Bull Pen Sessions

THURSDAY, NOVEMBER 8

7:45 CT Visit Vendor Booths

Morning Moderator: Karla Jenkins, UNL Panhandle Research and Extension Center

8:30 HERD HEALTH

Dale Grotelueschen, Great Plains Veterinary Education Center 51

9:10 ALTERNATIVE FORAGE SYSTEMS

Mary Drewnoski, University of Nebraska-Lincoln

Jay Parsons, University of Nebraska-Lincoln 59

10:05 Break and Visit Vendor Booths

10:20 GENETIC SELECTION FOR EFFICIENCY

Matt Spangler, University of Nebraska-Lincoln 65

11:00 PRODUCTION EFFICIENCY PANEL 71

Moderator: Matt Spangler

Panel Members: Mark Allan, Trans Ova Genetics

Douglas Olsen, Olsen Ranches

Jerry Wulf, Wulf Cattle

12:20 Wrap-up and have a safe trip home!

THANK YOU FOR ATTENDING THE 2018 STATE OF BEEF CONFERENCE

N EXTENSION

ON THE COVER: Cattle at the University of Nebraska Barta Brothers Ranch. Photo taken by Jess Milby.

Proceedings, State of Beef Conference
November 7 and 8, 2018, North Platte, Nebraska

MARKET OUTLOOK

Jim Robb
Livestock Marketing Information Center

Jim Robb is a Senior Agricultural Economist at the Livestock Marketing Information Center (LMIC). Twice he has been Center Director, serving in that capacity for a total of 24 years. Before joining the LMIC, Jim was an Agricultural Economist at the University of Nebraska. He also has worked in the agricultural finance sector. He received degrees in Agricultural Economics from the University of California – Davis, and Michigan State University.

NOTES

Proceedings, State of Beef Conference
November 7 and 8, 2018, North Platte, Nebraska

COW SIZE AND COWHERD EFFICIENCY

J. T. Mulliniks, M. Benell, and R. N. Funston
University of Nebraska West Central Research and Extension Center, North Platte

Introduction

What is the criteria for the right cow size? Is it calf weaning weight and eventual slaughter weight, marketing endpoint, optimal ranch forage utilization, optimizing net returns for the cow/calf operation, or a lower risk production system? The answer is "yes" to all above as they are all interrelated. Optimizing cow-herd production efficiency is a combination of feed inputs and output. In doing so, ranch efficiency requires an understanding and managing for genetic potential (i.e., cow size, milk production) and how it fits within the given environment and environmental constraints. Mature cow size of the herd has long been debated on what the optimal cow size for a given environment is. Cow size has traditionally been utilized in selecting cows to fit their environmental conditions. Cow size studies; however, are often limited in duration, size of study, simulation studies, or usually end at weaning. In semi-arid and limited resource environments, small to moderate size cows have been suggested to be more efficient than and as productive as larger cows.

A driver of cow size at the ranch is the energetic inefficiency of beef production due to the high cost of body maintenance requirements. With that in mind, of the entire beef production system, the beef cow or cowherd is the most energetically demanding segment. For instance, 71% of the total dietary energy expenditure in beef production is used for maintenance and that 70% of the maintenance energy is required for the cow herd (Johnson, 1984). Therefore, an overwhelming 50% of the total energy expended in producing beef is used for maintenance of the cow. However, with more genetic trends and selection for output traits, maintenance cost for the cowherd may have increased over time.

So why are differences in feed intake so important for the cow herd? Feed requirements amount to 50-75% of the annual maintenance requirement costs for the herd. Grazed forages comprise the largest and most important feedstuff for the cow. Due to increased pasture costs, increasing the utilization of forage with the optimal cow size is important. Thus stocking density of the pastures for the cow herd becomes an increasingly important management control point. As mature cow size increases from 1,000 to 1,400 pounds, intake, energy, and protein requirements increase 23%, 19%, and 13%, respectively for cows 90 days post-calving. Consider that each 100 pounds of additional mature cow weight requires the equivalent of about 600 pounds of additional high-quality grass hay per year to maintain their body weight and condition (NASEM, 2016). Bigger cows simply require more feed inputs, partially due to a larger body mass maintenance.

Calf weaning weight to cow weight ratio has previously been used as a measure of efficiency of cow size. However, there are some fundamentally flawed aspects to using this ratio as a measure of ranch efficiency. First of all, forage intake assumptions may be inaccurate, leading to over or under-estimation for inputs. And, milk production can have a negative or positive impact on the ratio. Across commercial and cow/calf operations in Oklahoma, Bir et al. (2018) reported no strong relationship between cow size and calf weaning weight, indicating there is a large variation in weaning weight. However, these authors do indicated that an additional 100 lb of mature cow body weight only resulted in an increase in 7 lb of calf weaning weight. With that in mind, larger cows have increased input costs and in some instances marginal increases in calf weaning weight, which may not pay for the greater input costs. In herds utilizing maternal genetics, calf weaning weight only influences ranch profitability by 5%. In limited nutrient environments, because of their greater maintenance requirements, the breeds with greater growth and milk potentials may have less energy to commit to reproduction. A fifty pound difference in weaning weight is minimal compared to weaning a four hundred fifty pound calf versus no calf.

Gudmundsen Sandhills Laboratory Cow Size Study

The University of Nebraska-Lincoln Institutional Animal Care and Use Committee approved all procedures used in this experiment. Cow performance data were collected from 2005 to 2017 at the Gudmundsen Sandhills Laboratory (Whitman, NE) from March (n = 3,448) and May (n = 934) calving herds.

Cows utilized in this study were Husker Red (5/8 Red Angus, 3/8 Simmental) and ranged from 2 to 11 yr of age. To correct for differences in BCS at weaning, cow body weight at weaning was adjusted to a common body condition score of 5. Cow size groups were then determine by taking the average adjusted BW within each age and stratifying to groups as small (< 1 standard deviation from mean within age), medium (within 1 standard deviation from mean with age), or moderate (> 1 standard deviation from mean with age). Grouping cow size within age was conducted to normalize data within age of cows so that younger cows would not automatically fall into small cow size and confound results by cow age. Cow size treatment groups were stratified within age to eliminate young cows not yet at mature BW from being miscategorized into the small category. In addition, young cows were left in the dataset to determine if cow age interacts with cow size on productivity. Cow BW at weaning ranged from 642 to 1745 lb with only 3% of cows over 1250 lb at weaning over the years.

Cow performance results

Cow BW at pre-calving, breeding, and weaning were greater as cow size increased ($P < 0.01$; Table 1), which was expected due to the experimental design. Moderate cows maintained BW from calving to weaning; whereas, small and medium sized cows lost BW ($P < 0.01$). In addition, BCS was lower ($P < 0.01$, Table 2) for small-sized cows at pre-calving, pre-breeding, and weaning. Pregnancy rates increased with increasing cow size ($P < 0.01$) with the lowest pregnancy rates in small cows. The increase in BW loss and decrease in pregnancy rate in small-sized beef cows may be due to an imbalance of genetic potential for milk production and ability to consume enough forage to support that milk production level. Although milk production level will increase forage intake, cow size will have larger impact on forage intake. Therefore, milk production in the small-sized cows may have been too great for the nutritional environment of the Sandhills, resulting in greater BW loss and decreased reproductive performance.

Calf BW at birth, breeding, weaning, and 205-d weight increased ($P < 0.01$, Table 1) as cow size increased. Calf ADG from birth to breeding was lower ($P < 0.01$) in calves from small-sized dams, where offspring from medium- and moderate-sized cows having similar ADG to breeding. Overall ADG from birth to weaning was greater ($P < 0.01$) in calves from moderate-sized cows. Although, as a percent of cow size, small-sized beef cows did wean a greater ($P < 0.01$)

percentage of their BW compared with their larger counterparts, which is expected. In general, small cows tend to be more efficient at weaning a larger percentage of their BW than larger cows.

Post-weaning steer performance

Steer feedlot entry BW increased ($P < 0.02$, Table 2) as dam size increased. Steer BW at reimplant tended ($P = 0.07$) to increase with increased dam size. In addition, final BW was greater ($P < 0.01$) for steer from moderate cows with no difference in finishing BW between steers from small and medium cows. Although finishing steer BW were lighter from smaller cows, small cows did have steers with a finishing feedlot BW approximately 1.5 times their mature BW. Feedlot ADG, DMI, and G:F were not different ($P \geq 0.52$) among steers from dams with increasing cow size. Similar to final BW, HCW increased ($P < 0.01$) in steers from moderate dams with no difference between steers from small and medium cows. Marbling score and yield grade were not different ($P > 0.39$) regardless of dam size. However, LM area and back fat thickness were different ($P < 0.05$) in steers from differing sized dams. Steers from small cows had decreased LM area compared to their counterparts with no difference between steers from moderate- or medium-sized cows. On the other hand, back fat thickness was greater for steers from small cows compared with steers from moderate- and medium-sized cows.

Conclusion

As beef cattle production costs increase, particularly those associated with feeding the cow herd, the size and nutritional requirements of the cow herd have to be addressed. The challenge for every beef cattle enterprise is to produce calves that meet market requirements as efficiently as possible. When analyzing optimal cow size, producers have to take into account the market endpoint they will be selling into. Cow mature weight has important implications for many of the production parameters associated with the overall cow herd. Heifer development, cow reproduction, and calf performance can be affected by cow weight. If bigger cows wean a heavier calf, does that difference in pounds weaned pay for the difference in forage that the larger dam will consume? In many instances, the level of inputs may be greater for larger cows than the offsetting increase in calf weaning weight.

In the UNL dataset, small cows resulted in decreased reproductive performance, smaller weaning weight of calves, and smaller carcass weights. Increasing cow size above cows managed at Gudmundsen does have a point of diminishing returns. Overall, each individual operation must analyze his own situation within their environment and management goals and fit the cow to that situation, however, at the same time projecting future demands with enough flexibility to make subtle alterations as conditions change. Intuitively, the goal would be modest size cows with high reproductive rates and low input costs which produce high-value calves.

Literature Cited

Bir, C., E. A. DeVuyst, M. Rolf, D. L. Lalman. 2018. Optimal beef cow weights in the U.S. Southern Plains. J. Ag. Res. Econ. 43:102-116.

Johnson, D.E., 1984. Maintenance requirements for beef cattle: Importance and physiological and environmental causes of variation. IN: Proc. Beef Cow Efficiency Forum. Michigan State Univ., E. Lansing, MI and Colorado State Univ., Fort Collins, CO. p. 6.

National Academies of Sciences, Engineering, and Medicine. (2016). *Nutrient requirements of beef cattle* (8th rev. ed.). Washington, DC: National Academies Press. doi:10.17226/19014

Notter, D. R. 2002. Defining biological efficiency of beef production. Proceedings Beef Improvement Federation. Omaha, NE.

Table 1. Effect of cow size on cow-calf performance in the Sandhills.

	Cow Size[1]				
Measurement	Small	Medium	Moderate	SEM	*P*-value
Cow BW, lb					
Pre-calving	961[a]	1,080[b]	1,187[c]	6	< 0.01
Breeding	947[a]	1,065[b]	1,178[c]	6	< 0.01
Weaning	882[a]	1,025[b]	1,187[c]	5	< 0.01
Cow BW change, lb					
Pre-calving to weaning	-72[a]	-54[b]	0[c]	5	< 0.01
Cow BCS[2]					
Pre-calving	4.8[a]	5.1[b]	5.3[c]	0.06	< 0.01
Breeding	5.2[a]	5.4[b]	5.6[c]	0.02	< 0.01
Weaning	4.9[a]	5.1[b]	5.2[c]	0.03	< 0.01
Pregnancy rate, %	86[a]	92[b]	97[c]	3	< 0.01
Calf BW, lb					
Birth	72[a]	76[b]	79[c]	0.6	< 0.01
Breeding	226[a]	235[b]	240[c]	2	< 0.01
Weaning	460[a]	483[b]	498[c]	3	< 0.01
205-d	425[a]	452[b]	474[c]	3	< 0.01
Percent of Cow Size Weaned[3], %	52.5[a]	47.7[b]	42.9[c]	0.4	< 0.01
Calf ADG, lb/d					
Birth to breeding	2.03[a]	2.12[b]	2.13[b]	0.02	< 0.01
Birth to weaning	1.78[a]	1.87[b]	1.94[c]	0.01	< 0.01

[abc]Within a row, means with differing superscript letter differ ($P < 0.05$).

[1]Cow size determined by adjusting cow weaning BW to a BCS 5.

[2]Scale of 1 (emaciated) to 9 (extremely obese).

[3]Calculated by dividing calf weaning weight by dam weaning weight.

Table 2. Effect of cow size on progeny steer feedlot performance.

	Cow Size[1]				
Measurement	Small	Medium	Moderate	SEM	P-value
Feedlot Performance, lb					
Entry BW	656[a]	667[b]	693[c]	15	0.02
Reimplant[2] BW	1,027	1,042	1,068	22	0.07
Final BW	1,399[a]	1,413[a]	1,469[b]	22	< 0.01
ADG, lb/d					
Entry to Reimplant	4.07	4.04	3.91	0.30	0.71
Reimplant to Final	3.75	3.81	3.83	0.18	0.74
Overall	3.91	3.95	3.88	0.13	0.66
Dry Matter Intake, lb					
Entry to Reimplant	27.52	27.33	27.87	0.98	0.79
Reimplant to Final	27.51	27.50	27.97	0.94	0.88
Overall	27.45	27.42	27.83	0.88	0.89
Gain:Feed					
Entry to Reimplant	0.1485	0.1486	0.1366	0.0107	0.52
Reimplant to Final	0.1377	0.1398	0.1354	0.0050	0.54
Overall	0.1463	0.1476	0.1421	0.0067	0.66
Carcass Characteristics					
HCW, lb	881[a]	890[a]	925[b]	14	< 0.01
Marbling[3]	506	506	505	16	0.99
LM area, in^2	14.07[a]	14.22[b]	14.41[b]	0.12	0.05
Back fat, in	0.60[a]	0.55[b]	0.53[b]	0.03	0.01
USDA Yield Grade	3.06	2.95	2.98	0.14	0.39

[abc]Within a row, means with differing superscript letter differ ($P < 0.05$).

[1]Cow size determined by adjusting cow weaning BW to a BCS 5.

[2]Approximately, 100 d prior to slaughter.

[3]Marbling: $Small^{00}$ = 400, $Small^{50}$ = 450, $Modest^{00}$ = 500.

Travis Mulliniks is an Assistant Professor in Range Production Systems at the University of Nebraska and located at the West Central Research and Education Center in North Platte, NE. He grew up in eastern Oklahoma and received his BS degree in Animal Science from Oklahoma State University. In addition, he earned a MS and PhD in Range Nutrition from New Mexico State University. Prior to coming to UNL, Travis was on faculty at the University of Tennessee. Dr. Mulliniks' research and extension objectives consist of developing an applied cow-calf research program that emphasize sustainability and economically viable management options through enhanced efficiency and strategic supplementation in beef cattle production.

NOTES

Proceedings, State of Beef Conference
November 7 and 8, 2018, North Platte, Nebraska

GENERAL MANAGEMENT CONSIDERATIONS TO IMPROVE SUCCESS OF ARTIFICIAL INSEMINATION AND NATURAL SERVICE CONCEPTION RATES

R.N. Funston[1], G.A. Perry[2], and M.F. Smith[3]
[1]University of Nebraska, West Central Research and Extension Center, North Platte;
[2]Department of Animal and Range Sciences, South Dakota State University, Brookings;
[3]Division of Animal Sciences, University of Missouri, Columbia

Introduction

Although artificial insemination is the most powerful tool available for genetic improvement, cow calf producers have been slow to adopt this technology due to the time and labor associated with estrous detection and a market structure that until recently has not provided an incentive to cow calf producers for genetic improvement. However, adoption of fixed-time artificial insemination protocols (FTAI) has been increasing due to a changing market structure that recognizes and provides an economic incentive for genetic improvement (e.g. premiums) combined with the development of FTAI protocols that result in pregnancy rates similar to AI following detection of estrus. FTAI protocols that result in pregnancy rates similar to AI following detection of estrus result in calves being born early in the calving season resulting in more pounds of calf weaned, which is a tremendous economic gain. A successful FTAI program is dependent upon optimization of the number of healthy cycling females at the beginning of the breeding season, careful attention to sire selection, implementation of an appropriate estrus synchronization protocol, low stress cattle handling, purchase of high quality semen, proper semen handling and insemination technique, and good nutritional management before and after FTAI. Most importantly, implementation of a successful FTAI program requires careful thought and attention to detail. The purpose of this paper is to review the major factors affecting the success of a FTAI program. Emphasis will be given to management considerations that should be implemented before, during, and after FTAI.

Importance of Early Conception

Calving date for first calf heifers may impact cow longevity and productivity. Calving late in year one increases the proportion of cows that either calve later next year or do not conceive (Burris and Priode, 1958). Research has indicated heifers having their first calf earlier in the calving season remained in the herd longer and had greater calf weaning weights compared with heifers that calved later in the calving season (Cushman et al., 2013). Therefore, heifers calving earlier in the calving season have greater potential for longevity and lifetime productivity.

Decreasing the calving period has far reaching implications across the cow-calf enterprise and beyond. Calf age is the single most important factor impacting weaning weight in cow-calf operations so herds with more concentrated calving distributions are expected to have heavier weaning weights compared with herds that do not. Effects of calving early in the calving season potentially extend much further into beef systems, including improved pregnancy percentages and subsequent calving distributions the next calving season, increased cow longevity, lower replacement rate, positive influences on carcass quality and value, reduced labor requirements, increased returns on feed inputs and improved overall sustainability.

The importance of maximizing the proportion of cows that conceive early in the breeding season cannot be overemphasized in a beef herd. Data from the University of Nebraska reported that heifers born during the first 20 days compared to the second or third 20 days of the calving season had greater weaning weights, prebreeding weights, and precalving weights; more heifers cycling by the start of the breeding season; and higher pregnancy rates. Heifers that conceive early in the breeding season have greater longevity in the herd which increases profitability. Furthermore, steer progeny born during the first 20 days compared to the second or third 20 days of the calving season had greater weaning weights, increased hot carcass weights, higher marbling score, and greater carcass value (Funston et al., 2012a). Consequently, the advantages of calves born early include improved end product quality as well as increased reproductive performance of heifers. Management strategies for increasing the proportion of early calving heifers and cows are discussed below.

Factors Affecting Pregnancy Rate

When it comes to reproductive management the things you do well do not compensate for the mistakes you make. Instead, the mistakes you make cancel out all the things you do well. This is best illustrated by examining the primary factors that affect pregnancy rate. In an AI program, pregnancy rate is the product of estrous detection rate and conception rate (Pregnancy rate = estrous detection rate x conception rate; see definitions below). The following definitions can be applied to an entire breeding season or to the synchronized period (period of time during which estrus is expressed after treatment with an estrus synchronization protocol [normally 5 to 7 days]).

Pregnancy rate – total number pregnant during the breeding season/ number of females exposed to breeding (expressed as a percent).

Estrous detection rate – total number of females detected in estrus/number of females exposed to breeding (expressed as a percent).

Conception rate – percentage of females that become pregnant to a designated insemination.

The effect of a decrease in estrous detection rate and/or conception rate on pregnancy rate can be seen in Table 1. Assume that 100% of the heifers have attained puberty and that you are able to detect 95% of the heifers in estrus during the synchronized period. With a conception rate of 70% the pregnancy rate would be: 95% estrous detection rate x 70% conception rate = 67% pregnancy rate! If we hold conception rate at 70% and decrease estrous detection rate to 75%, due to fewer animals cycling or less time spent detecting estrus, the pregnancy will be reduced to 53%. Alternatively, if estrous detection rate remains at 95% but conception rate is decreased to 50% due to compromised semen quality or poor insemination technique, the pregnancy rate would decrease to 48%. Finally, a decrease in both estrous detection rate and conception rate will decrease pregnancy rate from 67% to 38%. Therefore, understanding the effect of estrous detection rate and conception rate on pregnancy rate and the importance of attention to detail in every aspect of an estrus synchronization program is essential!

Table 1: Effect of estrous detection rate and conception rate on pregnancy rate in cattle.

Estrous detection rate	Conception rate	Pregnancy rate
95%	70%	67%
75%	70%	53%
95%	50%	48%
75%	50%	38%

Things to Do before Estrus Synchronization and Fixed-time Artificial Insemination

Where do I start?

When implementing an estrus synchronization and AI program the first decision should be where to start. Estrus synchronization and AI do not have to be used in combination. Estrus synchronization can be used in combination with natural service or AI. There are clear benefits to reproductive management of a herd from using estrus synchronization in combination with natural service (e.g. increase the proportion of females that conceive early). Two estrus synchronization protocols that are relatively low cost and have been effective in combination with natural service include: 1) Feed MGA (0.5 mg/hd/day) for 14 days to heifers and turn bulls in 10 days after MGA withdrawl, and 2) Turn in bulls (day 1 of breeding season) and inject all heifers and cows with prostaglandin $F_{2\alpha}$ (PGF) on day 4. Advantages of the preceding MGA protocol include no trips through the chute and a portion of the prepuberal heifers will be induced to cycle earlier; however, you have to feed MGA daily for 14 days and each heifer needs to receive the correct dose. The advantage of the PGF protocol is that you only have a single trip through the chute (PGF injection); however, all the heifers and cows need to be cycling in order to respond to PGF. Prepuberal heifers or noncycling cows will not respond to PGF since they do not have a corpus luteum. Once you become comfortable with implementing an estrus synchronization protocol in combination with natural service it is not difficult to make the next step to using AI instead of natural service.

What can I expect in terms of pregnancy rate?

When beginning an AI program it is essential to have realistic expectations regarding the pregnancy rate. As previously discussed, pregnancy rate is the product of estrous detection rate and conception rate. It is important to remember that a pregnancy rate of 67% to a single insemination is good whether you are talking AI or natural service. For natural service, expected pregnancy rates are normally 60 to 70% during 21 days of breeding assuming the bulls are fertile and that 100% of the heifers and cows are cycling. However, a pregnancy rate of 60 to 70% over 21 days is unusually high for natural service since rarely are all the heifers and cows cycling at the start of the breeding season. In a FTAI program, all the cows are injected with GnRH (to synchronize ovulation) and inseminated at a predetermined time. Since there is no estrous detection with FTAI, estrous detection rate becomes the proportion of heifers and cows that ovulate in response to GnRH injection at insemination. It is normal for the pregnancy rate to be higher following FTAI compared to protocols that are dependent upon estrous detection since ovulation is induced and semen is deposited in all the cows in a FTAI protocol. In an estrous detection protocol only the females detected in estrus are inseminated and females that are anestrus or not detected in estrus are not inseminated.

Are my heifers and cows good candidates for an estrus synchronization protocol?

The first question to ask is "Over the past few years what has been the pregnancy rate in my heifers or cows after a 60 to 80 day breeding season?" If the pregnancy rate at the end of the breeding season has been less than 85% there may be management issues that should be addressed before initiating a synchronization and AI program. If the pregnancy rate in your herd over the past few years has been ≥ 85% then you need to evaluate whether your heifers and cows are good candidates for an estrus synchronization and AI program.

Criteria for heifers. Studies in numerous species provide evidence that diet during development can mediate physiological changes necessary for puberty. In cattle, several studies have reported inverse correlations between postweaning growth rate and age at puberty and heifer pregnancy rates. Thus, postweaning growth rate was determined to be an important factor affecting age of puberty, which in turn influences pregnancy rates. This and other research conducted during the late 1960s through the early 1980s indicated puberty occurs at a genetically predetermined size, and only when heifers reach their target BW can increased pregnancy rates be obtained. Guidelines were established indicating replacement heifers should achieve 60 to 65% of their expected mature BW by breeding. Traditional approaches for postweaning development of replacement heifers used during the last several decades have primarily focused on feeding heifers to achieve or exceed an appropriate target BW and thereby maximize heifer pregnancy rates. Intensive heifer development systems may maximize pregnancy rates, but not necessarily optimize profit or sustainability. Since inception of target BW guidelines, subsequent research demonstrated that the growth pattern heifers experience before achieving a critical target BW could be varied. Altering rate and timing of BW gain can result in compensatory growth periods, providing an opportunity to decrease feed costs. Recent research has demonstrated that feeding replacement heifers to traditional target BW increased development costs without improving reproduction or subsequent calf production relative to development systems in which heifers were developed to lighter target BW ranging from 50 to 57% of mature BW (Funston et al., 2012b). A more comprehensive discussion of heifer development will be presented by Dr. John Hall.

Heifers that will be used for breeding purposes should not have received growth promoting implants. Previous studies report that implanting heifers within 30 days of birth impairs uterine function and decreases subsequent pregnancy rates. Implanting heifers as yearlings is also detrimental to reproduction (Tibbitts et al., 2017).

Criteria for postpartum cows. To increase the number of cows cycling at the beginning of the breeding season, they should have calved unassisted, be in good body condition at calving, disease-free, and allowed an adequate period of recovery from calving to the subsequent breeding season. Postpartum cows that are good candidates for an estrus synchronization program normally meet each of the following criteria: 1) body condition score at calving of ≥ 5 (1= emaciated; 9 = obese), 2) mean postpartum interval of the cows to be synchronized should be ≥ 40 days at the beginning of the protocol. This does not mean that each cow should be ≥ 40 days postpartum but that the mean of the entire group to be synchronized should be ≥ 40 days. If the estrus synchronization protocol you plan to use includes CIDR administration, each cow should be a minimum of 21 days postpartum at the time of CIDR insertion, and 3) low incidence of calving difficulty since dystocia will lengthen the postpartum interval.

How do I choose an AI sire and where do I obtain the semen?

Sire selection is of critical importance and can have a long term effect within a herd, particularly when heifers are retained as replacements. When choosing a sire the following questions need to be addressed: 1) Will I raise my own replacement heifers or purchase them? and 2) How will I market my calves? Answers to the preceding questions will determine the traits that need to be emphasized. If a producer raises his or her own replacement heifers then selection pressure should be placed on maternal traits such as milk, maternal calving ease, stayability, etc. However, if replacement heifers are purchased off the farm then emphasis on maternal traits in your herd would not be important. When selecting a sire, you need to think about how you will be paid (e.g. pounds of weaning weight, carcass weight, carcass quality) and let this affect your sire selection decisions. Producers that sell their calves at weaning need to place selection pressure on preweaning growth; whereas, producers that retain ownership and market their calves on a grid should emphasize carcass weight, marbling, and ribeye area.

Other genetic traits that have been demonstrated to influence the capacity of a cow to sustain reproduction and be retained include traits that contribute to calving difficulty, level of milk production, and mature size. The genetic changes that have occurred in response to selection for growth and milk production over the last several decades (American Angus Association; American Hereford Association; American International Charolais Association) have undoubtedly resulted in greater nutritional demand to sustain these production traits, leading to greater challenges in sustaining reproduction in nutrient sparse environments. The concept of interaction between genetic potential for production and environment is the basis for recommendation that producers consider selection of breed type or genetic potential of their cattle to match production environment. Converse to this strategy of matching genotype to environment is the recommendation that producers feed their heifers and cows to some target weight or BCS, without consideration of the environmental abundance of associated resources, in an attempt to assure relative high rates of reproductive success. An alternative interpretation of this approach may be that modification of the nutritional environment is needed to sustain a high production potential genotype. The long-term sustainability of this approach needs to be given greater consideration (Roberts et al., 2015).

Expected progeny differences (EPDs) are an effective selection tool and are reported to be 7 to 9 times more effective at generating a response to selection than focusing on measurements of individual performance, which is strongly affected by environment. Use AI sires with high accuracy EPDs and where the semen has been collected from a certified semen services (CSS) facility. Avoid using unproven bulls and do not be hesitant to seek advice from individuals in the AI industry to help make this important management decision.

Another consideration when selecting a sire is whether the bull's semen has worked in FTAI programs. Differences among sires in pregnancy rate to FTAI have been noted; however, the same differences in pregnancy rate may not occur when cows are detected in estrus and inseminated according to the AM/PM rule. Therefore, just because an AI sire has a good conception rate following estrous detection does not ensure he will perform equally well when ovulation is induced and insemination occurs at a predetermined time. It is a good idea to ask an AI representative if there is information available regarding how a bull has worked in a FTAI program.

Which estrus synchronization protocol should I choose?

When choosing an estrus synchronization protocol there are a number of issues to consider including whether you want to detect estrus and inseminate according to the AM/PM rule, inseminate at a predetermined time, or detect estrus for 72 to 84 hr (depending upon the protocol) and inseminate any cows not detected in estrus at a fixed-time. There is an estrus synchronization protocol sheet for heifers and cows that appears in the catalogs of the major AI companies and there are protocols that fit each of the preceding synchronization approaches. Other items to consider include the proportion of females that are cycling as well as the time, labor, and cost of the protocol.

If a significant number of animals are not cycling at the time of implementing an estrus synchronization program, it will be necessary to utilize a progestin-based protocol. Two progestin products that are commercially available for estrous synchronization include Melengestrol Acetate (MGA) and the CIDR (Controlled Internal Drug Release). An advantage of progestin treatment is that a proportion of the prepuberal heifers and anestrus postpartum cows will be induced to begin cycling. In cycling heifers, administration of MGA or CIDRs does not affect the time of corpus luteum regression. However, once corpus luteum regression has occurred, progestin administration can prevent a cow or heifer from showing estrus and ovulating. Consequently, progestin administration in cows that have experienced corpus luteum regression will delay the expression of estrus and ovulation until after progestin withdrawal.

At the start of a breeding season, most herds consist of a mixture of cycling and anestrous females. An effective estrous synchronization protocol must be able to induce a fertile estrus or ovulation in both anestrous and cycling heifers and cows. A short luteal phase usually occurs in prepuberal heifers and postpartum beef cows following the first ovulation (Perry et al., 1991; Werth et al., 1996). This short exposure to progesterone is believed to be necessary for reprogramming the reproductive axis to resume normal estrous cycling. Therefore, in herds that have a large proportion of prepuberal heifers or anestrous cows, progestin pretreatment before induction of ovulation can initiate estrous cycling status and eliminate or at least reduce the occurrence of short estrous cycles.

When should I administer the prebreeding vaccines?

Reproductive diseases, including bovine viral diarrhea (BVD), vibriosis, leptospirosis, and infectious bovine rhinotracheitis (IBR), can induce abortion in cattle and decrease profitability (Daly 2007ab). Consequently, a prebreeding vaccination program in combination with careful attention to biosecurity practices and reducing stress/disease transmission within a herd should be included in a herd health program. Since time and labor associated with trips through the chute have been a deterrent to implementating an estrus synchronization program, many producers want to combine prebreeding vaccines with administration of estrus synchronization products. A common question is "Can I administer prebreeding vaccines in combination with estrus synchronization products without decreasing the pregnancy rate to AI?" The answer to this questions depends on how quickly immunity will be established following vaccination and whether or not the vaccine itself will adversely affect reproductive performance and(or) the response to an estrus synchronization protocol (Daly, 2007b). In regards to the first issue, there is a lag time between vaccination and the establishment of immunity that will depend upon factors such as: 1) whether or not the animals were previously vaccinated, and 2) the type of vaccine – modified live (MLV) or killed vaccine. In general, animals that were previously vaccinated will respond more quickly than animals that are naive to the vaccine and the immune response is normally more rapid to MLV compared to killed vaccine.

Injection of heifers with the IBR virus (wild type and modified live) around the time of breeding resulted in ovarian lesions (particularly within the corpus luteum; Van Der Maaten and Miller 1985; Smith et al., 1990) and decreased conception rates (Miller et al., 1989; Chiang et al., 1990; Miller 1991). Several studies report that vaccinating naive heifers with MLV around time of breeding decreased pregnancy success (Miller et al., 1989; Chiang et al., 1990; Miller 1991). Furthermore, when heifers were vaccinated intravenously with MLV the day after breeding, necrotic lesions were found in the CL and ovaries 9 to 14 days after vaccination and heifers with severe luteal damage had decreased concentrations of progesterone (Van Der Maaten et al., 1985). Heifers vaccinated with a MLV vaccine on the day of the second PGF injection had decreased conception rates compared to control heifers not only for the insemination immediately after vaccination but also for the subsequent insemination. Vaccinated heifers had a first service conception rate of 30% and a second service conception rate of 57%; however, control heifers had a first service conception rate of 78% and a second service conception rate of 100% (Chiang et al., 1990). Furthermore, heifers infected with IBR at or near estrus had disrupted luteal function. In most heifers the next estrous cycle was normal, but in some heifers normal estrous cycles were delayed for up two months (Miller and Van Der Matten, 1985). However, when heifers that were previously vaccinated against IBR were administered IBR vaccine either at estrus synchronization or 30 days before insemination there was no detrimental effect of vaccination on pregnancy rate to fixed-time AI or overall pregnancy rate. (Stormshak et.al., 1997). Although the latter studies report that administering IBR vaccine at initiation of estrus synchronization to heifers previously vaccinated at weaning did not reduce pregnancy rate, an advantage of administering prebreeding vaccines 30 days or more before insemination is that there is adequate time for the build up of immunity before the heifers are inseminated.

General recommendations for prebreeding vaccinations include the following: 1) Replacement heifers should be vaccinated before and at weaning. The immune response of an individual heifer to a single vaccination is not known; therefore, heifers should receive an initial vaccination followed by a booster when dictated by the vaccination protocol, 2) Both heifers and cows should receive a booster vaccination approximately 30 days before breeding. If it is absolutely necessary to give a modified live vaccine less than 30 days prior to breeding, the vaccine should be administered as soon as possible and only to animals that were vaccinated both before and at weaning. Animals that have not previously been vaccinated (naïve animals) should not be vaccinated near the time of breeding. For additional information on reproductive diseases and the timing of prebreeding vaccines the reader is referred to Daly (2007ab).

Things to Do at Estrus Synchronization and Fixed-time Artificial Insemination

Animal identification and facilities

Individual animal identification and accurate records allow producers to manage animals on an individual basis. When handling animals for synchronization, double check their ear tags for legibility and clip hair from the ears to facilitate reading the tags. Records should include detailed calving, breeding, and pregnancy information. At insemination, document the animal ID, date, time, AI technician, and sire. These records will allow producers to track the reproductive efficiency of individual animals, as well as the skill of the technician.

Stress can suppress the expression of estrus and decrease conception rates. Working facilities should be designed to minimize stressing animals during handling. A well-designed facility will include sorting pens, a crowding tub, and an operable head gate or breeding box for animal restraint. The facility requirement will vary depending on the number and type of animals that will be inseminated as well as the estrus synchronization protocol being used. With a fixed-time AI program, facilities should be sufficient to handle the insemination of all animals within 2 to 3 hrs. Many AI companies or county extension offices have portable breeding chutes available to producers if needed.

Cattle temperament and pregnancy rate

Temperament will vary among animals and is both a safety and production (growth, reproduction, carcass quality) issue. In general, an excitable temperament is a fear-based response that is not breed dependent and can adversely affect reproduction (Cooke, 2010). Three common methods of evaluating temperament in cattle include exit velocity, chute score, and pen score. Exit velocity is a measurement of the speed with which an animal covers a specific distance after release from a squeeze chute and can be measured in feet per second or on a 1 to 5 scale (1 = slow; 5 = very fast). Chute score is a measure of an animals behavior in a squeeze chute (1 = quiet; 5 = excited) and pen score is a measure of an animal's response to a person when it enters a small pen and interacts with a person inside the pen (1 = quiet; 5 = excited). An excitable temperament in beef cattle is reported to decrease feed intake (Brown et al., 2004; Nkrumah et al., 2007), alter metabolism and nutrient partitioning (Cooke et al., 2009a; Cooke et al, 2009b), and decrease the probability of pregnancy during the breeding season compared to calm herd mates (Cooke, 2010). Attempts to adapt beef females to handling had a beneficial effect on pregnancy in replacement heifers but not older cows (Cooke, 2010). When Bos indicus-cross heifers were exposed to four weeks of human interaction and handling, temperament was improved and there was an increase in the proportion of heifers that reached puberty by 12 months and an increase in the proportion of heifers that become pregnant early in the breeding season (Cooke, 2010).

Implementation of an estrus synchronization protocol

Estrus synchronization protocols must be followed precisely. Each product must be administered at the correct dose on the correct day (refer to protocol sheet) and in some cases at the right time of day. For example, the interval from PGF to GnRH and insemination must be in accordance with what is recommended in the protocol sheet (e.g. 66 ± 2 hr for the CO-Synch + CIDR protocol). The recommended time of insemination relative to PGF injection is based on research trials and should be strictly adhered to. In addition, estrus synchronization products must be stored, handled, and administered correctly. For specific tips on handling estrus synchronization products see Figures 1 and 2. Should a mistake occur in product administration or the treatment timeline seek advice immediately from a veterinarian, an extension agent specializing in reproduction, or a representative from an AI company. To minimize the probability of making a mistake, a good practice is to write each of the days of treatment, the product name, dose to be administered, and the day of insemination on a calendar and ask a trusted veterinarian, extension specialist, or AI company representative to review it before beginning the protocol. The Synchronization Planner is an excellent tool to aid in the planning of a synchronization program (beefrepro.info under resources).

Understanding the basic principles of the bovine estrous cycle and how the products synchronize estrus and ovulation can be helpful in reducing the probability of administering the wrong product on a certain day. For more information on how estrus synchronization protocols synchronize estrus and ovulation refer to the article in the appendix entitled "Physiological Principles Underlying Synchronization of Estrus" or see the web based course entitled

"Fundamentals of Beef Reproduction and Management:Focus on Estrus Synchronization (http://animalsciences.missouri.edu/extension/beef/estrous_synch/).

Figure 1. Proper handling and administration of GnRH and PG products.

• All injections of GnRH and PG products should be given intramuscularly (IM)
• Wear latex gloves when administering GnRH and PG products
• An 18 gauge 1 ½ inch needle is recommended for these injections
• Change needles frequently
    o Make sure that injection sites are free of manure and dirt, which may cause infection
    o Injecting cattle during wet weather increases the potential for infection
• **Always** follow manufacturer's recommended storage, dosage and administration procedures

What should I do if a storm is going to hit near during the synchronized period?

A storm or major low pressure system may affect the pattern of expression of estrus in cattle during the synchronized period. Depending upon the temperature change or level of stress there may be a decrease in estrus expression during the synchronized period. If utilizing a FTAI protocol you should inseminate at the scheduled time regardless of estrus expression, provided the heifers or cows meet the criteria for being good candidates for an estrus synchronization program (see previous section). Alternatively, if using a protocol that requires estrous detection you should inseminate according to estrus expression (AM/PM rule) and consider using a cleanup AI (inject GnRH) at 72 to 84 hr after PGF injection.

Proper insemination technique

High pregnancy rates to FTAI are dependent upon a series of events including proper storage and thawing of semen as well as depositing semen in the correct location (uterine body). When synchronizing heifers or cows for FTAI an important question to ask is "How many animals can I (we) inseminate properly in a designated period of time?" The answer to the question will determine how many heifers or cows you synchronize and whether you will require assistance with the insemination process. Representatives of AI companies are available to assist with the entire estrus synchronization and AI process. They can assist you with choosing an appropriate FTAI protocol, administration of the estrus synchronization products, sire selection, purchase of semen, and insemination. If you choose to inseminate the heifers or cows yourself remember that the location of semen placement within the reproductive tract will have a significant impact on pregnancy rates. It is important to deposit the semen in the body of the uterus (target area) and not the cervix. Deposition in the cervix will significantly reduce the pregnancy rate to FTAI; whereas, placing the semen beyond the uterine body into one or both of the uterine horns is not beneficial. During the artificial insemination process it is important to know where the tip of the AI catheter is at all times. Some helpful tips when performing AI include: pay careful attention to the storage of semen, make sure the thaw unit is at the correct temperature (95°F), and follow the AI company's recommendations for thawing semen.

Figure 2. Proper handling and administration of progestins for estrus synchronization.
Controlled Internal Drug Release (CIDR)
1) Be sure to wear protective (e.g. latex) gloves when handling CIDR inserts.
2) The CIDR applicator should be rinsed in a disinfectant solution (Nolvasan or Chlorohexidine). There should be two buckets each containing a disinfectant solution. The applicator should be washed free of debris in the first bucket and then rinsed clean in the second. By keeping the same washing sequence the disinfectant in the second bucket will remain relatively clean for a sustained period of time. This sequence of events will improve sanitation from animal to animal and reduce the likelihood of infection.
3) Fold the wings of the CIDR and insert it into a clean applicator. The CIDR will protrude approximately one inch from the applicator.
4) Apply lube to the end of the applicator.
5) Wipe the vulva clean before inserting the applicator.
6) When inserting the CIDR make sure that the nylon tail is curved downward. If the tail is pointed upward it will be easier for other animals to pull out the CIDR thus reducing retention rate.
7) Gently insert the applicator containing the CIDR in an upward manner similar to the insertion of an AI catheter.
8) Push the applicator as far forward as possible, deposit the CIDR by pressing the plunger, and slowly remove the applicator.
9) To prevent other animals from removing the CIDR, the nylon tail can be clipped such that only 2 ½ inches protrude from the vulva.
10) At CIDR removal, gently but firmly pull on the nylon tail until it is removed. Be sure to dispose of the CIDR properly.
Melengestrol Acetate (MGA)
1) MGA is an orally active feed additive that should be fed once a day at the recommended dose - 0.5 mg in a 3 to 5 lb carrier. Do not top dress MGA on other feeds. Provide adequate bunk space - 18-24 inches per animal.
2) Allow heifers to adjust to carrier prior to MGA administration.
3) MGA is approved by the FDA for heifers intended for breeding (suppression of estrus) and for heifers fed in confinement for slaughter for increased rate of weight gain, improved feed efficiency, and suppression of estrus.
4) Use of MGA as part of any estrus synchronization protocol in beef cows constitutes and extra label use of medicated feed that is prohibited by the Animal Medicinal Drug Use and Clarification Act and regulation 21 CFR 530.11(b).

Things to Do after Fixed-time Artificial Insemination

Nutrition

Regardless of whether you are developing heifers to attain a target weight or feeding cows to attain adequate body condition at calving (BCS ≥ 5), nutrition prior to calving and up to the the start of the breeding season is of obvious importance. However, nutrition following breeding can also affect embryonic development and survival. A dramatic change in diet or feed intake following FTAI that results in weight loss can negatively impact pregnancy rate.

Heifer development systems will vary depending upon availability of pasture, forage, and supplements. In some cases heifers are developed on pasture or native range and provided a supplement such as dried distillers grains plus solubles (DDGS). Alternatively, heifers maybe developed in a feedlot and not have access to pasture or range until near the start of breeding. A study was conducted to evaluate the preceding management strategies for heifer development (Salverson et.al., 2009). Heifers were developed on pasture with a DDGS supplement or maintained in a feedlot until estrus synchronization and turnout to grass in the spring. Heifers developed on pasture gained more weight following turnout and had higher pregnancy rates compared to heifers developed in the feedlot. It is not clear whether the increased weight gain in pasture-developed heifers was due to differences in grazing behavior and(or) physiological differences between groups. Interestingly, grazing behavior preferences are learned relatively early in a calf's life (Provenza and Balph, 1988) and heifers that grazed from weaning to breeding had better grazing skills during the subsequent grazing season compared to heifers maintained in a feedlot (Olson et.al., 2002; Salverson et.al., 2009. Therefore, in the preceding study heifers developed on pasture were likely able to graze more efficiently which resulted in a higher average daily gain on pasture and a higher pregnancy rate. In summary, it is essential to ensure that heifers and postpartum cows do not experience significant weight loss following AI.

Although the strategy to feed heifers to initiate reproduction and feed the cow herd to sustain reproduction is widely propagated in the beef cattle industry, long-term implications that this approach has on overall production efficiency are not well documented. This management approach removes most, if not all, selection against less efficient animals in a herd. Recent reviews describe benefits of developing heifers to lower target weights than currently recommended by feeding less feed or lower-quality feeds (Funston et al., 2012b) and managing cows with periods of limited or insufficient nutrient availability (Funston et al., 2012c) to enhance production efficiency. The underlying strategy of this approach is that maintaining animals at lighter BW reduces NEm and provides greater opportunity for compensatory responses to small improvements in nutrient environment. It is also expected that implementation of this approach for lifelong management results in adaptation or selection of cows and their offspring that maintain reproductive function under limited nutrient environments, such as occurs during drought or extreme winter stress and in semiarid or arid landscapes, to a greater extent than animals developed or maintained with plentiful or unlimited feed inputs (Roberts et al., 2015).

When can I ship cattle after breeding?

In beef cattle, fertilization rate is frequently 90 to 100% however, pregnancy rate by day 30 to 40 after a single insemination rarely exceeds 70% and calving rate is even lower. Embryonic and fetal mortality may represent the largest economic loss to cow-calf producers (Geary 2006). Pregnancy losses before day 42 post insemination are generally referred to as embryonic loss and range from 20 to 44% (Humbolt, 2001); whereas, pregnancy losses after day 42 are called fetal loss and are approximately 4% in beef cattle. Factors affecting embryonic/fetal loss are numerous and include genetic abnormalities, fescue toxicosis, plant toxins, excess protein, heat stress, reproductive diseases, an effect of the sire, and handling or shipping stress.

In some cases producers ship cattle a long distance to summer or winter pasture following estrus synchronization and AI. Therefore, a common question is "Will shipping stress decrease the pregnancy rate to FTAI?" Shipping cattle on a trailer can induce stress and lead to embryonic/fetal mortality. Pregnancy losses are believed to be due to changes in the uterine environment that adversely affect embryo growth and development. The effect of time of shipping on pregnancy rates following insemination is shown in Table 2. Transporting cattle on a trailer decreased pregnancy rates by about 10% between days 5 and 42 after insemination and by 6% between days 45 and 60. The best time to ship cattle is before synchronization or within 4 days of FTAI.

Table 2. Effect of time of transport after insemination on pregnancy rates.†

	Days after insemination that transportation occurred			
	1 to 4	8 to 12	29 to 33	45 to 60*
Synchronized pregnancy rate	74%	62%	65%	
% pregnancy loss compared to transportation on days 1 to 4		12%	9%	6%*
Breeding season pregnancy rate	95%	94%	94%	

*Loss in heifers compared to percent pregnant prior to transportation (pregnancy determined by transrectal ultrasonography).

†Data adapted from Harrington et al., 1995, and T.W. Geary unpublished data

How do I determine what may have gone wrong during a FTAI program?

Occasionally the pregnancy rate following FTAI is much lower than expected. Trying to identify the root cause of a decreased pregnancy rate can be a daunting task due to the countless factors that can impact pregnancy rate following AI. When trying to trouble shoot what went wrong you should systematically work through the possibilities and not assume anything was done correctly – evaluate all the possibilities! A list of questions that may provide a systematic approach to identifying the problem is provided in Figure 3. Additional points to consider are included below.

What are the most common mistakes when implementing an estrus synchronization and AI program?

One of the most common problems accounting for reduced pregnancy rates following FTAI is that the heifers or cows do not meet the criteria for being good candidates for an estrus synchronization and AI program (see previous section). The second problem is poor choice of an estrus synchronization protocol and (or) protocol compliance. If you have a mixture of cycling and anestrus animals at the beginning of estrus synchronization treatment, you need to use a protocol that includes a progestin (e.g. CIDR or MGA).

Figure 3. Was pregnancy rate to FTAI lower than expected?	
1)	What was the pregnancy rate in your heifers or cows after 60 to 80 days over the past few years? If less than 85% there may be other issues that should be addressed before initiating an estrus synchronization and AI program.
2)	What was the nutrition (protein, energy, phytoestrogens, etc) and mineral program before and after FTAI?
3)	Did the animals meet the criteria for being good candidates for an estrus synchronization protocol (see earlier section)?
4)	Did you use fixed-time AI or did you breed following detection of estrus? If you inseminated following detection of estrus, how frequently did you detect estrus (when did you begin and when did you end), what criteria did you use for detecting estrus, and when did you inseminate relative to detecting estrus?
5)	What bull did you use and is there evidence that semen from this sire has resulted in acceptable pregnancy rates when using fixed-time AI or AI following estrous detection?
6)	What protocol did you use and exactly when did you administer each of the products? You will need to confirm that the correct products were administered at the correct dosages and at the correct times. It is helpful to record on a calendar which product was administered on a particular day so you can check back to see if a mistake was made.
7)	Was the biological activity of the various products compromised? You will need to verify that the products were not out of date and were stored and administered properly.
8)	If using fixed-time AI, when did you inseminate the heifers or cows? Did you record who inseminated each animal? This will be helpful in identifying if there is a technician problem.
9)	Where did you obtain the semen, how was it stored, and was the semen thawed correctly?

Progestin treatment will increase the proportion of prepuberal heifers and anestrus cows that will respond to the protocol. Furthermore, it is essential that each heifer or cow receives the correct estrus synchronization product, at the correct dose, and on the appropriate day. A third problem is that the facilities don't allow the cattle to be inseminated properly within a 2 to 3 hr time period and/or cause undue stress on the cattle. With a FTAI protocol you have to carefully consider how many animals you can inseminate properly within the designated time period (e.g. 66 ± 2 hr for CO-Synch + CIDR protocol) with a minimum of stress. As previously mentioned, renting a breeding barn (Figure 1) or contracting with an AI company that has breeding barns available can alleviate the problems associated with marginal facilities.

Biological activity of the estrus synchronization products

It is not uncommon to hear someone blame a particular estrus synchronization product or the protocol for poor results. The commercially available products are effective when properly stored and administered. Furthermore, the protocols have been shown to consistently work in a variety of environments. The estrus synchronization protocols listed in the AI catalogs published by Select Sires, ABS Global, Genex, and Accelerated Genetics have been thoroughly tested in the field in a number of herds by numerous investigators in many states.

Rarely does one find that the biological activity of a particular product has been compromised provided the product has been stored properly, administered at the appropriate dose on the correct day of the protocol, and that the expiration date has not been exceeded. It is not uncommon for PGF or GnRH products to be administered at the wrong dose or to be injected subcutaneously instead of in the muscle. Intramuscular injections should be administered using an eighteen-gauge, 1.5 inch needle to minimize the possibility of back flow.

Potential problems associated with feeding melengestrol acetate (MGA)

Occasionally there can be problems with feeding melengestrol acetate (MGA) if you don't pay attention to a few simple guidelines (Figure 3). The most common problem is that a heifer does not receive the correct dose (0.5 mg/hd/day). If a heifer does not receive enough MGA she may express estrus during the period of MGA feeding. Therefore, it is a good idea to watch the heifers for estrous activity as they come to the bunk. Alternatively, if a heifer receives more than the appropriate dose, expression of estrus may be delayed following the end of MGA feeding. To ensure that each heifer has an opportunity to receive the correct dose, MGA should be fed once daily in 3 to 5 pounds of carrier and each heifer should have 18 to 24 inches of bunk space. To be confident there is adequate bunk space and to train the heifers to come to the bunk it is a good idea to feed the carrier without MGA for a few days before the start of MGA treatment. At the end of 14 days of MGA feeding, heifers will express estrus within 2 to 5 days; however, heifers should not be inseminated at this estrus since pregnancy rates will be reduced. Be sure to inseminate the heifers at the designated time specified in the protocol.

Potential problems associated with CIDRs

Controlled Internal Drug Release (CIDR) is an intravaginal device that contains progesterone and acts like an artificial corpus luteum. Information on the proper handling and administration of CIDRs is provided in Figure 3. Normally there are few problems associated with CIDR treatment. CIDRs should not be inserted in cows that are less than 21 days postpartum because the probability of inducing cyclicity is low. CIDR insertion should be performed as cleanly as possible in order to reduce the risk of spreading disease (see Figure 3). When removing CIDRs it is not uncommon to detect a whitish discharge which is due to vaginal irritation from the wings of the CIDR and does not necessarily mean the animal has a vaginal infection. A difference in conception rate or pregnancy rate has not been detected between CIDR-treated animals that do or do not have a discharge.

Summary

There are significant benefits to genetic improvement and reproductive management that can be gained from the implementation of an estrus synchronization and AI program in heifers and postpartum beef cows. Artificial insemination in beef cattle is more practical than ever due to advances in FTAI, identification of sires with highly accurate EPDs, and a market structure that can identify and reward producers for the quality of their cattle. Above all, a successful estrus synchronization and AI program is dependent upon being proactive, well organized, and attention to detail. The success of these systems hinges on many factors. A check list of tips for a successful estrus synchronization and AI program is provided in Figure 4.

Figure 4. Check list of tips for a successful estrus synchronization and AI program.

Things to do before fixed-time artificial insemination

- Keep accurate calving, breeding, and pregnancy records.
- Animal identification should be clear and easily readable.
- Ensure herd health and disease prevention with a well-designed prebreeding vaccination protocol. Vaccinate females a minimum of 30 days before the breeding season begins.
- Decide which estrus synchronization protocol best fits your breeding program, facilities, and personnel (see protocol sheets in AI catalogs).
- Ensure all products are purchased and on-hand prior to initiation of the protocol.
- Prepare the calendar of actions to ensure protocol compliance.

Sire selection

- Determine if you will purchase or raise replacement heifers.
- Decide how you will market your calves.
- Select proven AI sires with high-accuracy EPDs that match performance goals.
- Purchase semen from a Certified Semen Services (CSS) collection facility.
- Prepare or update your semen inventory.
- Make sure females meet the criteria for being good candidates for estrus synchronization.

Heifer criteria

- Heifers may be developed utilizing a variety of resources, research over the past decade has demonstrated acceptable pregnancy rates in heifers developed from 50 – 57% of mature body weight.
- Expose additional heifers beyond replacement needs to determine how your genetics responds to a lower input system if implemented.

Cow criteria

- Synchronize and inseminate only cows with BCS at calving of ≥ 5 (1 = emaciated; 9.0 = obese).
- The average days postpartum of the group of cows to be synchronized should be ≥ 40 by the start of estrus synchronization and experience a minimum of dystocia.

Things to do at the time of estrus synchronization and artificial insemination

- Meticulously follow the estrus synchronization protocol!
- If detecting estrus, spend as much time observing the animals as possible.
- Use a minimum of one person to detect estrus per 100 head of cattle.
- Use estrous detection aids to facilitate visual observation of estrus.
- Use a properly trained technician for AI.

Things to do after fixed-time artificial insemination

- To distinguish between AI and bull bred pregnancies at pregnancy diagnosis, you should wait approximately 10 days to turn in clean up bulls after AI.
- Pregnancy check by 75 days after AI via ultrasound or 80 to 90 days after AI via rectal palpation to distinguish AI from bull bred pregnancies.
- If cattle need to be shipped do so between days 1 to 4 after AI and avoid shipping cattle between days 5 to 42 after AI.
- Maintain breeding females on an adequate nutrition and mineral program.

PAY ATTENTION TO DETAILS!

Literature Cited

Brown, E. G., G. E. Carstens, J. T. Fox, M. B. White, T. W. Welsh, Jr., R.D. Randel, and J.W. Holloway. 2004. Relationships between temperament and performance traits of growing calves. In: 2004 Beef cattle research in Texas. Available at: http://animalscience.tamu.edu/ansc/beef/bcrt/2004/brown_erin.pdf.

Burris, M. J., and B. M. Priode. 1958. Effect of calving date on subsequent calving performance. Journal of Animal Science 17:527-533.

Chiang, B. C., P. G. Smith, K. E. Nusbaum, and D. A. Stringfellow. 1990. The effect of infectious bovine rhinotracheitis vaccine on reproductive efficiency in cattle vaccinated during estrus. Theriogenology 33:1113-1120.

Cooke, R. F., J. D. Arthington, D. B. Araujo, and G. C. Lamb. 2009a. Effects of acclimation to human interaction on performance, temperament, physiological responses, and pregnancy rates of Brahman-crossbred cows. J. Anim. Sci. 87:4125-4132.

Cooke, R. F., J. D. Arthington, B. R. Austin, and J. V. Yelich. 2009b. Effects of acclimation to handling on performance, reproductive, and physiological responses of Brahman-crossbred heifers. J. Anim. Sci. 87:3403-3412.

Cooke, R. 2010. Effects of temperament and animal handling on fertility. Applied Reproductive Strategies in Beef Cattle Proceedings August 5 and 6, Nashville, Tennessee pages 255-263.

Cushman, R. A., L. K. Kill, R. N. Funston, E. M. Mousel, and G.A. Perry. 2013. Heifer calving date positively influences calf weaning weights through six parturitions. *J. Anim. Sci.* 91:4486-4491.

Daly, R. 2007a. Control of infectious reproductive disease: The role of biosecurity. Applied Reproductive Strategies in Beef Cattle Proceedings September 11 and 12, Billings, Montana, pages 197 – 208.

Daly, R. 2007b. Timing of reproductive vaccinations in beef cattle herds. Applied Reproductive Strategies in Beef Cattle Proceedings September 11 and 12, Billings, Montana, pages 209 – 214.

Funston, R.N., J.A. Musgrave, T.L. Meyer, and D.M. Larson. 2012a. Effect of calving distribution on beef cattle progeny performance. J. Anim. Sci. 90:5118-5121.

Funston, R. N., J. L. Martin, D. M. Larson, and A. J. Roberts. 2012b. Physiology and Endocrinology Symposium: Nutritional aspects of developing replacement heifers. J. Anim. Sci. 90:1166–1171.

Funston, R. N., A. F. Summers, and A. J. Roberts. 2012c. Alpharma Beef Cattle Nutrition Symposium: Implications of nutritional management for beef cow-calf systems. J. Anim. Sci. 90:2301–2307.

Geary, T. W. 2006 Management strategies to reduce embryonic loss. Applied Reproductive Strategies in Beef Cattle Proceedings October 3 and 4. Rapid City, South Dakota, pages 167 – 175.

Humbolt, P. 2001. Use of pregnancy specific proteins and progesterone assays to monitor pregnancy and determine the timing, frequencies, and sources of embryonic mortality in ruminants. Theriogenology 56:1417-1433.

Miller, J. M. 1991. The effects of IBR virus infection on reproductive function of cattle. Vet. Med. January: 95-98.Miller, J. M., M. J. Van Der Maaten, and C. A. Whetstone. 1989.

Infertility in heifers inoculated with modified-live bovine herpesvirus-1 vaccinal strains against infectious bovine rhinotracheitis on postbreeding day 14. Am. J. Vet. Res. 50:551-554.
Nkrumah, J. D., D. H. Crews, Jr, J. A. Basarab, M. A. Price, E. K. Okine, Z. Wang, C. Li, and S. S. Moore. 2007. Genetic and phenotypic relationships of feeding behavior and temperament with performance, feed efficiency, ultrasound, and carcass merit of beef cattle. J. Anim. Sci. 85:2382-2390.
Olson, K. C., J. R. Jaeger, and J. R. Brethour. 1992. Growth and reproductive performance of heifers overwintered inrange or drylot environments. Journal Production Agriculture 5:72-76.
Perry, R. C., L. R. Corah, G. H. Kiracofe, J. S. Stevenson, and W. E. Beal. 1991. Endocrine changes and ultrasonography of ovaries in suckled beef cows during resumption of postpartum estrous cycles. J. Anim. Sci. 69:2548-2555.
Provenza, F. D., and D. F. Balph. 1988. Development of dietary choice in livestock on rangelands and its implications for management. J. Anim. Sci. 66:2356-2368.
Roberts, A. J., M. K. Petersen, and R. N. Funston. 2015. BEEF SPECIES SYMPOSIUM: Can we build the cowherd by increasing longevity of females? J. Anim. Sci. 93:4235-4243.
Salverson, R. R., H. H. Patterson, G. A. Perry, D. Young, and M. L. Gibson. 2005. Evaluation of performance and costs of two heifer development systems. South Dakota State University Beef Report. p. 13-18.
Smith, P. C., K. E. Nusbaum, R. P. Kwapien, D. A. Stringfellow, and K. Driggers. 1990 Necrotic oophoritis in heifers vaccinated intravenously with infectious bovine rhinotracheitis virus vaccine during estrus. Amer. J. Vet. Res. 51:969-972.
Stormshak, F., C. M. Tucker, W. E. Beal, and L.R. Corah. 1997. Reproductive responses of beef heifers after concurrent administration of vaccines, anthelmintic and progestogen. Theriogenology 47:997-1001.
Tibbitts, B. T., H. R. Nielson, K. H. Ramsay, and R. N. Funston. 2017. Growth and reproductive performance of yearling beef heifers implanted with Revalor G in the Nebraska Sandhills. Prof. Anim. Sci. 33:92-96.
Van Der Maaten, M. J., and J. M. Miller. 1985. Ovarian lesions in heifers exposed to infectious bovine rhinotracheitis virus by non-genital routes on the day after breeding. Vet. Micro. 10:155-163.
Werth, L. A., J. C. Whittier, S. M. Azzam, G. H. Deutscher, and J. E. Kinder. 1996. Relationship between circulating progesterone and conception at the first postpartum estrus in young primiparous beef cows. J. Anim. Sci. 74:616-619.

Rick Funston is a professor and reproductive physiologist at the University of Nebraska. He received his BS from North Dakota State University, MS from Montana State University, PhD from the University of Wyoming, and completed post-doctoral work at Colorado State University. His research on lighter heifer development is receiving national attention/adoption; research on fetal programming effects on postnatal calf performance including carcass characteristics and reproduction has received national and international recognition; and he is a team member of nationally recognized beef systems research. In extension, he provides leadership and subject matter expertise for educational programs in cow-calf production and reproductive management.

NOTES

Proceedings, State of Beef Conference
November 7 and 8, 2018, North Platte, Nebraska

EXTERNAL AND INTERNAL PARASITES

David J. Boxler
University of Nebraska West Central Research and Extension Center, North Platte

External Parasites

The Horn Fly

Horn flies are small, less than a quarter of an inch in size and are commonly found of the backs, sides, and poll area of cattle. During warm weather, especially by mid-afternoon they will often be found on the belly region of cattle were there is shade and cooler conditions. Male and female flies will acquire more than 30 blood meals per day (Figure1). Once the female has mated she will leave the animal to deposit eggs in fresh cattle manure. During warm weather, the entire life cycle can be completed in 10 to 20 days. Newly emerged horn flies can travel several miles searching for a host, fly immigration can result in an increase in fly population numbers even if good fly management practices are in place.

Horn fly feeding causes irritation, blood loss, decreased grazing efficacy, reduced weight gains and diminished milk production in mother cows. Additionally, horn flies can spread summer mastitis. Research conducted in the U.S. and Canada have shown horn flies can decrease weight gain in cattle, and negatively impact calf weaning weights from 4- 15 percent. Trials in Nebraska have established calf weaning weights were 10-20 pounds higher when horn flies were controlled on mother cows. Yearling cattle can also be impacted by the horn fly; decreasing yearling weights by as much as 18 percent. Economic losses associated with horn flies are estimated at more than $1 billion dollars annually in the United States. The economic injury level is the smallest number of flies that will cause losses equal to the cost of controlling the fly.

The economic injury level (EIL) for horn flies is 200 flies per animal, and fly control should be implemented if the EIL is exceeded.

Many insecticides and delivery methods are available for managing horn flies. Backrubbers/oilers and dust bags they should be used in a forced-use system to achieve maximum horn fly control. Animal sprays delivered by low pressure or mist blower sprayers and pour-on products will provide 7 – 21 days of control and will need to be re-applied during the fly season. Insecticide ear tags and strips are a convenient method of fly control and should be applied late May to receive season-long horn fly control. If insecticide ear tags and strips are applied earlier, re-tagging or adding an additional form of fly control mid-fly season might be necessary. Oral larvicides (IGR's) impact developing larvae in the manure pats and prevent fly larvae from developing into adults. One important factor when using an oral larvicide is assuring steady consumption. An additional issue when using an oral larvicide is horn fly migration from neighboring untreated herds, which can disguise the efficacy of the product. The Vet Gun™ applies an individual capsule of insecticide to an animal and can provide control between 21 and 35 days.

For more information about horn flies, NebGuide G1180, The Horn Fly, can be accessed at http://extensionpublications.unl.edu/assets/pdf/g1180.

The Face Fly

Face fly adults are slightly larger and darker than the house fly. The face fly has a sponging type mouth part like the house fly and feeds on animal secretions, nectar, and dung liquids. Only the female face fly will be found clustering around an animal's eyes, mouth, and muzzle causing extreme annoyance and irritation. Livestock will react to fly feeding by bunching, seeking shade of trees or in some cases, standing in water in an effort to avoid the flies. Face flies will also feed on blood and other secretions around wounds caused by injury. Face flies are present throughout the summer, but populations usually peak in late July, August, and early September. They are most numerous along waterways, areas with abundant rainfall, canyon floors with trees and vegetation, and on irrigated pastures.

Female face fly feeding damages eye tissues; increases susceptibility to eye pathogens; and can vector *Moraxella bovis*, and M. *bovoculi* the causative agents of pinkeye or infectious bovine keratoconjuctivitis. Pinkeye is a highly contagious inflammation of the cornea and conjunctiva of cattle. Controlling face flies is essential in reducing most pinkeye problems. It is estimated $150 million per year is lost to pinkeye treatments, reduced weight gains, and reduced milk production from face fly feeding and irritation.

Adequate face fly control can be difficult because of their habit of feeding around the face and the significant time they spend off the animal. Control is increased when cattle receive daily insecticide applications by either dust bags, oilers, sprays, or an insecticide impregnated ear tag/strip. Ear tags/strips should be applied at the label recommended rate. Both adult animals and calves must be treated if control is to be achieved. Pinkeye vaccines are available and should be considered if face flies and pinkeye have been a recurring problem. Currently, commercial and autogenous pinkeye vaccines are available; please check with your local veterinarian about the use of these products in your area.

For more information about the face flies, NebGuide 1204, The Face Fly, can be accessed at http://extensionpublications.unl.edu/assets/pdf/g1204.pdf.

The Stable Fly

Stable flies are another serious pests of pastured cattle. Stable flies are blood-feeding flies, mainly feeding on the front legs of cattle, but can also be found on the belly area. It normally takes a stable fly about 2 to 5 minutes to complete a blood meal (Figure 3). Their bites are very painful and cattle react by stomping their legs, bunching in pasture corners, or standing in water to avoid being bitten. Stable flies cause similar weight grain losses to pasture and confinement cattle. University of Nebraska research recorded a reduction in average daily gain of 0.44 lbs. per head with animals that received no insecticide treatment compared with animals which received a treatment. The economic threshold of 5 flies per leg is often exceeded in mid-western pastures.

The female stable fly deposits eggs in spoiled or fermenting organic matter mixed with animal manure, soil, and moisture. Grass clippings and poorly managed compost piles may also be stable fly developing sites. Winter hay feeding sites where hay rings are used can be a source for larval development through the summer if proper moisture is present. The life cycle of the stable fly can take 14 to 24 days, depending upon weather conditions. The source of early season stable fly numbers on pastured cattle is not completely understood, but some probably develop locally. The presence of early season stable flies might be migrants from southern locations. However, it is well documented that stable flies can fly more than 10 miles or more.

Managing pasture stable flies is difficult, currently, the only adult control option is on-animal sprays, delivered by low pressure or by mist blower sprayers. Weekly applications are required to reduce fly numbers. Sanitation or clean-up of wasted feed a winter feeding sites may reduce localized larval development. If sanitation is not an option, these sites may be treated with a larvicide (Neporex®). Implementing either procedure may not totally reduce the economic impact of the stable fly.

Note of Caution about Fly Insecticide Resistance

Insecticides are categorized by Insecticide Mode of Action (MoA) groups based on how they work against insects.

Continual use of products from a single group against a pest species can lead to reduced control (resistance to all products in the group). To lessen control failures due to insecticide resistance, do not apply insecticides within the same MoA group number repeatedly, even when using different application methods (residual sprays, knockdown sprays, insecticide ear tags and feed-throughs (IGR's). Rotate between MoA groups during the fly season.

Cattle Lice

As the above average fall temperatures give way to winter conditions cattle lice numbers will increase. Cattle lice are a cold season insect that thrives in very cold conditions. Populations are most noticeable during December, January, February, and decline during March when temperatures warm. Lice are transmitted by contact from one animal to another. Cattle with hair loss, an unthrifty appearance, and leaving hair on fences and other objects from rubbing may be a sign of lice infestation. However other factors can mimic lice infestations such as natural shedding, poor nutrition, mite infestations, mineral deficiency, photosensitivity, and other diseases. To determine if lice is the problem, secure the suspect animal(s) in a chute and perform a two-handed hair parting on the top line, withers, and face. Lice numbers between 1-5 per square inch represent a low population, 6-10 per square inch represent a moderate population, and more than 10 lice per square inch is considered a heavy population.

In Nebraska we can encounter four different cattle lice species. The biting or chewing louse (little red) *Bovicola (Damalinia) bovis*, reddish brown in color with dark bands running transversally across the body. Typically the chewing louse feeds on hair, skin, skin exudates and debris near the skin surface. This species is initially found on shoulder and top line, and back, but as populations increase, can be found on the sides and sometimes over the whole animal.

The other three species are sucking lice, which feed on blood, and can cause irritation, anemia, impact weight gain, and even death in extreme cases.

The short-nose cattle louse, *Haematopinus eurysternus* is the largest louse at 3-5 mm in length and is typically found on older animals, but can be found on any age or breed of cattle. This species can usually be found in the neck region, dewlap, back, and base of tail.

The long-nose cattle louse, *Linognathus vituli* is about 2.5 mm in length, bluish in color and differs from other louse species by its long slender head. This louse can be found on the dewlap, shoulders, sides of neck and rump, but when numbers are high, they can be found over the entire body.

The little blue cattle louse, *Solenopotes capillatus* is about 1-2 mm in length, bluish in color, and smallest of the sucking lice species. It often can be found in dense patches on the dewlap, muzzle, around eyes, and neck. Heavy populations can greatly impact cattle weight gains.

University of Nebraska and other studies indicate heavy lice populations may reduce weight gains by as much as 0.21 lb/day. These studies also indicate calves fed at a higher nutrition level had lower lice populations and were affected less severely by lice than calves fed a maintenance ration.

Insecticide formulations fall into three categories: non-systemic pour-on, systemic pour-on, and systemic injectable. Some non-systemic pour-ons require just one application and some require two applications spaced 14 days apart. Systemic injectables work better on the three species of sucking lice than on the little red chewing louse. A systemic pour-on effectively kills both chewing and sucking lice.

Use of systemic control products between Nov. 1 and Feb. 1 is not advised as they may cause a host-parasite reaction from killing developing cattle grubs while they are in the esophagus or spinal canal of the animal. A systemic product used during fall weaning will not be a problem. Producers who did not use a systemic during fall weaning, should consider using only **non-systemic control products** during this November to February time frame.

Successful louse control depends on application timing. Many livestock producers will administer an endectocide treatment at weaning time, usually late September or October with intentions of controlling internal parasites, cattle grubs and cattle lice. These fall applications may help reduce lice populations, but may not remove the infestation. A warm extended fall, may slow down developing lice numbers. Livestock producers who use this management strategy should monitor their cattle for signs of lice especially during the months of December, January, and February. If replacement animals are brought into a herd during the winter months they should be examined for lice. If present, the animals should be isolated and treated before introduction into the existing herd.

Internal Parasites

Helminths, or parasitic worms hinder the performance of cattle, especially those raised on pasture. The term helminth describes several parasitic worms in cattle, including the gastronintestinal *nematodes Ostergia, Cooperia, Haemonchus, Trichonstrongylus, Oesophagostomom, Bunsostomum, and Nematrodirus*. The life cycle of these worms occurs within cattle and on grass. Sexual reproduction occurs within cattle intestines, while egg hatching and larval development occur on grass. One female worm may produce tens of thousands of eggs.

Helminths derive nourishment and protection from cattle, living in association with and at their expense. The primary host's expense is providing blood to the parasite. Worms cause problems ranging from mild gastrointestinal inflammation to clinical disease. The effects of internal parasites on cattle will vary with the severity of infection as well as age and stress level of the animal.

Calves and young cattle are most sensitive to helminths due to their underdeveloped immune systems. Cattle develop tolerance to worms as they age, and must be exposed to parasites in a managed fashion. There is significant economic evidence to support deworming young animals. Higher economic returns are observed because deworming allows an animal's body to use feed for normal metabolism and weight gain rather than diverting nutrients to support worms. Mature cows acquire a degree of immunity to parasites that reside in the lower gastrointestinal tract. Parasite loads are most damaging in mature cows near calving because immunity is suppressed. Cows, especially dairy, in early lactation are often in a negative energy balance due to the stress of lactation. These cattle are affected more than cows in later lactation, when smaller levels of milk are produced. Bulls are typically susceptible to internal parasites than cows.

The major effects of parasitism can be separated into two types, subclinical and clinical. Losses in animal productivity (milk production, weight gain, lower conception rates, and elevated rate of other diseases) are all subclinical effects; while visible disease-like symptoms (diarrhea, rough hair coat, lower weight gains, anemia, and edema) are clinical effects.

Understanding the life cycle of a helminth can help the livestock producer manage this pest. In a host animal, adult nematodes produce eggs. The eggs are expelled from the host with feces which then contaminate the pasture. A first-stage larva hatches from the egg and will molt two times before it becomes a third-stage larva. Once the larva is in the third-stage, it is capable of migrating from dung pats and soil onto moist grass. Infection occurs when the third-stage larva is consumed with the grass. The larva completes its life cycle in the gastrointestinal tract of its host. Once the adult stage is reached, mating occurs and the life cycle starts over. Most eggs do not survive, mortality is the greatest between egg and stage L2. Fungi and insects often help reduce eggs and larvae with in manure pats.

Unlike other nematodes, the medium stomach or brown stomach worm (*Ostertagia*) can spend part of its life cycle in hypobiosis, a condition similar to hibernation. This condition usually begins in spring with the hibernating larvae emerging in the summer.

Parasite pressure in a pasture varies with season and management. Parasite burden peaks during the spring and is lowest during the hot, dry summer months. Parasite pressure will be less under good management conditions which includes a good nutrition and health program.

There are several key pasture management practices which producers can use to reduce parasite contamination and load in their pastures. 1. Establish optimum stocking rates to prevent overgrazing. 2. Maintain pasture grass residual height of 4 inches or taller. 3. Limit rotational grazing events to less than 4 days. 4. Move more susceptible younger cattle to a safe pasture. Safe pastures include pastures that were not grazed during the last 12 months. 5. Older animals with tolerance to helminths should graze following younger animals. Pasture management practices may reduce the parasite burden in cattle, but, this method alone will not guarantee complete parasite eradication.

There are four broad classes of anthelminitcs: benzimidazoles, imidazothiazoles, macrocyclic lactones (ML), and tetrahydropyrimidines.

Benzimidoazoles (Albendazole, Fenbendazole, Oxfendazole) are often referred to as “white dewormers”. These compounds are given orally, have little residual activity and are quickly broken down in the gastrointestinal tract.

Imidazothiazole (Levamisole) can kill adult stages of worms: however these compounds have a short period of activity. These compounds are administered orally, and as an injection.

Macrocyclic lactones (ML) (Eprinomectin, Doramectin, Ivermectin, Moxidectin) are generally regarded as the most effective and least toxic dewormer currently in use. They offer longer residual activity. Long-acting formulations are popular because therapeutic levels of the compound are available to kill multiple –generations of susceptible larvae and adults without the need to re-administer the product. Administered as an injection or as a pour-on. Shortly after pour-on formations were made available, research found the absorption of pour-on products to be erratic and unpredictable.

Tetrahydropyrimidine (Morante) are short residual products that work on adult worms by interfering with their neuromuscular system. Administered as an injection.

Since bulls, cows and young animals are affected differently by internal parasites, treatment programs will differ. Mature cows should be treated at least one time per year. The best time to treat a mature cow is near calving. A mature cow’s vulnerability to parasite harm increases during this time due to stress of production and suppressed immune system. In situations where parasite load is high, such as overstock pastures, treating twice a year may be necessary. Bulls should be treated twice a year, spring and fall. Treatment of calves should begin when they reach three to four months of age and again at weaning if they are kept as replacements or stockers.

Yearlings can be treated on a seasonal basis, spring and fall, until they are mature cows. If calves are backgrounded in a dry lot, one initial treatment should be adequate.

Establishing a cost-effective internal parasite control program begins with your veterinarian. They will collect fecal samples and conduct a fecal egg count (FEG) which can be either qualitative (positive or negative for eggs) or quantitative (number of eggs per gram of manure). To gauge the overall herd infestation, 20% of the herd or 20 animals, whichever is greater should be sampled. If a dewormer is used, a fecal egg count reduction test (FECRT) should be used to determine the efficacy of treatment. Typically, the FECRT compares the FEC to a 14-day post-treatment FEC. Treatment is considered to be effective with a FECRT of 90%-95%. A FECRT of less than 90% indicates a less than desirable treatment, and may indicate resistance. Identification of the surviving parasites is important for managing the development of anthelmintic resistance. A specialized test called a polymerase chain reaction (PCR) is used to identify specific parasite species.

Resistance to anthelmintic compounds by internal parasites have been demonstrated throughout the world. The first documented case of anthelmintic resistance to endectocide compounds in the U. S. occurred in 2003. Currently, it appears that in the U.S. the following is the state of resistance in cattle nematodes: (A) widespread resistance to *Cooperia* spp. to the macrocyclic lactones, (B) resistance to *Haemonchus* sp. to macrocyclic lactone use is becoming more common, (3) there has only been one documented instance of resistance against the macrocyclic lactones by *O. ostertagi*, (4) resistance against drugs in the benzimidazole class of drugs has only been confirmed for *H. contortus*, and (5) the macrocyclic lactone resistant parasites have the potential to significantly impair cattle health and productivity. Resistance to a specific active ingredient class does not mean the worm is also resistant to other drug classes. Resistance to various drug classes is developing faster than new classes of dewormers are being developed. The development of resistance can be slowed by avoiding misuse of dewormers, particularly through sub-therapeutic use.

While not labeled for combination use, many veterinary parasitologists agree deworming concurrently with different classes of products will increase their efficacy without contributing to resistance. Fortunately, multiple-resistant worms have not yet been reported in cattle, regardless of the use of single or multiple ingredient classes. In combination, these dewormers kill resistant worms that would have otherwise survived. Studies have shown that administration of benzimidazoles enhanced the efficacy of injectable and pour-on MLs. Resistance to all MLs is delayed when used in combination with benzimidaloes or imidazothiazoles, Combination therapy is only appropriate when the active ingredients do not share the same mode of action.

An important factor in the development of heliminth resistance is the level of selective pressure applied against the parasite genome. One method of reducing that pressure is by a management tool of known as “refugia”. Refugia refers to the portion of the total nematode population at a given time of anthelmenitic treatment that do not develop to the infective stage and are not digested prior to the clearance of the antihelmintic from the treated host.

Refugia include larvae residing on pasture or within the intestine at the time of deworming. Intestinal larvae may not be exposed to the treatment due to various chemical or biological factors. Untreated herd mates also contribute to refugia. Stage L3 larvae on pasture at the time of treatment contribute to refugia when they are not ingested prior to clearance of the dewormer from the treated animal. Current management procedures rely upon leaving untreated animals in the herd.

Understanding the systems of internal parasites, their relationship with their host, and environment coupled with appropriate diagnostic testing allows producers to make informed decisions related to grazing and deworming. Overseeing this relationship effectively will result in improved animal health and producer productivity.

Dave Boxler is a Focused Extension Educator in livestock entomology, located at the West Central Research and Extension Center, North Platte. Boxler provides extension programming on livestock insects to local, state, regional, and international clientele. His research studies are currently focused on three pasture fly species: horn fly, face fly and stable fly. These studies involve assessing and evaluating current fly control methodologies, developing and evaluating biopesticides, designing and evaluating stable fly traps, and conducting insecticide resistance bioassays for horn flies and stable flies.

NOTES

Proceedings, State of Beef Conference
November 7 and 8, 2018, North Platte, Nebraska

ANIMAL BREEDING PROGRAMS TO SUPPORT AN EVER-CHANGING WORLD

Tom Rathje
DNA Genetics LLC, Columbus, NE

Tom Rathje currently serves in the role of Chief Technical Officer at DNA Genetics LLC, Columbus, NE. A native of Iowa, he grew up in Clinton on a diversified cattle and cropping operation. Tom received his B.S. in Animal Science from Iowa State University (1989), and his M.S. (1991) and PhD. (1995) in Animal Breeding and Genetics from the University of Nebraska where he currently holds an adjunct professorship in the Department of Animal Science.

Tom's M.S. Thesis focused on the effects of selection for testis size on sperm production in boars. His Ph.D. dissertation involved establishing one of the very first QTL mapping studies using selected populations. The study focused on identifying the association of QTL with variation in reproductive performance in swine.

He has been with DNA Genetics since its founding in 1995 and has played a key role in the development of the company, being responsible for implementation of the breeding program within nucleus and customer production systems and working in management to develop and support the growth of the company.

DNA Genetics has grown to become the second largest provider of swine genetics to the North American market and produces the most widely used terminal line in the swine industry, influencing over 35% of the pork produced. In this position he continues to pursue interests in genetic research including: application of genomic selection in pigs, disease susceptibility, sow longevity, identification of novel traits to improve production efficiencies and furthering the application of animal breeding principles to improve livestock populations at the commercial level.

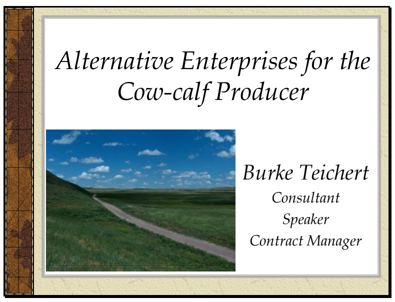
His personal interests include partnering with his wife, Kristi, to keep up with their three adult children, son-in-law and now two grandchildren. Tom and Kristi have a growing business breeding and marketing purebred Simmental cattle.

NOTES

Proceedings, State of Beef Conference
November 7 and 8, 2018, North Platte, Nebraska

ALTERNATIVE ENTERPRISES FOR THE COW-CALF PRODUCER

Burke Teichert
Orem, Utah



Whole Ranch Profit

It's **Profit per Acre** or **Whole Ranch Profit** that you strive to improve— **not Production or even Profit per Animal**.

Major Determinants of Profits

- Enterprise Structure—Cattle, Sheep, Wildlife, Recreation, Etc.
- Overheads (Including People)
- Stocking Rate
  - Cow Size and Milk Production
  - Grazing & Pasture Management
- Fed Feed vs. Grazed Feed
- Calving Season
- Realized Herd Fertility
- Wise Input Use for Optimum Production
- Marketing

Reduce Overheads
Market Well
Improve **Three *Key Ratios***

Acres per AU

AUs per Person

Fed Feed vs Grazed Feed

Five Essentials of Ranch Management

1. The approach must be both integrative and holistic
2. Continuous improvement of the key resources – Land, Livestock, People
3. Use of good planning and Decision making tools
4. War on cost
5. Emphasis on marketing

So
For Profitable Decision Making

(Managing Ranch Resources—Land, Livestock, Wildlife and People)

Become a Systems Thinker

Alternative Enterprises for the Cow-calf Producer

Alternative Enterprises

- Sheep and/or Goats
- Wildlife
- Recreation
- Custom Work
- Cattle alternatives and add-ons
- Marketing

Sheep and/or Goats

- It is commonly accepted that you can place one ewe with every cow on range or pasture and never miss any cow feed.
- It is often thought that the addition of goats to cows on pasture will increase the cow feed over time.
- Any time you can share overheads between two or more enterprises, there is a chance to improve profit.

Sheep and/or Goats

- Will you need to add overheads—labor, facilities, equipment? How much?
- What additions to direct costs—mainly supplemental feed and vet costs?
- Estimate the added revenue and calculate a gross margin for the enterprise.

Wildlife

- What are the possibilities?
- Fee hunting.
- Wildlife photo opportunities.
- Bird watching.
- Conservation partnerships with various groups to enhance wildlife habitat (many species) and simultaneously produce more feed while improving soil health and water quality.

Recreation

- Ranch vacations
- Agri-tourism
- Horsemanship or livestock handling schools
- Trail rides
- Hiking
- Camping
- Bird Watching
- Hunting

Custom Work

Using equipment or skills that are not fully utilized

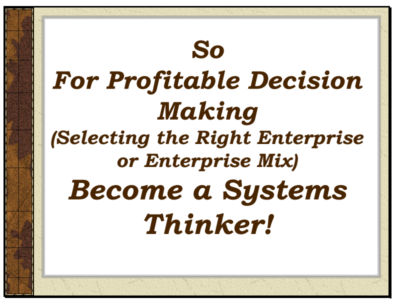
- Custom farming or haying
- Horse shoeing
- Fencing (repair or new fence)
- Cattle processing
- Trucking
- Horse Training

Cow-calf Alternatives

- Simple Terminal Mating Enterprise buying replacement females and selling all calves.
- Basic Cow-calf raising own replacements.
- Cow-calf-yearling.
- High turnover Cow-calf exposing lots of heifers and selling bred cows.
- Produce and sell breeding bulls.
- Stocker only.
- Combinations of the above.

Cow-calf Alternatives

- Leasing cows "in" or leasing cows "out."
- Custom grazing and care.
- Partnerships on cattle ownership.
- Produce embryo calves for seedstock producers.
- Be a progeny testing herd for AI firms or seedstock producers.
- Be a cooperative producer with a seedstock producer.



Burke Teichert was born and raised on a family ranch in western Wyoming. He earned his B.S. in Ag Business from Brigham Young University and his M.S. in Ag Economics from the University of Wyoming. Teichert has served as a faculty member at the University of Wyoming and BYU and a beef cattle specialist in the AI industry. He has also served as General Manager and Vice President for AgReserves, Inc., better known as Deseret Ranches, where he was involved in seven major ranch acquisitions in the U.S. and the management of a number of farms and ranches in the U.S. as well as Canada and Argentina. Teichert is now a consultant and speaker. He also writes a monthly column in BEEF *magazine.*

NOTES

ALTERNATIVE ENTERPRISES PANEL

Logan Pribbeno, Wineglass Ranch, Imperial
Sarah Sortum, Switzer Ranch, Burwell
Vern Terrell, Terrell Farms LLC, Hay Springs

Logan Pribbeno *is the 5th generation at Wine Glass Ranch in Southwest Nebraska. He returned to the family ranch with his wife in 2012 following a short career in accounting and finance in Silicon Valley. Wine Glass has recently expanded their stocker enterprise to accommodate growth and to enhance dryland farming returns.*

Sarah Sortum *grew up near Taylor, NE on her family's ranch. Her family operates the Switzer Ranch, with custom grazing, custom backgrounding and short term cow revenue streams. Her family also operates a nature-based tourism business, Calamus Outfitters, on the same acres that offers lodging, hunting, rivertrips, birdwatching and Jeep Safari tours. This diversification has enabled both Sarah and her brother, Adam, to return to the family ranch to raise their respective families.*

Vern Terrell *comes from a diversified farm and ranch operation with his wife, Marjean, son, Brock and his wife, Heidi. Terrell Ranch runs a cow herd to produce a terminal cross calves along with a band of ewes to help better utilize our range. Terrell Farms grows corn, seed wheat, edible beans along with forage crops. They also have a small feedlot where the prepare calves for finishing. Vern attended the University of Nebraska and is a graduate of the Nebraska LEAD program. He has been active in many local, county and state organizations. Vern is currently involved with Nebraska Grazing Lands Coalition, Ag Builders of Nebraska, Blueprint Nebraska and Nebraska Cattlemen. Vern is currently serving on the advisory board at the UNL Panhandle Research Station in Scottsbluff.*

NOTES

HERD HEALTH

Dale Grotelueschen, DVM, UNL Great Plains Veterinary Education Center, Clay Center

University of Nebraska Lincoln

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

Herd Health Issues 2018 -Food for Thought

Dale M. Grotelueschen, DVM, MS
Director, Great Plains Veterinary Educational Center
Clay Center, NE
dgrotelueschen@unl.edu
308-641-6658

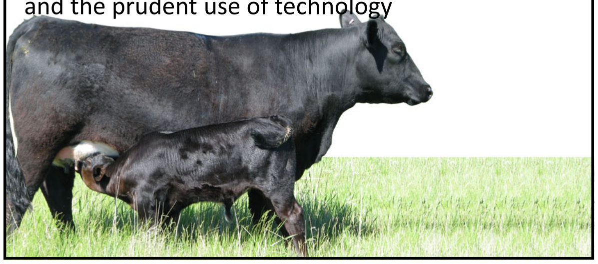
Definition

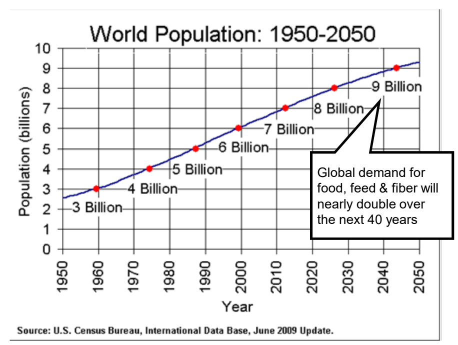
Stewardship:

Careful and responsible management of something entrusted to one's care (noun, Webster)

Animal Agriculture

Feeding the world by caring for animals through responsible resource management and the prudent use of technology





Source: U.S. Census Bureau, International Data Base, June 2009 Update.

http://www.census.gov/ipc/www/idb/worldpopgraph.php

http://www.fao.org/wsfs/forum2050/about-the-forum/en

4

Economic Research Service. (2000, September). A History of American Agriculture, 1607-2000. (ERS-POST-12.) Washington, DC: Author.
* USDA Publication: The 20th Century Transformation of U.S. Agriculture and Farm Policy Electronic Information Bulletin Number 3, June 2005; authors: Carolyn Dimitri, Anne Effland, and Neilson Conklin

Deloitte Food Value Equation Survey 2015

Capitalizing on the shifting consumer food value equation.

- Deloitte Consulting, Food Marketing Institute (FMI), Grocery Manufacturers Association (GMA)
- Survey of 5,000 consumers nationwide
- Interviews of executives from 40 companies—retailers, food & beverage manufacturers, ingredient suppliers, ag producers
- FMI, GMA and Deloitte secondary research

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

Deloitte Food Value Equation Survey 2015

Capitalizing on the shifting consumer food value equation.

- Consumer food purchase decisions—then
  - Traditional drivers—taste, price, convenience
  - other factors/drivers had small impact
- Consumer food purchase decisions—now
  - Traditional drivers—taste price convenience
  - Evolving drivers—health & wellness, safety, social impact, experience, transparency (overarching driver)

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

Deloitte Food Value Equation Survey 2015

Capitalizing on the shifting consumer food value equation.

The consumer value driver plate

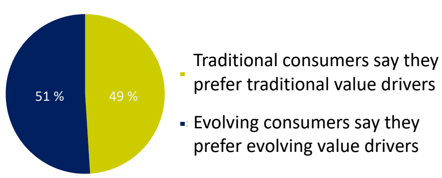
Source: Deloitte Food Value Equation Survey 2015, Deloitte Analysis

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

Deloitte Food Value Equation Survey 2015

Capitalizing on the shifting consumer food value equation.

About half of consumers surveyed indicated they weigh Evolving value drivers more heavily than Traditional ones



Source: Deloitte Food Value Equation Survey 2015, Deloitte Analysis

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

Summary Points

- Primary purpose of animal agriculture is food production
- Attitudes and perspectives of US and world populations are changing
- Increasing world human population & development requires increased food and fiber supplies
- Global resources are limited
- Production level animal care and use of science and technology offers current and future solutions

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

Topics Outline-Brief Comments

- Antimicrobial stewardship
- Nursing Calf/Summer Pneumonia
- Commingling
- Feedlot Mortality and Morbidity
  - Bovine Congestive Heart Failure study update

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

Everything should be as simple as possible, but no simpler.

Einstein

Antimicrobials/Antibiotics

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

What drugs cure disease?
Do antimicrobials cure disease?

- Kill
- Cleanup
- Replace/Repair
- Return to Function

Source: Dr. Gordon Brumbaugh

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

What drugs cure disease?
Do antimicrobials cure disease?

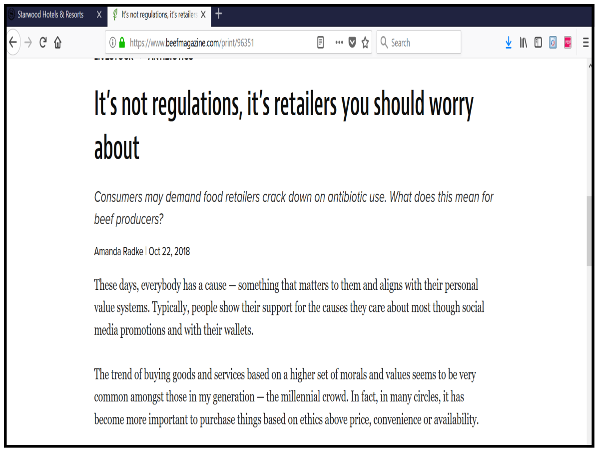
- Kill
- Cleanup
- Replace/Repair
- Return to Function

Other Mechanisms (→ Cleanup, Replace/Repair, Return to Function)

Respiratory tract healing takes time (~3-6 weeks)

Source: Dr. Gordon Brumbaugh

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences



Starwood Hotels & Resorts | It's not regulations, it's retailers

https://www.beefmagazine.com/print/96351

It's not regulations, it's retailers you should worry about

Consumers may demand food retailers crack down on antibiotic use. What does this mean for beef producers?

Amanda Radke | Oct 22, 2018

These days, everybody has a cause – something that matters to them and aligns with their personal value systems. Typically, people show their support for the causes they care about most though social media promotions and with their wallets.

The trend of buying goods and services based on a higher set of morals and values seems to be very common amongst those in my generation – the millennial crowd. In fact, in many circles, it has become more important to purchase things based on ethics above price, convenience or availability.

Antimicrobial Stewardship

- Primary concern is development of antimicrobial resistance impacting effectiveness in treating human diseases
- Stewardship of antimicrobials
  - Assumed or actual: Need for an antimicrobial represents production/economic loss
  - Systems approaches to reducing need/use
  - Re-examining need for antimicrobial use
    - A breach in the system?
  - Use appropriately

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

DEFINITION OF ANTIMICROBIAL STEWARDSHIP

Antimicrobial stewardship is the commitment to reducing the need for antimicrobial drugs by preventing infectious disease in cattle, and when antimicrobial drugs are needed, a commitment that antimicrobials are used appropriately to optimize health and minimize selection for antimicrobial resistance.

http://aabp.org/resources/AABP_Guidelines/AntimicrobialStewardship-7.27.17.pdf
Accessed 11/4/2018

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

Reduced risk for disease, control or elimination of disease

Biosecurity – the outcome of all actions used to prevent disease agent entry into a unit of interest.

Biocontainment – the outcome of all actions resulting in control of a disease agent in a unit of interest

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

Dargatz, et al Vet Cl FoodAn 18 (2002) 1-5.
Smith, Vet Cl Food An 18:1(2002) 157-175.

Nursing Calf Respiratory Disease

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

Simulation Model Estimate
$165 million annually

Ruminants

Cost of bovine respiratory disease in preweaned calves on US beef cow–calf operations (2011–2015)

Min Wang PhD
Liesel G. Schneider PhD
Kristina J. Hubbard DVM
David R. Smith DVM, PhD

From the Department of Pathobiology and Population Medicine, College of Veterinary Medicine, Mississippi State University, Mississippi State, MS 39762. Dr. Schneider's present address is Department of Animal Science, College of Agricultural Sciences and Natural Resources, University of Tennessee, Knoxville, TN 37996.

Address correspondence to Dr. Smith (dsmith@cvm.msstate.edu).

OBJECTIVE
To develop a partial budget analysis of direct costs associated with bovine respiratory disease (BRD) in preweaned calves on US beef cow–calf operations and identify factors that strongly influence those costs.

DESIGN
Risk analysis model.

ANIMALS
US preweaned beef calf inventory from 2011 through 2015.

PROCEDURES
A stochastic simulation model was developed by use of a computer spreadsheet and add-in software. Input data were obtained reviewed literature, and a survey of beef cow–calf producers. A simulation consisting of 10,000 iterations was used to account for either uncertainty

JAVMA, Sept 1,2018

Ruminants

Case-control study to determine herd-level risk factors for bovine respiratory disease in nursing beef calves on cow-calf operations

Amelia R. Woolums DVM, MVSc, PhD
Roy D. Berghaus DVM, PhD
David R. Smith DVM, PhD
Russell F. Daly DVM, MS
Gerald L. Stokka DVM, MS
Brad J. White DVM, MS
Tucker Avra DVM
Ali T. Daniel DVM
Matt Jenerette DVM

OBJECTIVE
To determine herd-level risk factors for bovine respiratory disease (BRD) in nursing beef calves.

DESIGN
Matched case-control study.

SAMPLE
84 cow-calf operations in Nebraska, North Dakota, and South Dakota.

PROCEDURES
Case herds were herds that treated at least 5% of the calf crop for BRD prior to weaning. Control herds were herds that treated < 0.5% of the calf crop for BRD prior to weaning. Each case herd was matched with 2

For consideration
Unintended consequences?

- Herds with 150-499 cows (OR 7.9 times)and 500 or more cows (OR 12 times) over herds with less than 150 cows
- Herds that used intensive grazing (OR 3.3 times greater)
- Herds that used estrus synchronization programs (OR 4.5 times greater)

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

Commingling

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

Commingling-The Forces At Play

Published December 5, 2014

Effects of commingling beef calves from different sources and weaning protocols during a forty-two-day receiving period on performance and bovine respiratory disease[1,2]

D. L. Step,*[3] C. R. Krehbiel,† H. A. DePra,† J. J. Cranston,† R. W. Fulton,‡ J. G. Kirkpatrick,* D. R. Gill,† M. E. Payton,§ M. A. Montelongo,‡ and A. W. Confer‡

*Department of Veterinary Clinical Sciences, Center for Veterinary Health Sciences; †Department of Animal Science, Division of Agricultural Sciences and Natural Resources; ‡Department of Veterinary Pathobiology, Center for Veterinary Health Sciences; and §Department of Statistics, College of Arts and Sciences, Oklahoma State University, Stillwater 74078

Study Design

- 509 Steers
  - MS Market-N=260
  - MO Ranch-N=249
- 2x3+1 Factorial
  - Weaning Management (Abrupt, Wean45, WeanVac45)
  - Commingled or not
  - Auction market calves served as control

Impact of Commingling

Table 5. Effects of calf origin/commingling on morbidity, mortality, and health costs[1]

Item	RANCH	MARKET	COMM	SEM[2]	*P* > *F*
Morbidity, %	11.1[a]	41.9[b]	22.6[c]	5.6	<0.001
Treated once, %	7.4[a]	31.9[b]	15.9[a]	4.2	<0.001
Treated twice, %	1.9	4.0	6.1	2.4	0.32
Treated thrice, %	1.8[a]	6.0[b]	0.6[a]	1.6	0.04

Impact of Weaning/Vaccination

Table 6. Effects of weaning management on morbidity, mortality, and health costs[1]

		RANCH				
Item	MARKET	WEAN	WEAN45	WEANVAC45	SEM[2]	*P* > *F*
Morbidity, %	41.9[a]	35.1[a]	5.9[b]	9.5[b]	4.2	<0.001
Treated once, %	31.9[a]	22.2[a]	5.0[b]	7.7[b]	3.8	<0.001
Treated twice, %	4.0[ab]	9.2[a]	0.9[b]	1.8[b]	2.2	0.05
Treated thrice, %	6.0[a]	3.7[ab]	0.0[b]	0.0[b]	1.5	0.02

Effects of on-arrival versus delayed modified live virus vaccination on health, performance, and serum infectious bovine rhinotracheitis titers of newly received beef calves[1]

J. T. Richeson,* P. A. Beck,*[2] M. S. Gadberry,* S. A. Gunter,* T. W. Hess,* D. S. Hubbell III,* and C. Jones†

*University of Arkansas, Division of Agriculture, Department of Animal Science, Fayetteville 72701; and †Boehringer-Ingelheim Vetmedica Inc., St Joseph, MO 64501

ABSTRACT: Stress commonly associated with weaning, marketing, and shipment of feeder cattle can temporarily compromise immune function, thereby reducing the effective response to vaccination intended to control bovine respiratory disease (BRD). Two vaccination timing treatments were used to evaluate the effect of timing of a multivalent modified live virus (MLV)

titers, and comparisons were made between treatments on a receiving-day basis and an equivalent postvaccination day basis. Daily BW gains were greater ($P \leq 0.05$) for DMLV calves from d 0 to 14 (1.16 vs. 0.88 ± 0.22 kg/d) and from d 0 to 42 (0.75 vs. 0.65 ± 0.09 kg/d). Days to first treatment, total treatment cost, percentage death loss, and pasture ADG after the 42-d receiving

Summary
Getting to Implementation

- Understanding of the system
  - Address current outbreak, prevent new cases in current outbreak, prevention in future years
- Owner/Decision maker engagement in plan
  - Priorities and decision making

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

Feedlot mortality and morbidity rates have not improved in spite of technological and other advances

Bovine Congestive Heart Failure “Brisket Disease”

- The bovine cardiopulmonary system (heart and lungs) is small relative to body mass
- Increased body mass may be surpassing the ability of the cardiopulmonary system to sustain normal function
- Oversimplified?

Right-Sided Heart Failure in North American Feedlot Cattle

- Study objectives
  - To evaluate risk of RHF over time and among feedlots
  - To investigate some of the risk factors for RHF
  - To determine how these risk factors affect the time to RHF occurrence

Neary, Booker, et al, J Vet Intern Med,30:326-334

Right-Sided Heart Failure in North American Feedlot Cattle

- Data from 10 Canadian feedlots for 2000, 2004, 2008, 2012 (1.28 million hd) and 5 US feedlots for 2012 (273,319 hd)
- Categorized at entry: date of entry, age, sex, risk of BRD/UF
- All mortalities were examined post mortem by a veterinarian and primary cause of death recorded.
- Individual records of RHF and digestive deaths (DD) were evaluated. DD served as a competing cause.
- Risk factors evaluated: Treatment for BRD, feedlot entry date, risk of BRD/undifferentiated fever, age at feedlot entry.

Neary, Booker, et al, J Vet Intern Med,30:326-334

Right-Sided Heart Failure in North American Feedlot Cattle

- Results
  - Adjusted risk of RHF doubled from 2000 to 2012 (p=0.003)
    - CA feedlots had ~2/10,000 hd in 2000 & 2004 to ~4/10,000 hd in 2008 & 2012
  - For every 10,000 hd entering US feedlots in 2012, 11 cattle died from RHF.
    - CA feedlots had about half the risk
  - The median time to RHF was 19 weeks
  - Cattle treated for BRD were 3X more likely to die from RHF, and they died earlier in the feeding period

Neary, Booker, et al, J Vet Intern Med,30:326-334

Right ventricular hypertrophy with heart failure in Holstein heifers at elevation of 1,600 meters

- CO front range heifer raising facility (1,600 m = 5,249 ft)
- Second leading cause of death (first was pneumonia) in heifers <1.5 years of age.
  - Premature sale or death of 55 heifers over a 5 year period (yard population varied from 1,000-4,000 hd)
- Clinical, necropsy and histological findings consistent with brisket disease due to pulmonary hypertension

Malherbe, et al, JVDI 24(5) 867-877, 2012

Some outbreaks clustered by source (Western Plains Feedlots)

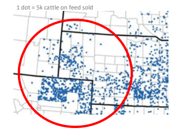
Up to 7% loss observed in single-source groups (lot)

- 40 of 600 (May, 2017)
- 39 of 500 (January, 2018)

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

Congestive heart failure in feedlot cattle

NE04_20170622_858_020

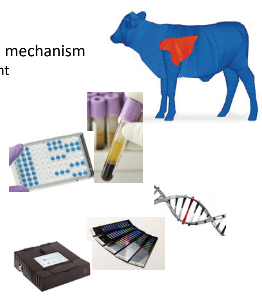


USDA ARS USMARC
An equal opportunity provider and employer

UNIVERSITY OF NEBRASKA-LINCOLN
School of Veterinary Medicine and Biomedical Sciences
GREAT PLAINS VETERINARY EDUCATIONAL CENTER

Desired outcomes

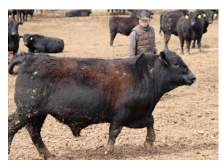
- Better understanding of the disease mechanism
  - Essential for prevention and treatment
- Blood test for diagnosing disease
  - Identify and manage cattle at risk
- DNA test for causative mutation
  - Eradicate from breeding stock



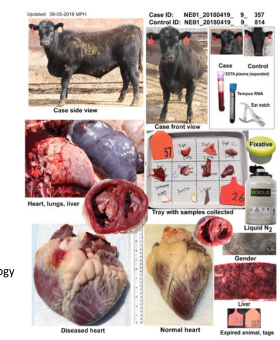
GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

Study design

- 100 matched case-control pairs
  - Four feed yards ~4000 ft
  - Pen riders identify clinical cases



- Differential diagnosis
  - Clinical presentation, necropsy, histopathology
- Preserve tissues
  - DNA, RNA, protein



GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

What did we see?

Day 1 arrival at feed yard

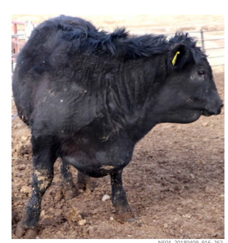
Day 238 ready for processing

Clinical cases at every stage of the feeding cycle

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences

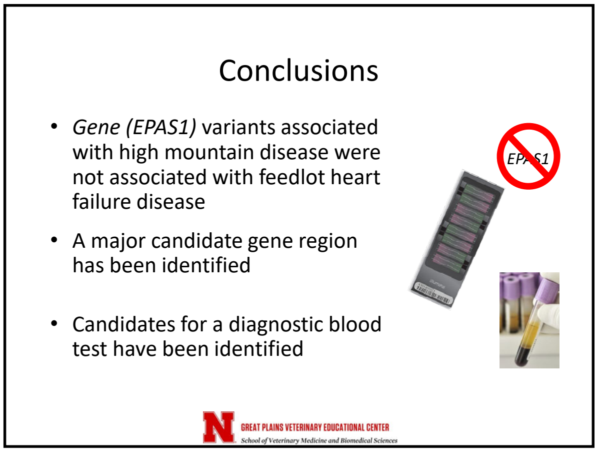
Other clinical signs

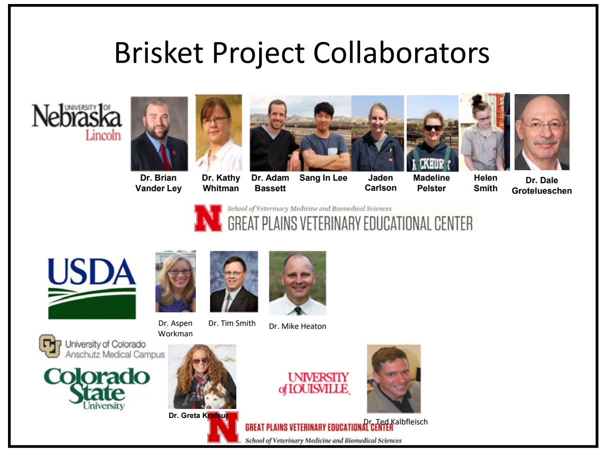
Jugular distension

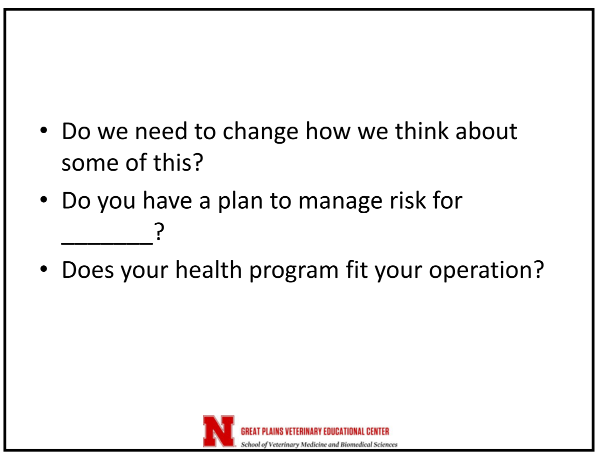


Submandibular edema

GREAT PLAINS VETERINARY EDUCATIONAL CENTER
School of Veterinary Medicine and Biomedical Sciences







Dr. Dale Grotelueschen's interests include beef health systems management, preventive health planning, diagnostic investigations, also including factors influencing morbidity and mortality, control of bovine viral diarrhea virus, neonatal calf diarrhea, and bovine respiratory disease. He has served as Director of GPVEC since 2013 following service as a managing veterinarian, Beef Cattle Veterinary Operations, Pfizer Animal Health for 12 years, with the University of Nebraska 16 years as professor, Veterinary Extension and Diagnostics and as Director of the Panhandle Veterinary Diagnostic Laboratory, Scottsbluff, Nebraska, and in private veterinary practice for 11 years, mostly in southwest Nebraska. He is active in organized veterinary medicine and the beef industry. He received his DVM from the University of Missouri and MS, Clinical Sciences from Colorado State University. He and his wife, Elizabeth, are parents of 2 grown daughters and reside in Harvard, Nebraska.

Proceedings, State of Beef Conference
November 7 and 8, 2018, North Platte, Nebraska

CONSIDERATIONS FOR USING ANNUAL FORAGES COST EFFECTIVELY

M. E. Drewnoski, D. D. Redfearn, and J. Parsons
Departments of Animal Science, Agronomy and Horticulture, and Agricultural Economics,
University of Nebraska Lincoln

Introduction

The high pasture rental rates in Nebraska have led to some cattle producers asking if there are alternative forage options available that might lower costs. Like pasture rental rates, cash rent for crop ground is also quite high, especially for irrigated ground. Making forage production cash flow on this ground compared to other cropping options can be difficult (Parsons et al., 2018). However, there are opportunities. In the eastern part of the state double cropping a forage crop after a cash crop may be possible on both irrigated and dryland ground (Drewnoski and Redfearn, 2015). The lower rainfall in the western part of the state, causes double cropping in dryland situations to be high risk or virtually impossible. However, rental rates for dryland acres are lower and incorporating annual forages into the cropping rotation may work (Berger, 2017). Additionally, double cropping a forage crop after a cash crop is possible on irrigated ground (Jenkins et al., 2016).

Selecting Annual Forages

While there are many annual forage options available, the potential window for planting and/or the window in which the forage is needed will narrow down the options. The use for grazing and desire for re-growth vs. use for hay, silage, or stockpile grazing can also impact species selection. Annual forages can be broken down into three main types: 1) cool-season, winter hardy (winter types), 2) cool-season, winter sensitive (spring types), and 3) warm-season, summer annuals. The type of annual forage selected should be based on planting date and forage need (Table 1). Cool-season, winter hardy forages can be planted in fall and used in the early spring. Cool-season, winter sensitive forages can be planted in spring and used in late spring/early summer or can be planted in late-summer for fall or winter forage. Warm-season, summer annual forages are planted in late spring/early summer for late summer, fall, or winter forage. Within a type there are differences among species and even within species (variety) in their growth and productivity. Grasses will produce the greatest biomass and are usually the most cost effective annual forage source, although strategic use of brassicas in a mix with cool-season, winter sensitive small grains can be cost effective (Redfearn and Drewnoski, 2018).

Table 1. Guidelines for establishment of annual forage in Nebraska (adapted from Drewnoski and Redfearn, 2017).

Annual Forage	Forage Type	Full Rate lbs/ac	Seed Depth, inch	Planting Date	Winter Hardy
Fall planting (April-June grazing)					
cereal rye: Elbon	CG	65	1.5	8/1-11/1	to -30º F
cereal rye: VNS	CG	70	1.5	8/1-11/1	to -30º F
triticale, winter	CG	70	1	8/1-11/1	to -20º F
wheat, winter	CG	70	1.25	8/15-10/15	to -20º F
vetch, hairy	CL	20	1	8/1-9/15	to -20º F
Spring planting (May-July grazing)					
oats, spring	CG	90	1	3/15-5/1	No
triticale, spring	CG	70	1	3/15-5/1	No
barley, spring	CG	80	1.25	3/15-5/1	No
pea, spring forage	CL	40	2.25	3/15-4/15	No
forage collards	Br	5	0.5	3/15-5/10	No
rapeseed	Br	7	0.5	3/15-5/10	No
hybrid grazing turnip	Br	8	0.5	3/15-5/10	No
Late spring planting (July-Sept grazing)					
millet, pearl	WG	15	0.5	5/15-8/1	No
sorghum	WG	10	1	5/15-8/1	No
sudangrass	WG	20	1	5/15-8/1	No
sudan-sorghum hybrid	WG	25	1	5/15-8/1	No
millet, foxtail	WG	15	0.5	5/15-8/1	No
cowpea	WL	42	1.25	5/15-7/15	No
soybean	WL	50	1.25	5/1-7/15	No
Summer planting (Sept-Jan grazing)					
oats, spring	CG	90	1	8/1-9/1	No
triticale, spring	CG	70	1	8/1-9/1	No
barley, spring	CG	75	1.25	8/1-9/1	No
turnip, Purple top	Br	5	0.5	7/15-8/20	No
rapeseed	Br	5	0.5	7/15-8/20	No
hybrid grazing turnip	Br	5	0.5	7/15-8/20	No
forage collards	Br	5	0.5	7/15-8/20	No
Do not plant legumes (CL or WL) or brassicas (Br) alone for grazing, mix with a grass. For mixes target the percent of full seeding rate of the species to add to 100 to 150%. For instance if Elbon rye was planted at in a mix with hairy vetch at 50 lbs rye (50/65 = 77%) with 9 lb vetch (9/20 = 45%) then seeding rate would be 122%.					

Spring forage production

Earliest spring grazing (starting in April) can be achieved through fall planting of winter hardy cool-season species like cereal rye or winter triticale.

Cereal rye is a popular choice for planting as a double-crop within cash cropping systems. One of the main reasons for its popularity is that it is the most winter hardy small cereal and it tends to have greater yields earlier in the spring than other options. This is especially true for southern varieties such as Elbon since they break dormancy earlier in the spring (Redfearn et al., 2016). This can be beneficial when the window for their use is relatively narrow, but this also results in earlier spring maturity. Thus, the harvest window is narrow and can make grazing management more difficult because forage quality can rapidly decrease. Much of the cereal rye available is variety not stated (VNS) and with this comes greater variability in growth from year to year that is due to plant genetics. Planting can be done as late as early November with cereal rye. However, spring yields will be lower with late planting. Ideally, planting of winter hardy small grains should occur before October 1.

In general, wheat tends to have slower growth, which can result in lower forage yields, when harvested in early spring. However, wheat also has a longer harvest window and does not mature as rapidly. Another advantage of wheat is that the seed can be low cost with varieties available that have been tested across the state.

Triticale is a hybrid of cereal rye and wheat. It has many advantages as a forage, and like wheat there is an active breeding program in Nebraska. This means improved varieties are available that have been tested across the state. While its growth does not start as early as cereal rye, it is not far behind. Its yields are as good as or better than cereal rye (especially if allowing the forage to grow later into the spring). Like wheat, triticale maintains it forage quality better through the spring than cereal rye. Compared to cereal rye, triticale also has a lower potential to produce volunteer plants the next year. This is especially important if triticale will be grown in fields where a wheat cash crop is in the rotation.

One of the challenges with using annuals for forage is that they tend to grow and mature rapidly making timely management key. However, there are some ways that producers can "lengthen" the window. Using multiple species to take advantage of their differing growth patterns when planting multiple fields can help distribute the growth and need for harvest (grazing or cutting) over a wider window of time. For instance, planting cereal rye on one field and triticale on another can result in both early (cereal rye) and late (triticale) spring forage being available for grazing.

Later spring grazing (starting in May) can be gained through planting winter sensitive, cool-season species like oats, spring barley, or spring triticale in mid to late March. Oats have been one of the traditional spring-planted forage species. However, there are improved spring varieties of barley and triticale available. In the spring, using later maturing varieties, often called "forage type" can improve spring yields and again lengthen the harvest window as they do not mature as rapidly as "grain" type small grains. If grazing is the goal, brassicas can be included with the small grains forages. Brassicas, such as turnip, rapeseed and collard, tend to be high energy and high in crude protein even when mature. However, there are anti-quality factors in some brassicas that tend to increase with maturity. The forage varieties are often selected for regrowth potential and may be more valuable when rotational grazing is being used. Brassicas grow well in the eastern and central part of the state, but are more variable in western NE. This is likely due to the shallow planting depth and potential for low surface soil moisture.

Summer forage production

Warm-season annual grasses can be planted in late spring or early summer to provide mid- and late-summer grazing or stockpiled and used for winter grazing (Anderson and Volesky, 2013).

Sudangrass is a rapidly growing warm-season grass, with good regrowth potential. It usually contains lower levels of prussic acid than sorghum-sudangrass hybrids, but it is also slightly lower yielding. It is a good option for grazing during the growing season.

Sorghum-sudangrass hybrids closely resemble sudangrass, but the hybrids are taller, have larger stems and leaves, and generally produce higher yields. However, regrowth can be slower and thus it may not be the best option for grazing during the growing season. Sorghum-sudangrass hybrids are more likely to contain toxic levels of prussic acid when immature than sudangrass. Sorghum-sudangrass hybrids are often used for silage, hay, or stockpiled for winter windrow grazing.

Pearl millet has smaller stems than sorghum-sudangrass hybrids, is leafier and does not produce prussic acid. It is a good option for hay and winter grazing. There are commercial varieties adapted to Nebraska. While forage yields are typically less than sorghum-sudangrass, pearl millet is a close second. It has slower regrowth and may not be as well suited to grazing during the growing season as sudangrass.

Foxtail millet can be a good option for hay production in western Nebraska because it has low water requirements and is fine stemmed. Foxtail millet does not yield as well as sorghum-sudangrass hybrids, pearl millet, or sudangrass. However, its seed cost is usually about 1/3 of other summer annuals making it a lower investment risk in western dryland systems (Jenkins et al., 2017). Foxtail millet reaches maturity faster and fits well into short growing windows. It is shallow rooted and is not well suited to grazing.

If winter feed is needed, cutting and windrowing sorghum-sudangrass or pearl millet in the fall, then swath grazing in the winter is a good option, especially in western NE (Berger and Volesky, 2012).

Fall forage production

Late fall and winter grazing can also be achieved through planting of winter sensitive cool-season species like oats, spring triticale, or spring barley in late summer. These winter sensitive species will out yield winter hardy species in terms of fall forage production (Redfearn et al., 2016). Unlike spring and early summer planted annuals, forage maturity and quality with late summer planting is generally not as big of an issue. In fact, there may be no advantage of planting a "forage" type over a "grain" type when planting in late summer. However, if planting in early to mid-August there is likely a forage quality advantage with the "forage" varieties.

Brassica can also be included with winter sensitive small grains. While there are forage varieties, use of non-improved varieties such as purple top turnip or rapeseed may be the most cost effective for late summer planting, especially if multiple grazing is not planned. Nutritive value of brassicas, when planted in the mid- to late-summer does not appear to vary much among brassica species (Villalobos and Brummer, 2015; Lenz et al., 2018). The brassicas are low in fiber and high in both energy and crude protein, with nutritive value more similar to concentrates than forages. In general, brassica and small grains both maintain their quality well into the winter (Lenz et al., 2018). Given their cost, either purple top turnip or rapeseed, can reduce seed cost compared to a small grain monoculture while simultaneously improving feeding value of the forage (Riley et al., 2019). Some producers have concerns about cattle choking on the root (bulb) of purple top turnips. Using a non-bulb brassica like rapeseed maybe more attractive in this instance.

Nutritive value of late summer planted small grain forages with or without brassicas is high and suited to the requirements of lactating cows or growing calves. Weaned calves grazing stockpiled oats and brassicas have gained between 1.5 and 2.2 lb/d.

The shorter the growing window, the lower the likelihood that adding nitrogen fertilizer will pay. With late summer planting, high nitrate content of both small cereals and brassicas have been observed (Lenz et al, 2019). Thus, if planting winter sensitive species in late August, it is not recommended to add supplemental nitrogen. However, with low soil residual N and earlier planting (early to mid-August) 30 to 50 lb N/acre may improve forage production.

Planting a mixture of winter hardy and winter sensitive forages to have both fall and spring forage from a single planting often results in lower fall and spring yields than winter sensitive or winter hardy monocultures, respectively, but similar total (fall plus spring) forage yield (Volesky, 2018).

Implications

Annual forages can be cost effective that can fit into some cropping systems. One of the most important drivers of forage productivity and cost effectiveness of annual forages is planting date. Planting dates outside of the recommended planting window is unlikely to result in desired growth. For instance, planting cool-season winter sensitive annuals like oats in mid-September is likely to result in reduced growth with little return on investment. Using annual forages as a double-crop is not fool-proof and can have major challenges. Having realistic expectations of planting date is one of the keys to proper species selection.

Literature Cited

Anderson, B. E. and J. D. Volesky. Summer Annual Forage Grasses. Nebguide G2183. http://extensionpublications.unl.edu/assets/html/g2183/build/g2183.htm

Berger A. and J. Volskey. 2012. Windrow Grazing. Nebguide G1616. http://extensionpublications.unl.edu/assets/html/g1616/build/g1616.htm

Berger, A. 2017. Annual Forages and Windrow Grazing as an Alternative to Cash Grain Crops https://beef.unl.edu/annual-forages-and-windrow-grazing-alternative-cash-grain-crops

Drewnoski, M. E. and D. D Redfearn. 2015. Annual Cool-Season Forages for Late-Fall or Early Spring Double Crop. Nebguide G2262. http://extensionpublications.unl.edu/assets/pdf/g2262.pdf

Drewnoski, M. E. and D. D. Redfearn. 2017. Planting Annual Forages. https://beef.unl.edu/planting-annual-forages

Jenkins, K. H., C. Creech, R. Higgins and J. Buttle. 2017. Summer Cocktail Forage Reseach in the Panhandle of Nebraska.Nebraksa Beef Report. p 55-56. https://beef.unl.edu/documents/2017-beef-report/201720-Summer-Cocktail-Forage-Research-in-the-Panhandle-of-Nebraska.pdf

Jenkins, K., H. A. Berger, and G. Hergert. 2016. Annual Forages following Irrigated Winter Wheat. Nebraska Beef Report. p68-70. https://beef.unl.edu/documents/2016-beef-report/24-2016-Annual-Forages-following-Irrigated-Winter-Wheat.pdf

Lenz, M. E., J. L. Cox, K. E. Hales, H. C. Wilson and M. E. Drewnoski. 2018. Late Summer Planted Oat-Brassica Forage Quality Changes during Winter Grazing. Nebraska Beef Report p 60-62. https://beef.unl.edu/documents/2018-beef-report/2018-20-Late-Summer-Planted-Oat-Brassica-Forage-Quality-Changes-during-Winter-Grazing.pdf

Lenz, M. E., R. J. Kern, C. E. Orvis and M. E. Drewnoski. 2019. Nitrate Concenrations of Annual Forage Grown for Grazing in Nebraska. Nebraska Beef Report. p 45-46.

Redfearn, D., B. Anderson, J. Volesky and M. Stephenson. 2016. UNL BeefWatch July. https://beef.unl.edu/winter-small-grains-or-spring-small-grains

Redfearn, D. D. and M. E. Drewnoski. 2018. Planting Decisions for Alternative Forages: Plant and Animal Perspectives. https://grassland.unl.edu/NGC%20Proceedings%20FINAL%20072418.pdf

Riley, H. E., K. E. Hales, S. D. Shackelford, H. C. Freetly and M. E. Drewnoski. 2019. Effect of Rapeseed Inclusion in Late-Summer Planted Oats Pasture on Growing Performance of Beef Steers. Nebraska Beef Report. p40-41.

Parsons, J., M. E. Drewnoski and D. D. Redfearn. 2018. Economics of Producing Forage on Cropland. https://beef.unl.edu/beefwatch/economics-producing-forage-cropland

Villalobos, L. A. and J. E. Brummer. 2015. Forage Brassicas Stockpiled for Fall Grazing: Yield and Nutritive Value. Crop Forage and Turfgrass Management. DOI: 10.2134/cftm2015.0165

Volesky, J. 2018. Mixed Seeding of Winter and Non-winter Hardy Annual Forages. UNL BeefWatch. August https://beef.unl.edu/beefwatch/mixed-seeding-winter-and-non-winter-hardy-annual-forages

Mary Drewnoski is a Beef Systems Specialist with the University of Nebraska-Lincoln. Prior to joining UNL in 2014, she spent time learning and working in cattle systems in many locations across the U.S. including: Kentucky, North Carolina, Iowa, and Idaho. She is a beef cattle nutritionist with expertise in forage-based production systems and is a part of an interdisciplinary team evaluating Economical Systems for Integrated Crop and Livestock Production in Nebraska.

Jay Parsons is an agricultural economist with the University of Nebraska-Lincoln. He specializes in farm and ranch management decision analysis, risk management, and production systems analysis. He teaches Advanced Farm Management and Linear Programming and is a part of an interdisciplinary research and extension team evaluating economical systems for integrated crop and livestock production in Nebraska. Dr. Parsons has almost 20 years of experience helping farmers and ranchers understand risk and emerging management tools.

Proceedings, State of Beef Conference
November 7 and 8, 2018, North Platte, Nebraska

GENETIC SELECTION FOR EFFICIENCY

M. L. Spangler
Department of Animal Science, University of Nebraska, Lincoln

Introduction

Efficiency has become a buzz word, often with many different interpretations. In simple terms, there is both biological efficiency and economic efficiency. Although these two broad categories are related, they are not the same. Indeed, the beef industry needs to focus more attention on selection for efficiency, but the "how" is often debated. The intent of this summary is to simply identify methods and tools by which producers could use breeding systems and genetics to improve overall production efficiency.

Breed Utilization

There is little scientific literature that clearly characterizes breed differences for feed intake and gain during feed intake test periods. One of the largest, and certainly the most recent, comes from data collected at the U.S. Meat Animal Research Center (USMARC) as part of their Germplasm Evaluation (GPE) project. Table 1 shows breed differences in average daily feed intake and average daily gain while on test as reported by Retallick et al. (2017). Interestingly, Retallick et al. (2017) also compared breeds based on a restricted (feed intake is not expected to increase when selection pressure is applied to gain while on test) and unrestricted index for feed efficiency. Beefmaster and Limousin were the most efficient compared to all other breeds based on the unrestricted index using steer data (significant breed differences at $P<0.05$).

Table 1. Breed Differences in grams (SE) of on-test average daily feed intake (ADFI) and on-test average daily gain (ADG) of steers and heifers relative to Angus[1]

Breed	Steer ADFI	Steer ADG	Heifer ADFI	Heifer ADG
Angus	0	0	0	0
Hereford	-788 (286)*	-35 (45)	-962 (266)*	-21 (44)
Red Angus	-310 (275)	-66 (52)	-684 (255)*	-86 (42)*
Shorthorn	-997 (320)*	-100 (61)	-1,021 (298)*	-98 (49)*
South Devon	-1,856 (666)	-274 (134)*	-1,576 (641)*	13 (109)
Beefmaster	-771 (346)*	72 (68)	-1,556 (641)*	-91 (56)
Brahman	-1,321 (350)*	-124 (68)	-1,351(319)*	-185 (53)*
Brangus	-173 (335)	-31 (65)	-585 (317)	-120 (53)*
Santa Gertrudis	-569 (334)	22 (63)	-1,039 (306)*	-113 (50)*
Braunvieh	-1,488 (351)*	-180 (68)*	-1,841 (305)*	-299 (50)*
Charolais	-521 (289)	-18 (55)	-876 (270)*	-75 (45)
Chiangus	-1,245 (334)*	-81 (64)	-1,049 (296)*	-118 (49)*
Gelbvieh	-1,051 (278)*	-72 (53)	-723 (253)*	-114 (42)*
Limousin	-1,238 (281)*	-5 (53)	-1,471 (255)*	-160 (42)*
Maine Anjou	-1,646 (334)*	-150 (64)*	-1,101 (302)*	-102 (50)*
Salers	-1,211 (333)*	-136 (63)*	-1,176 (306)*	-139 (51)*
Simmental	-43 (288)	-19 (55)	-530 (275)	-68 (45)
Tarentaise	-1,178 (678)	-150 (136)	-1,926 (566)*	-312 (96)*

[1] Significant breed differences ($P<0.05$) indicated by "*"

Within Breed Selection

Efficiency metrics, and indicators of efficiency, are indeed heritable and would respond favorably to selection (Table 2).

Table 2. Heritabilities (diagonal) and genetic correlations (off-diagonal) for feed efficiency traits[1]

	ADG	DMI	RFI	G:F
ADG	0.26	0.56	-0.15	0.31
DMI		0.40	0.66	-0.60
RFI			0.52	-0.92
G:F				0.27

[1]Adapted from Rolfe et al. (2011).

In addition to growth and dry matter intake EPD, some EPD do currently exist to select for partial efficiency. Examples of those are detailed below.

	Bull A	Bull B
Residual average daily gain	-0.1	0.05
Residual feed intake	-0.3	0.0
Maintenance energy	0	10

Residual average daily gain (Angus)- Calves sired by bull B should gain 0.15 pounds per day more when fed the same amount of feed during the post weaning phase.

Residual feed intake (Gelbvieh)- Calves sired by bull A would consume 0.3 lbs of feed per day less on average than calves sired by bull B to gain the same amount of weight.

Maintenance energy (Red Angus)- Daughters from bull B should require 10 Mcal/month less energy for maintenance. If average hay quality is 0.86 Mcal/lb. this equates to 11 lb. less forage per month.

Even though some EPD do exist for components of efficiency, feed intake phenotypes are expensive to collect and thus for the foreseeable future, wide-spread collection of individual intake data in the seedstock sector will remain sparse at best. Moreover, residual gain and residual feed intake are not phenotypes per se, but rather restricted selection indices. Although these residuals are biologically intriguing, they are suboptimal at generating response to overall profitability given that they only allow for improvement in either gain or feed intake and not both traits simultaneously.

Selection Methods for Efficiency

In terms of guidelines for the U.S. beef industry to follow relative to genetic selection for improved feed efficiency, Nielsen et al. (2013) recommend an index-based approach. From a total life-cycle perspective, maintenance energy costs are estimated to be about 70% of the total energy intake in the beef production system. Thus, a primary goal must be to decrease maintenance energy requirements while not reducing output. This means that profitable selection decisions must contemplate multiple traits simultaneously. Using selection index values will be very beneficial to achieve the overall goal of improved profitability. If constructed correctly, multiple-trait index tools can account for antagonisms that may exist between feed intake and other economically relevant traits, including cow-herd centric traits.

Rolfe et al. (2011) estimated selection response for three feed efficiency related phenotypes and four different selection indices (Table 3). From these results, it is clear that an economic index approach to selection is the most desirable.

Table 3. Expected response (selection intensity*lbs) to selection[1]

Selection Criterion[2]	Direction	DMI Response, lbs.	Gain Response, lbs.
DMI	Down	-125.0	-11.91
GAIN	Up	+57.98	+16.54
G:F	Up	-60.63	+5.29
I_1	Down	-98.33	+4.19
I_2	Down	-84.88	0
I_3	Down	-27.34	+11.91
I_4	Down	0	+16.98

[1] Adapted from Rolfe et al. (2011).

[2] DMI= Dry matter intake; GAIN = Weight gain; G:F = Gain to feed ratio; I_1 = Phenotypic RFI; I_2 = Genetic RFI; I_3= Economic index including DMI and Gain; I_4=Economic index including Gain and RFI.

Although Rolfe et al. (2011) illustrated that an economic index based approach was superior to single trait selection when considering both feed intake and gain, a more comprehensive approach is to consider feed intake as a cost in existing economic selection indices such as Angus's $B or Simmental's TI, therefore considering traits such as carcass merit, feed intake, carcass weight, survival, and other traits as dictated by the complete breeding objective.

The importance of feed intake in a terminal index is well documented. In example, Ochsner et al. (2017a) assumed a terminal breeding objective for Beefmaster cattle whereby all calves were born from mature cows, retained through the feedlot phase and sold on a grid-based system. The five objective traits considered for the terminal index included hot carcass weight (HCW), marbling score (MS), ribeye area (REA), 12th-rib fat (FAT) and feed intake (FI), with the latter representing the only expense related phenotype among the objective traits. Relative economic values for the terminal objective traits HCW, MS, ribeye area REA, FAT, and FI were 91.29, 17.01, 8.38, -7.07, and -29.66, respectively.

Economic indices are the preferred tool for multiple trait selection. A bio-economic index is simply a collection of EPDs that are relevant to a particular breeding objective, whereby each EPD is multiplied by an associated economic weight. Consequently, a high index value does not necessarily mean that an animal excels in all EPD categories given that superiority in trait can compensate for inferiority in other traits depending on how the EPDs are weighted in the index. A high index value should be thought of as excelling in the ability to meet a breeding objective and ultimately net profit. It is important to note, however, that before proper use of an index can be ensured, a breeding objective must be clearly identified. For example, the use of an index such as the American Angus Association's Dollar Beef ($B) in an enterprise that retains replacement heifers can lead to adverse effects, given that sire selection pressure has been placed on terminal traits via $B.

An example of an all-purpose index (often called maternal in the beef industry because it contemplates the retention of females) that compares the importance of different weight traits comes from the Beefmaster breed. Ochsner et al. (2017b) developed a maternal selection index for use by Beefmaster breeders. The index assumed that Beefmaster bulls would be bred to British based cows and heifers and that heifers would be retained in the system and all cull heifers and steers would be sold at weaning. Six objective traits (the economically relevant traits that we wish to improve) were considered for the maternal index including calving difficultly direct (CDd), calving difficulty maternal (CDm), 205-day weaning weight direct (WWd), 205-day maternal growth (WWm), mature weight (MW) and heifer pregnancy (HP). Results showed that decreasing CDd, CDm and MW while increasing WWd, WWm and HP would increase profitability of the operation. Mature weight was the primary driver receiving 49.2% of the emphasis, implying that for the assumed parameters decreasing MW will do the most to improve profitability of operations with a maternal objective. Weaning weight direct was the second highest priority objective trait receiving 27.2% of the emphasis. These two traits are antagonistic to each other relative to the breeding objective, but since the genetic correlation between them is not unity progress can be made in both traits simultaneously.

Table 3. Breed association selection indexes, market progeny endpoints and breeding system[1]

Breed	Index Name	Progeny Endpoint	Breeding System
Angus	$W (Weaning)	weaned feeder calves	A
Angus	$EN (Maintenance Energy)	replacement heifers	M
Angus	$F (Feedlot)	live fed cattle	T
Angus	$G (Grid)	beef carcasses sold on a CAB grid	T
Angus	$B (Beef)	beef carcasses from retained ownership sold on a CAB grid	T
Charolais	TSPI (Terminal Sire Profitability Index)	beef carcass sold on grid	T
Gelbvieh	$Cow	replacement heifers	G
Gelbvieh	EPI (Efficiency Profit Index)	feedlot efficiency	T
Gelbvieh	FPI (Feeder Profit Index)	beef carcass sold on grid	T
Hereford	BMI$ (Baldy Maternal Index)	beef carcass sold on grid; replacement heifers retained	G
Hereford	BII$ (Brahman Influence Index)	beef carcass sold on grid; replacement heifers retained	G
Hereford	CHB$ (Certified Hereford Beef Index)	beef carcass sold on CHB grid	T
Limousin	MTI (Mainstream Terminal Index)	beef carcasses sold on grid	T
Red Angus	HerdBuilder	beef carcass sold on grid; replacement heifers retained	G
Red Angus	GridMaster	beef carcasses sold on grid	T
Simmental	API (All Purpose Index)	beef carcasses sold on grid; replacements retained	G
Simmental	TI (Terminal Index)	beef carcasses sold on grid	T

[1] Adapted from Weaber fact sheet available at www.eBEEF.org.
T=terminal, G=general-purpose, M=Maternal

Implications

There are clear breed differences for growth, feed intake, and proxies for maintenance energy (maternal weaning weight and mature weight). Moreover, well-structured cross-breeding programs that are able to exploit these differences between breeds and take advantage of heterosis for reproduction traits are well positioned to improve enterprise level efficiency. The goal of commercial producers should be profit, not simply the increase in revenue or the decrease in costs. In order to select for profit, both input and output traits must be considered simultaneously. To do so, the use of economic selection indices is advisable. The improvement in these indices will largely come from the development of additional EPD for traits of economic relevance at the commercial level aided by the collection of commercial level phenotypes.

Literature Cited

Hazel, L. N. 1943. The genetic basis for constructing selection indexes. Genetics 28:476-490.

Nielsen, M.K., M.D. MacNeil, J.C.M. Dekkers, D. Crews, T.A. Rathje, R.M. Enns, and R.L Weaber. 2013. Life cycle, total-industry genetic improvement of feed efficiency in beef cattle: Blueprint for the Beef Improvement Federation. Prof. Anim. Sci. 29: 559-565.

Ochsner, K.P., M.D. MacNeil, R.M. Lewis, and M.L. Spangler. 2017a. Economic selection index development for Beefmaster cattle II: General-purpose breeding objective. J. Anim. Sci. 95:1913-1920.

Ochsner, K.P., M.D. MacNeil, R.M. Lewis, and M.L. Spangler. 2017b. Economic selection index development for Beefmaster cattle I: Terminal breeding objective. J. Anim. Sci. 95:1063-1070.

Retallick, K.J., J. M. Bormann, R. L. Weaber, M. D. MacNeil, H. L. Bradford, H. C. Freetly, K. E. Hales, D. W. Moser, W. M. Snelling, R. M. Thallman, and L. A. Kuehn. Genetic variance and covariance and breed differences for feed intake and average daily gain to improve feed efficiency in growing cattle. 2017. J. Anim. Sci. 95: 1444:14450.

Rolfe, K.M., W. M. Snelling, M. K. Nielsen, H. C. Freetly, C. L. Ferrell, and T. G. Jenkins. 2011. Genetic and phenotypic parameter estimates for feed intake and other traits in growing beef cattle, and opportunities for selection. J. Anim. Sci. 89: 3452-3459.

Matt Spangler grew up on a diversified crop and livestock farm in Kansas. He received degrees from Kansas State University (BS; 2001), Iowa State University (MS; 2003), and the University of Georgia (PhD; 2006) and is currently a Professor and Extension Beef Genetics Specialist at the University of Nebraska. He works as part of a team with colleagues at UNL and US MARC to improve genetic/genomic selection tools and methods.

Proceedings, State of Beef Conference
November 7 and 8, 2018, North Platte, Nebraska

GENETIC SELECTION FOR EFFICIENCY

Mark Allan, Trans Ova Genetics
Douglas Olsen, Olsen Ranches
Jerry Wulf, Wulf Cattle

***Mark Allan** presently serves as the Director of Genetic Technology for Trans Ova Genetics, Sioux Center, Iowa. In this role he oversees R&D for genetics/genomics, genetic marketing opportunities and new product development activities. Early career established himself with expertise in livestock industry production. First in the beef industry working directly with purebred/commercial cow-calf production. He returned to graduate school at the University of Nebraska and studied mouse models to understand the genetic basis of energy metabolism and response of correlated traits in livestock species. Dr. Allan served as a Research Geneticist for the United States Department of Agriculture's Agricultural Research Service at the U.S. Meat Animal Research Center (2003-2008) in Clay Center, Neb, where he led the R&D programs for the genomics of feed efficiency and reproduction in bovine. At USMARC he also served as a member of the team of scientists that developed and brought the first bovine 50K genomic chip to market. From (2008-2011) he served as the Associate Director of Global Technical Services for Pfizer Animal Health-Genetics, helping develop and launch the Angus HD50K and Dairy Clarifide products, firsts for the dairy and beef industries. From 2006-2011 he also served as an adjunct faculty member of the University of Nebraska Animal Science Department. Mark has given numerous invited symposia talks in North America and abroad.*

***Douglas Olsen**, with his father, manages Olsen Ranches, Inc., a 4th generation family-owned diversified operation located in Harrisburg, Banner County, Nebraska. Douglas's great grandfather came to the western panhandle of Nebraska in 1885, and, today, this progressive operation has a commercial and registered cow herd that markets harvest ready animals as well as replacement females and bulls. Custom services include custom individual feed intake data collection with a GrowSafe system, custom feeding, and custom AI work. The farm enterprise crops include wheat, corn, barley, peas, annual forages, and alfalfa on both dry land and irrigated farm ground. In 2010, Olsens installed a GrowSafe system on the ranch to measure feed intake of steers that are part of the American Hereford Association's National Reference Sire Program as well as bulls and heifers from Olsens' registered program along with custom data collection for other producers seeking intake data on bulls, heifers, or steers. Olsen Ranches has participated as a test herd for the American Hereford Association's National Reference Sire Program (NRSP) since 1999, through which Olsens collect birth weight, weaning weight, yearling weight, and all carcass data on harvested progeny. This has given Olsens the opportunity to use some of the Hereford breed's elite sires in the herd AI program. Olsens continue to work with the AHA as well as Red Angus breeders to test sires through the commercial cow herd. The Beef Improvement Federation awarded the ranch its Commercial Producer of the Year Award in 2004. Douglas and his wife, Pamela, have three sons, Isaac, Luke, and Gabe.*

Jerry Wulf *is partner and advisor in Wulf Cattle. Wulf Cattle is one of the largest genetics to rail beef operations in the U.S. Currently running 1500 registered Limousin, Lim-Flex, and Angus females, supplying both the Beef and Dairy industries with value added genetics. Jerry helps oversee the day to day genetics, production, and marketing, consisting of 600 bulls, semen, and 80,000 head of fed cattle annually. Founded by his father the late Leonard Wulf in 1955, it started as a small cattle feeding farm in western Minnesota. In the early 70s, Wulf's were entrepreneurs in introducing the Limousin breed to the US Beef industry. Jerry has had an integrate part in building Wulf Cattle into what it is today. Geographically they operates in 3 Midwestern states, MN, SD, and NE, and have strategically aligned themselves with ranchers, dairymen, and beef processors which makes up the holistic system. Today they are an internationally recognized Seedstock company, and are one of the largest suppliers of Value added (Natural and NHTC) fed cattle in the US.*

NOTES