KEN & CAROLINE ENG FOUNDATION COW-CALF SYMPOSIUM

Dr. Kenneth and Caroline McDonald Eng Foundation

COW-CALF SYMPOSIUM

Hosted by the University of Nebraska–Lincoln

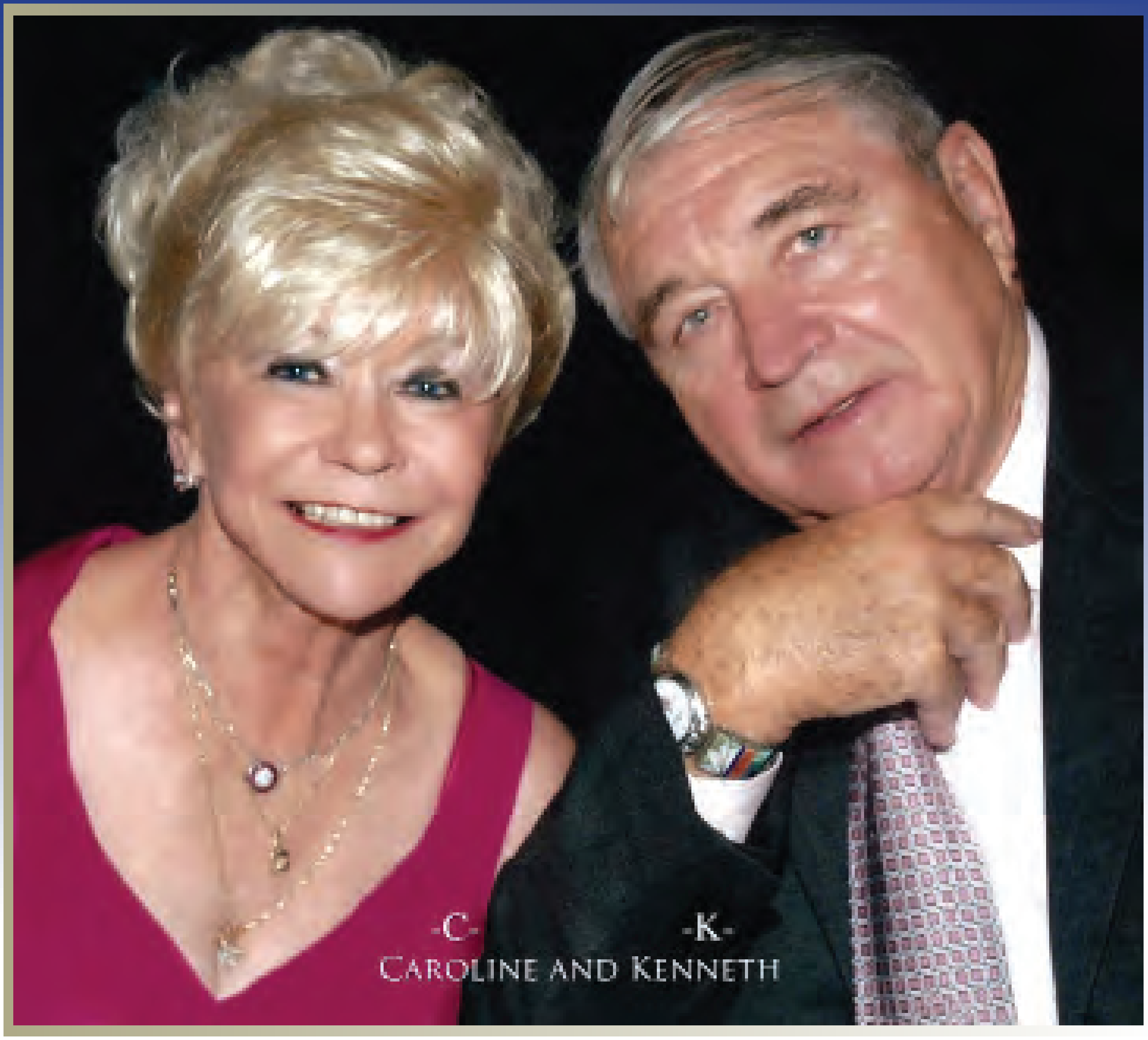
September 12-13, 2013
Embassy Suites
Lincoln, Nebraska

OKLAHOMA STATE UNIVERSITY

TEXAS A&M UNIVERSITY

Dr. Kenneth and Caroline McDonald Eng Foundation

COW-CALF SYMPOSIUM



AGENDA

Cow-Calf Symposium

Embassy Suites, 1040 P Street, Lincoln, Nebraska

Alternative Methods of Improving Cow Efficiency in Times of Stress*

September 12, 2013

1:00 - 1:15 p.m. *Introduction* — Larry L. Berger, H. Russell Cross, Clint Rusk, and Kenneth Eng
1:15 - 2:45 p.m. *15 Years of "Hands On" Experience with Confined Cow Production* — Kenneth Eng
2:45 - 3:15 p.m. Break

University of Nebraska–Lincoln
Moderator — Larry Berger

1:45 - 2:15 p.m. *Using Crop Residues and By-Products to Limit Feed Cows in Confinement* — Karla Jenkins
2:15 - 2:45 p.m. *Early Weaning and Reproductive Performance of Beef Cows* — Rick Rasby and Jason Warner

2:45 - 3:15 p.m. Break

University of Nebraska–Lincoln

3:15 - 3:45 p.m. *Health and Management of Confined Cows and Calves* — David Smith, Mississippi State University
3:45 - 4:15 p.m. *Economics of Confining Cows and Calves* — Terry Klopfenstein, Karla Jenkins, Jason Warner, Rick Rasby, and Kate Brooks

4:15 p.m. Questions and Answers — Larry Berger

September 13, 2013

Texas A&M University
Moderator — Russell Cross

8:00 - 8:45 a.m. *Defining Value and Requirements in Cow Rations: What is a Calorie Worth?* — Jason Sawyer

8:45 - 9:30 a.m. *Variation in Efficiency of Growing Heifers and Implications for Intensified Cow-Calf Production* — Gordon Carstens

9:30 - 10:00 a.m. Break

Oklahoma State University — David Lalman
Moderator — Clint Rusk

10:00 - 11:00 a.m. *Improving Forage Use Efficiency Cow/Calf Semi-Confinement Systems* — David Lalman, Sara Linneen, Dillon Sparks, Adam McGee, Alyssa Rippe and Clint Rusk

11:00 - 11:40 a.m. *Nutritionist and Veterinarian Role* — Dicke, McClellan and Griffen

11:40 - 12:00 p.m. Questions, Answers and Wrap Up — Kenneth Eng

**Produced by University of Nebraska–Lincoln, Oklahoma State University, Texas A&M, and the Dr. Kenneth & Caroline McDonald Eng Foundation.*

Pre-registration — $100.00 / $125.00 at the door.

For more information contact the above Universities or the Dr. Kenneth & Caroline McDonald Eng Foundation, Kenneth Eng (210-865-8376) or Annie Powell (575-743-6331) or engnm@hotmail.com.

TABLE OF CONTENTS

Kenneth Eng, Jr., Ph.D.

CONSULTANT

Eng – Inc.

Kenneth Eng was born on a farm in Boone County, NE approximately 50 miles west of Norfolk. Following graduation from High School at Newman Grove he attended college at Wayne State, received a BSC and MSC from University of Nebraska and his Ph.D in Animal Nutrition from Oklahoma State. He then joined the staff at Texas A&M doing Animal Nutrition research. He later returned to Texas A&M ('69 and '70) on a consulting basis where he designed and taught the first classes in the A&M feedlots Managers' Master's Degree program. In 1965 he became Ralston-Purina's first feedlot Technical feedlot consultant mainly in the Western area of the United States. Three years later he entered the independent feedlot consulting business and was active in research and consulting in the late 60s, 70s, and 80s. In the 1968 he designed one of the first feedlot performance and profit projection programs based on the University of California net energy system. Many of these programs are still used.

In 1990 he began downsizing his consulting business and focused on personal yearling operations in the 90s and cow-calf operations beginning in 2000. Beginning in 1990, his wife, Caroline was a constant companion, business partner and soul mate until she drowned in 2010. Since Caroline's death he further limited his research and consulting and has concentrated on the cow, ranch and farmland investments in California, New Mexico, Texas, Oklahoma and Nebraska. In early 2012, he shifted his agricultural investments to South Mississippi along the Pearl River, approximately 80 miles east of Natchez and 90 miles north of New Orleans. He and his staff are concentrating on timber, cattle and recreational (hunting and fishing) and educational events.

Following Caroline's death, he initiated the Dr. Kenneth & Caroline McDonald Eng Foundation to fund research and education in the areas of cow-calf efficiency and production. "The Foundation is in recognition of Caroline's love for the cattle business and cattle people and a partial payment for my good fortune in the industry," Eng said. The Foundation is funding approximately $2 million in research in the area of beef cow efficiency, including dry lot cow production, to the University of Nebraska, Oklahoma State University and Texas A&M. (A portion of these funds will go towards annual cow-calf efficiency symposiums.)

"We chose Lincoln, Nebraska for the first symposium because of the support of the Nebraska producers to our Foundation and for the University. Also, the support of the Nebraska Animal Science Department has been outstanding and somewhere deep in my soul, I'm still a Nebraska Country boy," Eng said. Grants are also awarded to Wayne State College building projects and Plains Nutritional Council for Research Poster Session awards.

Eng has authored over 600 articles including Feed Stuffs Beef Bottom Line articles for 30 years, as well as 7 books of poetry and 10 calendars. In recent years Eng has received the Oklahoma State Graduate Student of Distinction Honor, Plains Nutrition Industry Service Award, Feedlot Achievement Industry Award and most recently, the Beef Magazine Trail Blazer Award Honoree. Whatever successes he's been fortunate to achieve are due to good friends, good clients, good luck and good timing.

Sincerely,

Kenneth S. Eng

ENG RANCHES (-K-) (-C-)
7970 Fredericksburg Rd, #101-377
San Antonio, Texas 78229
(210) 979-0698
Fax (210) 979-0631
Cell (210) 865-8376
ken-eng@hotmail.com

ENG Ranch (-K-)
Winston, NM 87943
(575) 743-6331
Fax (575) 743-0087

ENG-Pearl River Ranch
Silver Creek, MS
(601) 886-7351
Fax (601) 886-7917

WELCOME

On behalf of the University of Nebraska, the Institute of Agriculture and Natural Resources and the Department of Animal Science, it is my pleasure to welcome you to this inaugural Cow Efficiency Symposium sponsored by the Dr. Kenneth and Caroline McDonald Eng Foundation. This symposium is the result of Dr. Kenneth Eng's visionary leadership in recognizing a huge challenge facing the beef industry and then taking deliberate steps to address the issue. The issue is "how do we reverse the decline cow herd trend in light of the recent droughts and high grains prices that are pulling land resources to other enterprises?" Dr. Eng, through his foundation, has committed nearly $2 million to address this issue by supporting research at the University of Nebraska, Oklahoma State University and Texas A&M University. Here is a man who made his livelihood in the beef industry and is now giving back so that future generations may have the same opportunity. All of us owe a debt of gratitude to Dr. Eng and his foundation for being a role model of how one person can impact the future of a whole industry.

The University of Nebraska–Lincoln Department of Animal Science is committed to doing its part to serve the beef industry. The department can best accomplish this goal through its teaching, research and extension missions.

Preparing students for the future is our top priority. Preparing students to be tomorrow's leaders in the beef industry requires that they possess a wide range of skills. We are committed to helping students develop critical thinking and problem-solving skills. The issues these students will face in the beef industry will be more complex than ever before and will not be solved without creative solutions.

Experiential learning and effective communication skills are essential for future leaders and are being taught both inside and outside the classroom. For example, the meats and livestock judging teams provide experiential learning. Communication skills are enhanced through participation in the Block and Bridle Club and Beef Industry Scholars program. The Beef Scholars program combines the knowledge and insights and direct involvement of leaders in the beef industry with science-based courses led by nationally recognized faculty. Students can focus intently on the beef industry through hands-on classes, thought-provoking seminars, internships and other activities designed specifically for them. Another experiential learning opportunity is available through the Feedlot Internship program. This is a nationally recognized feedyard management training program, exclusive to UNL, which has been training future feedyard managers and industry leaders since 1989. The internship trains students through comprehensive feedyard management classes and with real world experiences in the most progressive feedyards.

Our faculty and staff are passionate about providing the best possible science to address the complex issues facing the beef industry. We are committed to using a systems approach to evaluate the impact of new technology from conception to consumption. A perfect example of why this approach is needed is the confinement cow feeding projects sponsored by Dr. Eng. Feeding cows in confinement is not a new concept, but taking a holistic approach that integrates all aspects of the production process has seldom been attempted. For example, supplying essential nutrients at certain stages of gestation can have a fetal programing effect. This research shows that proper nutrient supplementation of the cow during critical stages of gestation can influence the productivity of that fetus for the rest of its life, even though there are no observable differences at birth. Never have the opportunities been greater, or the need more immediate to use science to address food safety, greenhouse gas production, feed efficiency, water requirements, improving feed resource utilization and a host of other issues facing the beef industry.

The Institute of Agriculture and Natural Resources, under Vice Chancellor Ronnie Green's leadership, is taking bold steps to hire the talent that will bring science to bear on the issues facing beef industry. These new and existing faculty will be working in multi-disciplinary teams to tackle complex issues facing Nebraska farmers and ranchers. For example, a team of faculty with backgrounds in agronomy, agricultural economics, veterinary medicine, and animal science will be addressing the issue of how to optimize corn residue utilization under various production environments. Another example is where a team with expertise in molecular biology, bioinformatics, microbial ecology, ruminant nutrition, meat science, and food safety are evaluating novel methods to reduce *E. coli* O157:H7. Confinement feeding of beef cows is also being evaluated using a multi-disciplinary, multi-institutional approach. We believe our research will have an impact not only in Nebraska, but also on a national and international level.

The extension component of the department is committed to developing creative, effective delivery methods of getting information to end users. For example, the department has teamed up with the Nebraska Cattlemen and Nebraska Beef Council to develop a nationally recognized Beef Quality Assurance (BQA) program. By working together as a team, synergies between the existing beef extension programs and the new BQA program can be maximized for the benefit of all. We are looking to optimize how information is disseminated through a combination of face-to-face meetings, printed materials, webinars, YouTube videos, phone apps, etc., to allow producers to have flexibility in how they obtain the information they need.

The opportunities and challenges facing the beef industry have never been greater. The Department of Animal Science is committed to developing the human capital, science-based information and technology transfer systems needed to allow the beef industry to thrive in the future. Thank you for participating in this important conference that has the potential to influence the entire beef industry.

Larry L. Berger. Ph.D.
Marvel L. Baker Head
Department of Animal Science
University of Nebraska–Lincoln

COW-CALF SYMPOSIUM

15 Years of "Hands On" Experience with Confined Cow Production

Kenneth Eng
Eng (-K- & -C-) Ranches
Mississippi, Nebraska, and Texas

Major New Millennium Events

(If you are bored and not confused, you're not paying attention)

2000 – 2013

Does Semi-Confined Beef Cow Production Have a Place?

By K. S Eng, Ph.D.
Eng (-K- & -C-) Ranches, Mississippi, Nebraska and Texas

Major Cattle Industry Events (Short Version)

Past 13 Years

1. Relentless beef cow liquidation
2. Relentless land value increase
3. Severe drought first in Southern Plains and spreading to Central Plains and Southwest
4. Cows and offspring are getting larger, gaining faster with excellent carcass traits. But how about efficiency (82% average weaned calf crop?)

January 1 Cow Numbers, Million Head

Year	Beef	Dairy	Total
1950	15.95	22.00	37.95
1960	25.68	17.65	43.33
1970	36.39	12.09	48.78
1975*	45.71	11.22	56.93
1980	37.11	10.76	47.47
1990	32.43	10.02	42.47
2000	33.57	9.19	42.76
2010	31.38	9.08	40.05
2011	30.86	9.15	40.01
2012	30.20	9.20	39.40
2013	29.30	9.20	38.50

*A wreck

Average Land Price $/Acre

2000	1,090.00
2001	1,150.00
2002	1,210.00
2003	1,270.00
2004	1,360.00
2005	1,650.00
2006	1,900.00
2007	2,160.00
2008	2,350.00
2009	2,400.00
2010	2,500.00
2011	Crop land 3,020.00 Pasture land 1,090.00
2012	Crop land 3,550.00 Pasture land 1,150.00

*Individual states much greater increase, e.g. Nebraska land prices up 36% in 2011

Cattle Fax Cattle and Corn Prices

	10/26/01	10/14/11	7/20/12	7/12/13
Slaughter Steer (CWT)	$64.97	$119.24	$113.00	$119.50
550 lb. Calf (CWT)	$91.34	$145.21	$149.00	$158.00
750 lb. Yearling (CWT)	$86.05	$135.15	$133.00	$143.00
Utility Cow (CWT)	$39.12	$65.67	$77.00	$80.00
Bred Cow	$800.00?	$1200.00?	$1,300.00?	$1,400.00?
Omaha Corn (but)	$1.80	$6.28	$8.12	$7.14
May Feeders Future	$75.00	$148.47	$150.30	$150.12 (August)

3 Years of Records, 2011 – 2013

1. More of the same, but weaker feeder and cow market
2. Record drought in South Plains (Texas, Okla. & N. Mex.) and then in Central Plains and Southwest
3. Record corn prices
4. $132.00 Fat Cattle
5. $210.00 Calves
6. $160.00 Yearlings
7. $95.00 Packer Cows
8. $105.00 Packer Bulls
9. $1,400 - $2,000.00 Bred Cows
10. $1,800 - $2,200.00 Bred Heifers

Major Cattle Industry Events

Net Results

1. Massive Cow Liquidation in TX, OK & NM in 2011 and in Central Plains in 2012
2. Smallest Beef Cow Herd in over 50 years
3. Continued Excess Feedlot Capacity
4. Record High Cattle Prices, especially Calves and Yearlings but now disappeared with record feed prices and shortages
5. Transfer of Wealth to former "Have not's"
6. Semi-Confinement Cow Production
7. (A necessity in some area and an opportunity in other areas.)

Possible Short & Long Term Repercussions
Let's hope it doesn't occur but,

1. **According to the Texas State Climatologist Dr. John Nielson-Gammon**

   "Another 5 – 10 More Years of Drought is a Strong Possibility"

2. **The 12 month period beginning September 2010 was the hottest and driest on record in Texas**

   a) Resulted in Record Cow movement and Liquidation

   b) Feed Shortages and Record Feed Prices

   c) At very least it has been a Short Term "Game Changer" not only for Texas but the entire South Plains and in 2012 drought moved north to Central Plains (KS, NE, CO & WY)

   d) Should the Drought persist for several years it will change the face of the entire Beef Industry, 25% of the Beef Cows reside in Texas and Oklahoma

   e) It is difficult to feed your way out of a drought with high priced hay

3. **Some Good News**

   a) Good rains East of 98th Meridian from Texas to Canada in 2013 but West Texas, NM, CO, AZ and CA remain extremely dry.

   b) However, even with more rain, Cow Liquidation is continuing and perhaps accelerating.

   c) When repopulation in Texas is possible, other species such as Sheep, Goats, Deer etc. may be considered. However, predators are a major problem.

Potential Advantages of Semi-Confinement Cow Systems

1. Reduced Cow Unit Carrying Capacity Cost

2. Reduced Cow Energy Requirements

   a) Reduced Programmed Intake Increases Digestibility.

   b) Reduced Movement Reduces Maintenance requirements.

   c) Reduced Gut and Liver Size Reduces Maintenance requirements.

3. Calf Weaning & Preconditioning made easy.

4. Easier to apply all types of technology.

5. **Major disadvantage** — If land acquisition, accumulation and possible appreciation is your goal, owning ranch land is a good excuse to own cows and vise a versa.

Cow Trading in a Drought
(Better to buy than sell?)

Buyer Advantages

1. Cheaper cows because of depressed market, poor body condition and lighter weights.

2. Poor condition bred cows may be low maintenance cows

Buyer Disadvantages

1. Shortage of grass — Dry lot alternative.

2. You may buy someone else's problems (Bad temperament, health problems, etc.)

3. You may be the new kid on the block

Future Expansion

1. When will the cow herd expand?
2. Where will it expand? (Feed Follows the Water, Cattle Follow Feed)
3. Should the Cow Herd Expand? (Cattle are getting larger and beef demands may be declining)

Many base herd expansion forecasts on weather, numbers and economics only. True, increasing expenses and the drought are important. However, expansion or lack thereof is also determined by other factors.

This includes an aging rancher population made up of individuals who have spent a lifetime in what has previously been essentially a break even business with occasional profits coming from land appreciation. The old adage that "A Cow Man who dies rich has died before his time" contained more truth than fiction. Due to current higher land and cattle prices many may opt to "take the money and run".

A major factor which some may like to "sweep under the rug' is many cowmen are suspicious of current consolidation occurring in the packing and Feedlot sectors and what this could do to their bargaining power. Cowmen may not be the smartest guys in the room but, they didn't just fall off the turnip truck. They can see what has happened to the fat cattle market and the independent feedlot operator where often a "cash market" is non-existent. The old ten year cattle cycle was a disaster for many cowmen and they don't want to see it return.

In spite of significant profits cow numbers have steadily declined since the beginning of the millenium. This sends a powerful message that the cow-calf industry is undergoing significant changes.

Final Thoughts

1. Times are changing and always will.
2. Be flexible and have an exit strategy.
3. Listen to, but be skeptical of expert opinions.

Expert opinions in late 70's (I was there) included:

a) Global cooling will be a major problem

b) World population will peak at 6 billion, then decline

c) No more grain fed to cattle

Thank You

Kenneth Eng Ph.D.

Good Times Don't Last Forever!
Remember 1974, 1986, 2003 2008, etc.
Occasionally we have a "Good News Overdose"

The harvest was good & feed prices low
The pastures are green & the creeks all flow
Health is no problem cause the pens are dry
Performance is great & cattle prices high

The bankers relaxed & sit there smiling
I feel nervous; cause there's no reason for lying
He grins and asks, "Can we lend you more money"
I should be happy, but I feel sort of funny

There just something missing, a mysterious void
I've called my physic & I'm reading on Freud
I'll write Ann & Abby when I get back
If that doesn't work, I'll call Baxter Black

I talked to my bartender who's experienced & loyal
We had several sessions, along with Crown Royal
He said "you're like a cow given too much hot feed
You've had too much good news & now you've O.D"

You're accustom to bad news, it may sound strange
But, the business you're in, good news will change
I drove back to the ranch, met the wife at the gate
She said "we've got problems & you're 7 days late"

"The truck is stuck in the furthest field
The buyer is mad cause the cattle didn't yield
The banker called & they hired a new staff
They took your values & cut them in half"

"Our foreman is in the hospital, got thrown off his horse
The cook went home and filed for divorce
The vet looked at the sick calves, the advice he gave
It's too late to worry cause there's not many to save"

She said, "let's go to bed, you've done enough harm
The furnace isn't working & you can keep me warm"
Then she whispered in my ear about some IRS letter
It must be the bad news; I'm starting to feel better

By K. S. Eng

COW-CALF SYMPOSIUM

Using Crop Residues and By-Products to Limit Feed Cows in Confinement

Karla H. Jenkins
Cow-Calf, Range Management Specialist
University of Nebraska Panhandle
Research and Extension Center
Scottsbluff, Nebraska

Using Crop Residues and By-Products to Limit Feed Cows in Confinement

Karla H. Jenkins
Cow/calf, Range Management Specialist
University of Nebraska Panhandle Research and Extension Center
Scottsbluff, NE

Introduction

The available forage supply for maintaining beef cow herds continues to be threatened by several factors. High commodity prices encourage the conversion of pasture land into crop ground, cities and towns continue to sprawl out into rural areas creating subdivisions where historically cattle grazed, and drought, fires, hail, and insects continue to periodically deplete forage supplies. When forage supplies cannot be located or are not affordably priced; cattle producers must either sell their cattle or feed the cattle in confinement.

Feeding beef cows in confinement is not a new concept. However, limit feeding them (less than 2% of body weight on a DM basis) an energy dense diet, with the intent of keeping the cows in the production cycle, rather than finishing them out, needs to be thoroughly evaluated. Keeping cows in confinement 12 months out of the year may not be the most economical scenario, but partial confinement when pastures need deferment or forage is not available, may keep at least a core group of cows from being marketed. Producers will need to know how and what to feed the cows while in confinement to make it feasible. Crop residues, poor quality hays such as those from the conservation reserve program (CRP), and by-products tend to be the most economical ingredients to include in confinement diets.

Nutrient Requirements of the Cow

When producers decide to limit feed cows in confinement there are three concepts that become key to successful feeding. The first concept to understand is the cow's nutrient requirements. The cow's nutrient requirements vary with age, size, and stage of production (NRC 1996). Two and three year old cows still have requirements for growth as well as gestation and/or lactation and should be fed separately from mature cows in a limit feeding situation to allow them to consume the feed needed to meet their requirements. When lactation starts, the cow's nutrient needs increase and peak at about 8 weeks of lactation (*Figure 1*). Producers need to either increase the energy density of the diet or increase the pounds of dry matter fed when lactation starts.

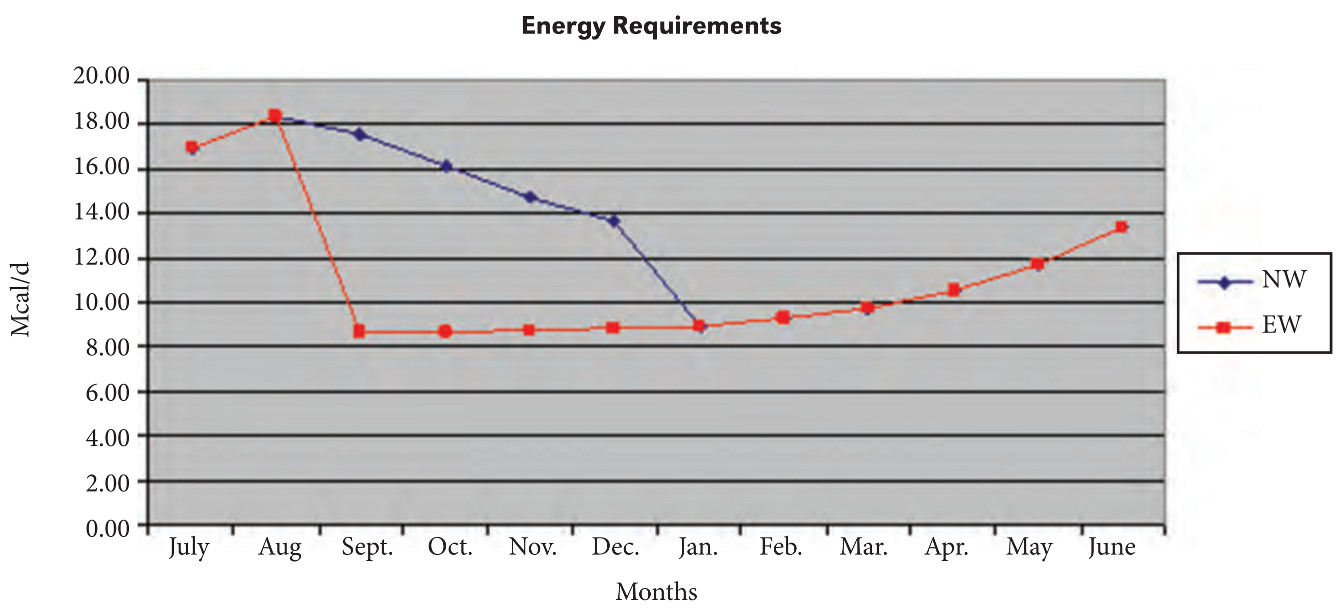


Figure 1. Energy requirement for gestating and lactating cows calving June 15, early weaned calves weaned at 90 days (EW) and normal weaned (NW) at a traditional 205 d weaning

Nutrient Content of the Feedstuffs

Another important consideration is the nutrient content of the commodities used in the limit fed ration. Most producers are familiar with feeding low to medium quality forages to mid-gestation cows. They typically supplement with a protein source to improve forage digestion and the cows are allowed ad libitum access to the forage. The protein allows the cow to adequately digest the forage and if the forage is not restricted, the cow can usually meet her energy requirements. Limit feeding cows while maintaining body condition requires a mindset shift for producers. While the protein needs of the cow do need to be met, the first limiting nutrient, especially for the lactating cow, is energy. Typically, producers are always encouraged to send feed samples to a commercial laboratory for testing. The TDN value listed on commercial laboratory results is not from an analysis but is actually calculated from acid detergent fiber (ADF). In the case of forages, this is fairly similar to the digestibility and is an acceptable measure of forage energy. However, due to the oil content of some by-products, and the interaction of by-products in residue based diets, the University of Nebraska recommends using TDN values for by-products based on animal performance in feeding trials (*Table 1*). Estimating too much energy for a commodity can result in poorer than expected cattle performance, while underestimating the energy value of a commodity would cause overfeeding, resulting in an increased expense for the confinement period.

Table 1. Total Digestible Nutrients of common by-products and commodities in forage based diets determined from feeding trials

Ingredient[1]	*TDN (% dry matter)*
Corn distillers grains, wet, dry, modified	108
Corn condensed solubles	108
Sugar beet pulp	90
Soyhulls	70
Synergy	105
Corn gluten feed	100
Midds	75
Corn	83
Wheat straw/cornstalks	43
Meadow Hay	60

[1]Feeding trials are reported in the Nebraska Beef Cattle Reports, 1987, p.4; 1988, p.34; 1993, p.46; midds data from Kansas State Research Report.

Feed Intake of the Nursing Calf

The third important consideration is the feed intake of the calf. Nursing calves can be seen nibbling at forage within the first three weeks of life. By the time they are three months old, research indicates they are eating about 1% of BW in forage (1995 NE Beef Report, p.3). A 300 lb. calf would eat 3 lb. of DM in addition to nursing the cow. If calves are not weaned and in their own pen at this time, additional feed should be added to the bunk for them. Early weaning does not save feed energy but may be a good management practice in the confinement feeding situation. Research conducted at the University of Nebraska indicated that when nursing pairs were fed the same pounds of TDN as their weaned calf and dry cow counterparts, cow and calf performance was similar at the 205 d weaning date (*Figure 2, Table 2*). While not resulting in an advantage in feed energy savings, early weaning can be advantageous in other ways. Early weaning would allow the calves to be placed in a separate pen from the cows. Producers would then have the flexibility of feeding the calves a growing or a finishing diet, or even allowing them to graze forages if available. The cows then, without the demands of lactation, could be placed on a lower energy diet.

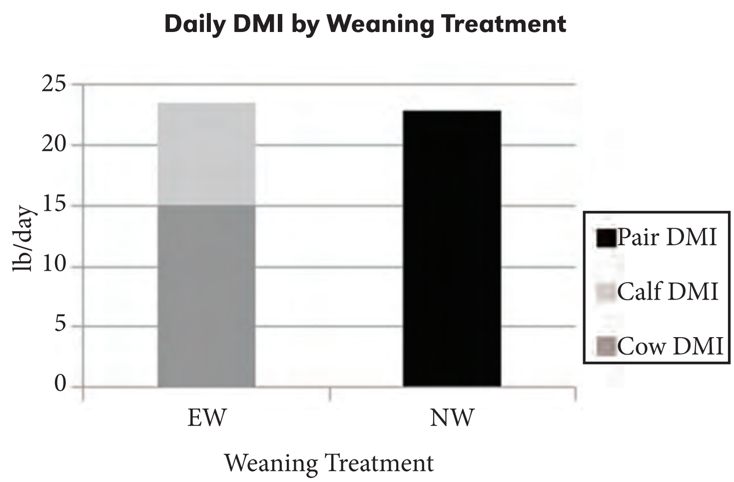


Figure 2. Daily dry matter intake of nursing pairs (NW), weaned calves and their dry cows (EW) from early weaning (90 days) until normal weaning (205 days)

Table 2. Performance of nursing pairs weaned at 205 days (NW) and weaned calves and their dry dams weaned at 90 days (EW)

	ARDC[1]		*PREC*[2]		*P-value*		
Item	*EW3*	*NW4*	*EW*	*NW*	*Weaning*	*Location*	*W*L*
Cow BW, lb							
Early weaning (prebreeding)	1115	1101	1150	1134	0.56	0.21	0.95
Normal weaning	1129[a]	1109[a]	1266[b]	1165[a]	0.05	0.01	0.16
Cow BW change, lb	15[a]	7[a]	115[b]	32[a]	0.01	<0.01	0.02
Cow BCS[3]							
Early weaning (prebreeding)	5.4	5.3	5.0	5.0	0.56	0.06	0.91
Normal weaning	5.1	5.1	5.4	5.1	0.23	0.23	0.34
Cow BCS change	-0.3[a]	-0.2[a]	0.3[c]	0.1[b]	0.23	<0.01	0.03
Calf BW, lb							
Early weaning	276	295	288	0.85	0.23	0.76	274
Normal weaning	447[a]	501[b]	494[b]	479[a,b]	0.17	0.36	0.03
Calf ADG, lb	1.48[a]	1.93[b,c]	1.65[c,d]	1.58[a,d]	0.01	0.12	<0.01

[1]ARDC = Agricultural Research and Development Center, Mead, NE
[2]PREC= Panhandle Research and Extension Center, Scottsbluff, NE
[3]BCS= Body condition score 1(emaciated) to 9 (obese) scale

Management Considerations for Young Calves in Confinement

A common misconception producers often have is that calves nursing cows do not need to drink very much water. In reality, they do need water, and especially so, when the temperatures are warm. Young calves need to be able to reach the water tank and have access to sufficient water. In the UNL confinement feeding trial, calves as young as a couple of days drink water during July calving. Tanks need to be banked high enough that calves can reach the edge and water flow needs to be unrestricted enough that the tank can refill quickly after cows drink. The size of the tank needs to be big enough that on extremely hot days calves can access the water without cows pushing them away. In the research trial it was necessary to put small tubs of water out of reach of the cows but accessible to the calves. Feed access is also an issue as calves begin eating at a fairly young age. In the UNL confinement study, creep feeders were placed at the back of the feedlot pen to allow calves access to alfalfa pellets prior to 90 days of age. Although consumption was low (0.37% BW), it probably served to initiate some rumen function. Calves begin eating at the bunk with cows at an early age and therefore would need to be able to access the feed bunk as well.

Defining Confinement Feeding

Feeding in confinement does not necessarily have to be done in a feedlot setting. Although, the advantages of the feedlot often include feed trucks with scales and mixers, concrete bunks, good fences, and access to commodities not always available to ranchers. However, feeding cows in confinement can be achieved by setting up temporary feed bunks or feeding under a hot fence on harvested crop ground, pivot corners, a winter feed ground, or even, as a last resort, a sacrifice pasture. It is important to keep in mind that cattle limit fed a diet on a pasture will continue to consume the forage in the pasture and overgrazing can result if this is the option that has to be implemented. Regardless of location, cows will need a minimum of 2 ft. of bunk or feeding space and calves will need 1.5 ft.

Limit Fed Diet Options for Confined Cows or Pairs

Numerous commodities are acceptable in cow diets and their inclusion will depend on nutrient content, availability, and price. At least in Nebraska, there is large diversity in commodities available, particularly from the eastern to the western ends of the state. As a result, many diets

Table 3. Example Diets of by-products and residues for gestating, lactating, and lactating cows with 60 day old calves

Diet (DM ratio)	*Ingredients*	*Late Gestation Cow*	*Lactating Cow*	*Cow with 60 day old calf*
			Dry matter intake, lb	
57:43	Distillers grains:straw	15.0	18.0	20.0
30:70	Distillers grains:straw	19.2	23.0	25.6
40:20:40	Distillers grains:straw:silage	15.4	18.5	20.6
20:35:45	Distillers grains:straw:beet pulp	14.6	17.5	19.4

have been formulated for producers. Some diets include ingredients unique to an area, while other ingredients are available in limited quantities in some areas and therefore cannot be included at very high levels. Purchase price and trucking costs also impact commodity inclusion. The following example diets were formulated by UNL extension specialists for research trials or Nebraska producers (*Table 3*). These diets have been used to maintain body condition on cows and can be adapted for other regions with the help of a nutritionists or extension personnel. Handling characteristics should be considered as well when determining what ingredients to use. Research has indicated a diet containing 80% ground cornstalks and 20% wet distillers grains will result in some sorting. Ground wheat straw or low quality hay may not result in the same degree of sorting. Corn wet distillers grains often results in less sorting than dry distillers. Unfortunately, many producers do not have access to the wet product. Mixing some water with the diet can reduce sorting or including silage or beet pulp can add enough moisture to reduce sorting. Rumensin can be added up to 200 mg/ton to improve efficiency and limestone should be added at 0.3 lb/cow to enhance the Ca:P ratio.

Conclusion

Limit feeding an energy dense diet to cows or pairs in confinement for a segment of the production cycle can be a viable alternative to herd liquidation. Producers choosing to limit feed cows or pairs in confinement must consider the nutrient needs of the cow, changes in nutrient requirements as production phase changes, nutrient content of available feeds, availability and associated costs of available feeds, as well as the increasing feed demands of the growing calf.

COW-CALF SYMPOSIUM

Early Weaning and Reproductive Performance of Beef Cows

Rick Rasby and Jason Warner
Department of Animal Science
University of Nebraska–Lincoln

Early Weaning and Reproductive Performance of Beef Cows

Rick Rasby and Jason Warner
Department of Animal Science
University of Nebraska–Lincoln

Introduction

Calves reared in conventional beef production systems are weaned from their dams at 180 to 220 days of age. Early weaning is typically applied when calves are 60 to 150 days of age. The immediate result of early weaning is the premature end of milk production by the dam and reduced nutrient needs as a result of the female transitioning from lactation to a non-lactation status. The resource-sparing effects of early weaning are a result of this event: nutrient requirements of the dam decreases, intake of forage decreases, and stocking rate decreases. Cow performance can be conserved through improved body condition, reduced postpartum anestrous interval, and maintenance of a 12-month calving interval. Early-weaned calves can be managed such that their body weights at 205 days of age are similar to or greater than those of conventionally weaned calves.

In a ranch setting, a reduction in range forage production/quality has consequences. Reduced reproductive performance associated with poor body condition is a concern (Lusby et al., 1981). A greater concern is damage to range resources that can take years to repair (Heitschmidt, 2004; Smart et al., 2005). Management strategies that spare forage resources and reduce the nutrient requirements of females during the breeding season can mitigate the effects of lower range production that can occur during a drought.

The primary benefits of early weaning of beef calves as a management strategy are: 1. to reduce grazed forage demand when forage is limited; 2. enhance reproductive performance, typically when beef females are thin at calving, and; 3. to manage body condition of beef females prior to calving.

Forage Sparing Effect of Early Weaning

Early weaning provides an opportunity to reduce demand for pasture forage and other feed stocks during conditions such as drought (Hammes et al., 1970; Harvey et al., 1975; Rasby, 2007).

Heitschmidt (2004) reported that a majority of the variation in annual range forage production in the Northern Great Plains (i.e., approximately 66%) was explained by the total precipitation during the months of April and May. Smart et al. (2005) reported similar results. It was estimated that 79% of annual production by perennial grasses in the Northern Great Plains was achieved by July 1 during 2 out of every 3 years. In 19 out of 20 years, 65% of annual perennial grass production was achieved by July 1 (Heitschmidt, 2004).

Rainfall information and timely forage production measurements can be used in concert to judge whether implementation of a drought mitigation strategy is warranted. Ranchers need only to access historical precipitation information for their area and to be willing to collect annual measurements of forage productivity on or near July 1. In this model of management, July 1 becomes what is known as a trigger date for drought-related decisions (Mousel, 2007).

Mosley (2002) proposed that the following relationship could be used to estimate forage yield for a given year:

$$\frac{\text{Total precipitation in April, May, June}}{\text{Median total precipitation in April, May, and June}} = \text{Annual Forage Yield (\% of median)}$$

Annual forage yield can be measured in several ways (Mousel, 2007); ranchers should contact local conservation agents, extension agents, or beef industry consultants to determine a method that best suits their needs. Forage productivity estimates should be collected from the same general locations and range sites each year. If possible, forage condition should be further documented by taking photographs from fixed reference points each year (e.g., looking down a fence line from a specific point; Smart et al., 2005; Mousel, 2007). Forage yield estimates collected on July 1 represent conservatively about 80% of annual forage yield (Heitschmidt, 2004).

Table 1. Conception rate, postpartum interval, and calf performance at normal weaning time (October 11) for spring calving very thin first-calf Hereford heifers and their dams.

Item	*Normal Weaning 7 months of age*	*Early Weaning[a] 6 to 8 weeks of age*	*Difference*
Conception rates, %	59	97	38
Calving to conception, days	91	73	18
Cyclic at 85 days postpartum, days	34	90	56
Weight at normal weaning, lb	788	875	87
Calf weight at normal weaning, lb	373	374	1

[a]Early weaned calves managed in a drylot or on pasture (JAS 1981;53:1193-1197).

On many ranches, rapidly diminishing range forage and thin cows are the forces that drive decision making during drought. The decision to implement a drought mitigation measure, such as early weaning, should be made in advance and based on objective observations of both precipitation and forage condition. Reports addressing the effects of early weaning on range condition or range forage conservation are hard to find. In the absence of original research on these topics, the best alternative is to estimate forage conservation based on changes in dry matter intake (DMI) that accompany early weaning. As discussed above, the resource-sparing effects of early weaning result from the premature end of lactation and concomitant reduction in nutrient requirements by cows and heifers. Calf removal also has a resource-sparing effect because forage intake by suckling calves begins by as early as 30 days of age.

The National Research Council (NRC, 2000) estimated DMI by a 1200 lb beef cow (peak milk production = 20 lb) to average approximately 28 lb per day during lactation. The same animal, without producing milk, consumes an average of 24 lb DM (DM) per day during mid-gestation. Using this scenario, the savings in range forage accrued on a daily basis due to cow intake alone would average 4.0 lb per day or 120 lb per month.

Range forage consumption by beef calves has been estimated to average 4.3 lb DM per day between 30 and 150 days of age (Boggs et al., 1980). Hollingsworth-Jenkins et al. (1995) estimated that a 300 lb beef calf consumed approximately 5.3 lb DM per day, whereas Lusby et al. (1976) reported that 370 lb Hereford calves consumed 2.9 lb DM per day. If a calf consumes 1.5% of its body weight on a DM basis of an average quality forage in a grazing scenario and if the calf weighs 300 lb on average across the grazing season, then it will eat approximately 4.5 lb of forage DM per day or 135 lb per month during the preweaning period.

Conservatively, the combined effects of reduced nutrient requirements by the cow and removal of the calf could reduce demand for range forage by 8.5 lb DM per day or 255 lb per month. Using this logic, there would be one extra day of grazing for the dry cow in early to mid-gestation for every 2.5 days that the calf is weaned. Work by Bohert et al. (2006) indicated that cows grazing native range may distribute their grazing activities more widely following early weaning.

Effect of Early Weaning on Reproduction

Reduced reproductive performance associated with poor body condition is usually the most immediate threat (Lusby et al., 1981) when forage is limited after calving and prior to the start of the breeding season. Early weaning has been used successfully as a management strategy to spare body condition or to promote reproductive performance of heifers and cows (Laster et al., 1973; Lusby et al., 1981; Houghton et al., 1990; Purvis et al., 1996; *Table 1*). Early-weaning has been viewed historically as a last-resort measure to deal with the consequences of sub-par nutrition following parturition (Rasby, 2007).

The Decision to Wean Early — Calf Age

The beef calf is a functional monogastric for the first 2 to 3 weeks of life. The rumen of a newborn lacks the symbiotic microbial population that enables adult cattle to process forage fiber via fermentative digestion. Bacteria, protozoa, and fungi enter the rumen through the nose and mouth during the first days of life as the calf comes into contact with the saliva of other animals and environmental features such as soil, bedding, and feed (Bryant and Small, 1960). By 3 days of age, there are significant numbers of cellulolytic, amylolytic, proteolytic, and lactate-using bacteria in the rumen (Anderson et al., 1987).

Ruminal development starts when microbial action within the immature rumen liberates volatile fatty acids from food particles. These act as chemical signals that stimulate maturation of the absorptive surfaces of the rumen. Butyrate is particularly effective in stimulating the development of ruminal papillae (Tamate et al., 1962; Anderson et al., 1987). Moreover, the presence of solid feeds in the rumen enables development of the muscles and nerves controlling ruminal motility (Heinrichs and Jones, 2003).

Anderson et al. (1987) reported that dairy-type cattle weaned at 30 or 45 days of age had nearly complete ruminal function within 2 weeks of weaning. Ruminal development proceeded rapidly once solid food consumption had begun. Additionally, the calves of spring-calving beef cows grazing native range consumed significant amounts of forage at 30 days of age (Boggs et al., 1980). These data were interpreted to suggest that the rumens of 30-day-old calves were functional enough to permit weaning (i.e., removal of milk and milk replacers). Beef calves weaned at young ages can be successfully managed provided the diet is palatable and energy/protein dense. Early weaned calves have high requirements and DM/nutrient intake is critical.

Breeding Females — Expectations for Performance

Many benefits of early weaning that happen to breeding females can be attributed to increased body condition. Body condition score is linked to reproductive performance. As body condition score increased up to a moderate level (i.e., BCS 5; 1 to 9 scale), the length of the post-partum anestrous period decreased and conception rate increased (Smith and Vincent, 1972; Lusby et al., 1981; Houghton et al., 1990). Embryonic loss may also be minimized when body condition score is adequate (Geary, 2005).

The relationship between body condition score and lactation is firmly established. Ciminski et al. (2002) reported that lactating cows lost one-tenth of a body condition score (1 to 9 scale) for every 2 weeks they suckled their calves. Improved body condition score and increased body weights (Lusby et al., 1981; Purvis et al., 1996; Story et al., 2000; Ciminski et al., 2002; Bohnert et al., 2006), reduced post-partum interval (Smith and Vincent, 1972; Lusby et al., 1981; Houghton et al., 1990), and greater conception rates (Laster et al., 1973; Lusby et al., 1981) have been attributed to early weaning. Early weaning was also occasionally associated with reduced winter feed costs (Peterson et al., 1987; Purvis et al., 1996; Story et al., 2000) and greater income per cow (Peterson et al., 1987).

Reproductive Considerations When Dry Lotting Beef Cows

1. Artificial Insemination is easier to implement provided labor/time is available.
   a. Estrous Synchronization is easier to implement.
      i. With AI or natural service
      ii. Estrous Synchronization Calendar *http://www.iowabeefcenter.org/estrus_synch.html*
   b. Sexed semen
      i. AI pregnancy rates are lower for sexed semen but may be an option to increase the percentage of male calves — assumes pregnant females are purchased as replacement for a terminal system.

2. Bull to Cow ratio
   a. A function of bull age
      i. 15 month old bull will be expected to service 15 cows
         1. For young bulls, we would not change bull:cow ratio when breeding in a dry-lot setting.
      ii. Mature bull
         1. 1:30 to 1:35 (usually 1:25)
   b. Never have single sire pens (one bull per pen or pasture)
      i. If you have to have single sire pens or pastures: Check bulls frequently
         1. Rotate bulls amongst pens every 7 to 10 days

3. Transporting cows
   a. AI — Transport within 3 days post AI or need to wait until 35 days post AI
   b. Natural Service — Transport 35 days after pulling the bulls

4. Sort young cows (2's and 3's) from old cows — especially during lactation
   a. If managed together after calving, young cows in the herd will lose weight and body condition, especially when limit-fed.
      i. Young cows losing body condition after calving and before the beginning of the breeding season will have low reproductive performance.
      ii. Tools to learn condition scoring beef cows.
         1. Extension Circular *http://www.ianrpubs.unl.edu/sendIt/ec281.pdf*
         2. Mobile App *https://itunes.apple.com/us/app/nubeef-bcs/id592184721?mt=8*

5. Include an approved ionophore in the ration.
   a. Feed efficiency improved by at least 4% to 5% in high concentrate diets
   b. Reproductive component
6. Provide an area for the calf when pairs are together during the breeding season to reduce injury to the calf.

References

Anderson K. L., T. G. Nagaraja, J. L. Morrell, T. B. Avery, S. J. Galitzer, and J. E. Boyer. 1987. Ruminal microbial development in conventionally or early-weaned calves. J. Anim. Sci. 64:1215-1226.

Arthington, J. D., and R. S. Kalmbacher. 2003. Effect of early weaning on the performance of three-year-old, first-calf beef heifers and calves reared in the subtropics. J. Anim. Sci 81:1136-1141.

Barnes, K. C., G. E. Selk, and K. S. Lusby. 1996. Early weaning fall-born beef calves for improved rebreeding or decreased winter feed. Okla.. Agric Exp Sta Res Rep. MP-951:85-87.

Bohnert, D. W., D. C. Ganskopp, D. D. Johnson, S. J. Falck, M. L. Merrill, and A. A. Clark. 2006. Effects of early weaning on cow performance, grazing behaviour, and winter feed costs in the intermountain west. Proc. West. Sec. Amer. Soc. Anim. Sci. 57:121-123

Bryant, M. P., and N. Small. 1960. Observations on the ruminal microorganisms of isolated and inoculated calves. J. Dairy Sci. 43:654-667.

Ciminski, L., D. Adams, T. Klopfenstein, D. Clark, J. Musgrave, R. Sandberg, and A. Applegarth. 2002. Weaning date for spring-calving cows grazing sandhills range. MP 79-A:1-3.

Geary, T. 2005. Management strategies to reduce embryonic loss. In: Range Beef Cow Symposium XIX, December 6-8, Rapid City, SD. http://beef.unl.edu/beefreports/symp-2005-09-XIX.shtml Accessed July 19, 2007.

Hammes, R. C., R. E. Blaser, J. P. Fontenot, H. T. Bryant, and R. W. Engel. 1968. Relative value of different forage and supplements for nursing and early-weaned beef calves. J. Anim. Sci. 27:509-515.

Harvey, R. W., J. C. Burns, T. N. Blumer, and A. C. Linnerud. 1975. Influence of early weaning on calf and pasture productivity. J. Anim. Sci. 41:740-746.

Heinrichs, A. J., and C. M. Jones. 2003. Feeding the newborn dairy calf. http://www.das.psu.edu/dairynutrition/documents/feednewborn.pdf Accessed July 11, 2007

Heitschmidt R.K. 2004. Drought management — do you have to run out of forage before managing? Proc., Symp. on Rangelands in Transition. Soc. Range Manage., 57th Annual Meeting, Jan 24-30, Salt Lake City, UT. p. 77-79.

Houghton, P.L., R.P. Lemenager, L.A. Horstman, K.S. Hendricks, and G.E. Moss. 1990. Effects of body composition, pre- and post-partum energy level and early weaning on reproductive performance of beef cows ad preweaning calf gain. J. Anim. Sci. 68:1438-1436.

Jenkins-Hollingsworth, K., T. Klopfenstein, D. Adams, and J. Lamb. 1995. Intake and diet selectivity of cow/calf pairs grazing native sandhills range. Nebraska Beef Cattle Rep. MP 62-A:3-4.

Laster, D. B., H. A. Glimp, and K. E. Gregory. 1973. Effects of early weaning on postpartum reproduction of cows. J. Anim. Sci. 36:734-740.

Lusby, K. S., R. P. Wettemann, and E. J. Turman. 1981. Effects of early weaning calves from first-calf heifers on calf and heifer performance. J. Anim. Sci. 53:1193-1197.

Lusby, K. S., D. F. Stephens, and R. Totusek. 1976. Effects of milk intake by nursing calves on forage intake on range and creep intake and digestibility in drylot. J. Anim. Sci. 43:1066-1071.

Mosely, J. 2002. Grazing management during and after extended drought in Montana. In: Proc., 51st Montana Nutr. Conf. May 7-8, Bozeman. Montana Agr. Exp. Sta.

Mousel, E. 2007. Drought checklist. http://beefmagazine.com/mag/drought_checklist/ Accessed July 25, 2007.

Myers, S. E., D. B. Faulkner, F. A. Ireland, and D. F. Parrett. 1999. Comparison of three weaning ages on cow-calf performance and steer carcass traits. J. Anim. Sci. 77:323-329.

NRC 2000. Nutrient Requirements of Beef Cattle. 7th rev. ed. Natl. Acad. Press. Washington, DC.

Neville W. E., and W. C. McCormick. 1981. Performance of early- and normal-weaned beef calves and their dams. J. Anim. Sci. 52:715-724.

Peterson, G. A., T. B. Turner, K. M. Irvin, M. E. Davis, H. W. Newland, and W. R. Harvey. 1987. Cow and calf performance and economic considerations of early weaning of fall-born beef calves. 65:15-22.

Purvis, H. T., C. R. Floyd, K. S. Lusby, and R. P. Wettemann. 1996. Effects of early weaning and body condition score (BCS) at calving on performance of spring calving cows. Okla. Agric. Exp. Sta. Res. Rep. MP-951:126-132.

Rasby, R. J. 2007. Early weaning beef calves. Pages 29-40 in Veterinary Clinics of North American Food Animal Practice, Volume 23, Number 1: Cow Calf Nutrition and Management. K. Olson and L. Hollis, eds. Elsevier Saunders, Philadelphia, PA.

Schultz, C. L., D. G. Ely, D. K. Aaron, B. T. Burden, and J. Wyles. 2005. Comparison of an early and normal weaning management sytem on cow and calf performance while grazing endophyte-infected tall fescue pasture. J. Anim. Sci. 83:478-485.

Smart, A. J., R. Gates, and B. H. Dunn. 2005. Drought and stocking rate effects on forage yield from western South Dakota Rangelands. South Dakota Ag. Exp. Sta. ExEx2046. p 1-3.

Smith, L. E., and C. K. Vincent. 1972. Effects of early weaning and exogenous hormone treatment on bovine postpartum reproduction. J. Anim. Sci. 35:1228-1232.

Story, C.E., R. J. Rasby, R. T. Clark, and C. T. Milton. 2000. Age of calf at weaning of spring-calving beef cows and the effect on cow and calf performance and production economics. J. Anim. Sci. 78:1403-1413.

Tamate. H., A. D. McGilliard, N. L. Jacobson, and R. Getty. 1962. Effect of various dietaries on the anatomical development of the stomach in the calf. J. Dairy Sci. 45-408-420.

Whittier, J. C., B. L. Weech, and R. Eakins. 1995. Effect of weaning calves from primiparous cows at the beginning of the breeding season following first calving on subsequent dam and calf productivity. J. Anim. Sci. 73(Suppl.):241.

COW-CALF SYMPOSIUM

Health and Management of Confined Cows and Calves

David R. Smith
College of Veterinary Medicine
Mississippi State University
Starkville, Mississippi

Health and Management of Confined Cows and Calves

David R. Smith
College of Veterinary Medicine
Mississippi State University
Starkville, Mississippi

Introduction

The methods employed to produce beef calves differ widely because of dissimilarity in the characteristics and availability of natural resources, human resources, and capital. Natural resources include land and cattle. Cow-calf production systems are inherently tied to the land by the availability of feed and forage, weather conditions, and geography. Human resources include the availability and skill of labor and management. In many regions of the Unites States it has become a challenge to hire and retain skilled ranch employees. Capital includes the availability of money, credit, and facilities.

Collectively, the practices and procedures used on a cow-calf ranch to produce calves can be considered a complex adaptive system. A ranching system is complex because of the many external and internal factors that change, sometimes rapidly and unpredictably. A ranching system is adaptive because learning takes place, by both people and cattle, in response to the changing factors and conditions. In practice, we often investigate small portions of the system at a time to learn how to resolve problems or become more efficient. However, ultimately it becomes important to look at how actions in one sector affect the entire production system including financial outcomes as well as the health and well-being of the people, the cattle, and the environment.

The subject of this report is to discuss how confined cow-calf production systems might affect the health and well-being of cows and calves, and how we might adapt the system to avoid important foreseeable hazards. Recognizing and understanding potential problems allows the cattle producer to make long-term and near-term plans to minimize risk. Managing risks requires greater understanding of the factors associated with those hazards, how to mitigate those factors, and the associated costs (Moore, 1977). Economics should not be the sole basis for making decisions about the care of animals. However, the cost of health care remains an important financial constraint to most cattle producers, and therefore, an important consideration. The relative costs of disease prevention and control practices are relevant to risk management decisions.Cattle producers might enlist the help of a veterinarian to identify potential hazards and make recommendations to prevent problems; for example, the veterinarian may conduct a herd-specific risk assessment.Risk assessment is a process of:

1) evaluating the likelihood and costs (or benefits) of potential hazards (or opportunities) — termed **risk analysis**

2) determining what actions, at what relative cost, can be taken to mitigate those hazards — termed **risk management**

3) sharing the action plan with all members of the team, as well as keeping records to show what was done and whether the actions were successful — termed **risk communication.**

During the risk analysis phase, it may be useful to supplement published data with herd-specific data from health records (Rae, 2006), outbreak investigation (Smith, 2012), or clinical trials (Sanderson, 2006). It may be possible to recognize important hazards and estimate their costs without ranch data, but it is more difficult to evaluate progress or compliance in the risk management stage without using records. Unfortunately, few cow-calf operations collect animal health data in a format that is easily analyzed (National Animal Health Monitoring System (U.S.), 2008). The lack of a simple record keeping system on many farms hinders the process of recognizing important hazards and their costs, makes it difficult to document that risk management actions were implemented, and to evaluate if those actions were effective.

A risk assessment evaluates the reasons hazards occur, their likelihood, and their cost. In the absence of farm-specific information, risk assessments are often based on published information and expert opinion. For example, a national survey of beef cattle herds (National Animal Health Monitoring System (U.S.), 2008), reported that 2.9

percent of calves were born dead and another 3.5 percent died or were lost prior to weaning. These rates were similar regardless of the herd size. In this survey, the reasons for beef calves to die in the first three weeks of life, in order of frequency, were:

1) birth related (25.7 percent of deaths)
2) weather related (25.6 percent)
3) unknown causes (18.6 percent)
4) digestive system related (14 percent)
5) respiratory disease (8.2 percent); and
6) predation or injury (6.2 percent).

Not every beef herd experiences these losses, or at these frequencies. However, in the absence of herd-specific information, these data tell us that, on average, the important hazards to the survival of neonatal calves are 1) problems occurring during and around the time of calving; 2) dangers from the environment, and 3) contagious diseases. In fact, if we exclude reproductive problems, the subject of another paper, these three categories probably represent the major health risks associated with confinement cow-calf production systems to cows and their calves.

Health Problems at Calving

Successful calving occurs when a live calf is born without complications to the calf or the dam. Problems with the birthing process are called dystocia. Dystocia may be due to factors of the calf or factors of the dam (Rice, 1994). Of the factors associated with the calf, large birth weight is the most common cause of dystocia for most beef cattle herds, and the factor most preventable, through genetic selection (8). Factors of dystocia attributable to the dam are age, pelvic size, and metabolic health (Rice, 1994). Dystocia is more likely to occur with heifers, and also cows with small pelvic dimensions. Common metabolic problems at calving are from muscle weakness due to protein-energy malnutrition, exhaustion during prolonged muscular contractions, and low blood levels of calcium or magnesium.The consequences of dystocia to the calf are metabolic or physical injury which may result in death during or following calving. Lack of oxygen in the blood causes injury to cells and results in acidosis and low blood sugar. Physical injuries include congestion and swelling of the head and tongue which may prevent nursing, or broken bones due to excessive force during calving assistance. The dam may experience metabolic or physical injury during or following the birthing process. The most common problems for the dam are exhaustion from muscular contractions, pressure injury to leg muscles while being down, and bruises or tears to the uterus and vagina. The consequences of these problems include failure of the dam to get up after calving, prolapse of the uterus, excessive bleeding, or infection of the reproductive tract. Each may ultimately be fatal.

In confinement systems, cow nutrition and exercise during gestation are important to dystocia prevention. Another important aspect of managing dystocia risk is to know when veterinary assistance should be sought. Cattle producers should seek veterinary assistance when they:

1) don't know what is wrong

2) know what is wrong, but either don't know what to do, or recognize that the problem is beyond their abilities

3) know what is wrong and what to do about it, but they have been unsuccessful after 30 minutes of trying (Mortimer, 1993).

Dangers from the Environment

Common environmental hazards are weather extremes, crowding, predators, and physical sources of injury. At birth, the calf is limited in its ability to regulate its body temperature so extremely warm or cold environmental conditions present a risk for hyperthermia, or hypothermia, respectively; especially when accompanied by dry and dusty or wet and muddy conditions. The crowded conditions of confinement systems increase the opportunities for injury from being stepped on, butted, or otherwise injured by others in the herd, and increase opportunities for pathogen exposure and transmission. Predators are less likely to be a problem in confinement systems but dogs, wild canids, or other predators might still enter pens and kill or injure newborn calves or calves weakened by illness or injury.Cows are less susceptible to weather stressors compared to their calves, but dystocia or metabolic disease increases their risk for hypothermia or hyperthermia. When cows are heavy with calf they may be more likely to slip and fall, and the likelihood further increases when the floor surface has a steep slope or is slippery from snow, ice, or mud. Cows calving near fences, walls, or low spots are at risk for not being able to rise after lying down. In confinement, cows or calves may become injured from a variety of hazards in the lots including protruding nails, broken posts, loose wire, holes, steep embankments, standing water, and various sources of electricity. Insect pests such as flies can be a problem in confinement systems, but there may be easier opportunities to apply insect control methods compared to pasture systems. Water sources may be compromised by freezing in the winter or because of inadequate flow rates or limited access in the summer.

The risk of injury to cow or calf can be minimized by providing favorable environmental conditions. Long-term strategies include selecting a breeding season so that calving and subsequent production stages occur during optimal weather conditions and designing and using facilities with minimal physical hazards. Near-term strategies for environmental safety include ongoing surveillance of the facilities for potential sources of injury and providing supplemental sources of shade, windbreaks, or water as appropriate.

Contagious Diseases

All things being equal, contagious diseases are more likely to become evident in confinement systems than pasture systems because of greater opportunities for cattle to cattle contact and subsequent pathogen transmission. However, other important risk factors for introduction of contagious diseases are movement of cattle from other operations or from fence-line exposure, independent of degree of confinement.The contagious disease most likely to affect calves in the first weeks of life is neonatal calf diarrhea, commonly called scours (National Animal Health Monitoring System (U.S.), 2008). Calf scours is a detriment to calf health and well-being, and the disease is costly to cattle producers because of reduced calf growth performance, death loss, the expense of labor and medicines to treat sick calves, and the risk for worker injury while treating sick calves (Anderson et al., 2003; Swift et al., 1976). Agent, host, and environmental factors collectively explain the occurrence of clinical signs of diarrhea, and these factors interact dynamically over the course of time (Smith et al., 2008). Cattle producers and their veterinarians have to understand the dynamic relationships occurring between agent, host, and environmental factors within the context of the specific production system to successfully prevent or control scours (Barrington et al., 2002). Even if the scours pathogens existing in the herd are known, it may not be possible to prevent or control disease until the various sources of the agent and the important routes of transmission on the farm are understood and the practices that affect source and transmission are managed.Although the adult cow-herd likely serves as the source of most calf scour pathogens from year to year (Collins et al., 1987; Crouch and Acres, 1984; Crouch et al., 1985; McAllister et al., 2005; Ralston et al., 2003; Watanabe et al., 2005), the average dose-load of pathogen exposure to calves is likely to increase over time within a calving season because calves infected earlier serve as pathogen-multipliers and become the primary source of exposure to younger susceptible calves. This multiplier-effect can result in high prevalence of infective calves and widespread environmental contamination with pathogens (Atwill et al., 1999). Therefore, calves born later in the calving season may receive larger dose-loads of pathogens, and, in turn, may become relatively more infective by growing even greater numbers of agents. Eventually the dose-load of pathogens overwhelms the calf's ability to resist disease. This is likely to be especially true in confinement systems.

In theory there are three approaches to preventing outbreaks of calf scours:

1) eliminate the pathogens from the population
2) increase calf immunity against the pathogens
3) alter the production system to reduce opportunities for pathogen exposure and transmission (Sanderson and Smith, 2005).

However, the pathogens that cause diarrhea are found in most beef cattle herds and it is difficult or impossible to eliminate these agents from cattle herds. Colostral immunity is critical to protect neonatal calves from disease, but this passive immunity against diarrhea pathogens decreases with time (Cortese, 2009), and managers of beef cattle herds have limited ability to improve calf ingestion and absorption of colostral antibodies beyond not interfering with maternal bonding. Also, unfortunately, vaccines are not available against all pathogens associated with calf diarrhea. That leaves the third option as the most viable approach to control calf scours in most cattle herds.

One example of a beef cattle management system for controlling neonatal calf diarrhea is the Sandhills Calving System (Smith, 2009; Smith et al., 2004). The management actions defined as the Sandhills Calving System prevent effective contacts among beef calves by segregating calves by week of age. This is achieved through scheduled weekly movement of pregnant cows to clean calving lots or pastures. The objective of the system is to re-create, during each subsequent week of the season, the more ideal conditions that exist at the start of the calving season. These more ideal conditions are that cows are calving on ground that has been previously unoccupied by cattle (for at least some months) in the absence of older, infective calves. Key components of the systems are age-segregation of calves, the frequent movement of pregnant cows to clean calving areas, and opportunity for maternal bonding and colostrum ingestion with little management interruption. Age segregation prevents the serial passage of pathogens from older calves to younger calves. The routine movement of pregnant cows to new calving pastures prevents the build-up of pathogens in the calving environment over the course of the calving season, and helps to prevent exposure of the latest born calves to an overwhelming dose-load of pathogens. The system is adaptable to confinement housing.

Pneumonia (bovine respiratory disease or BRD) is a leading cause of sickness and death in beef calves after the first few weeks of life. As with scours, the occurrence of BRD is affected by factors of host immunity, presence of specific pathogens, and opportunity for transmission. In confinement systems the opportunity for pathogen transmission is high. Although the bacterial pathogens of pneumonia are commonly found in the upper respiratory tract of cattle, the inciting damage is often due to viral infections that may not be present in all herds. Maternal immunity against respiratory pathogens wanes with time. Every 16 to 20 days after ingestion, the amount of maternal antibodies left in the blood stream is halved, so that by 96 to 120 days of age, a calf retains less than 2 percent of the antibodies it absorbed from colostrum. The immune system is functional but unprimed at birth. Prior to 5 to 8 months of age the immune response of calves is weak, slow, and easy to overcome (Cortese, 2009). Therefore, even in the absence of additional stressors, calves 3 to 4 months of age may be particularly susceptible to infectious diseases. Herd immunity is the protection afforded to susceptible individuals because the majority of the individuals in the population are immune. In herds with a narrow calving window, calves are of similar age and herd immunity is lost as most calves approach 3 to 4 months of age. Weaning and severe weather can be powerful stressors that further reduce a calf's ability to resist disease. Management practices that provide opportunity for pathogen introduction, such as commingling, or that increase stress, such as weaning, may have less impact on health if they are completed prior to or after calves are 3 to 4 months of age (Smith, unpublished). Vaccines against respiratory pathogens have been important for reducing the incidence of BRD in feedlot calves. However, the optimum vaccination protocol to prevent BRD in calves less than 5 months of age remains an important subject of investigation.

Other important contagious diseases that might have greater likelihood of occurrence in beef confinement systems are pinkeye and coccidiosis. Pinkeye is a bacterial infection of the eye that is exacerbated by irritants or injury to the cornea. Protecting calves from blowing dust, irritating feedstuffs, and controlling flies is helpful for preventing pinkeye. Coccidiosis is a diarrheal disease caused by a protozoa and spread by fecal-oral transmission. Prevention of coccidiosis includes general environmental hygiene, including preventing calves from climbing in feed bunks or defecating on feed, and reducing the fecal shedding of oocysts by feeding cows and calves coccidiostatic medications, such as an ionophore.

Health Outcomes in the First Year of UNL Cow-Calf Confinement Trials

The objectives of this study were to observe health outcomes in a cow-calf confinement study, test for potential risk factors associated with disease, and evaluate the effect of disease on growth performance. Pregnant cows (n=84) were allocated to confinement at the UNL Feedlot at Mitchell, NE (n=42) or the UNL Feedlot near Mead, NE (n=42). Cows calved at both locations between May 1 and July 30 (*Figure 1*) using the Sandhills Calving System to segregate calves by age. During the calving phase, one calf at Mitchell was treated for pneumonia at two days of age and one cow was euthanized after a uterine prolapse. At Mead, two calves were born premature and died, and one calf died due to injury. No calves at either location experienced neonatal calf diarrhea.

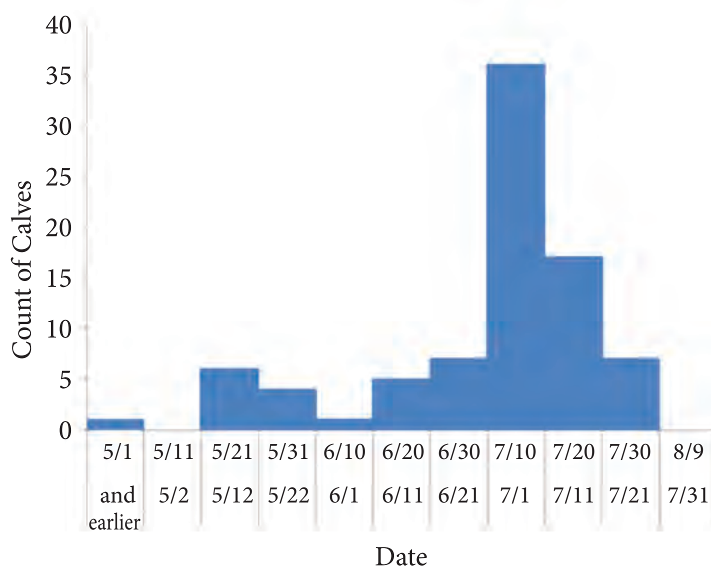


Figure 1. Calving distribution for 84 cows fed in confinement at UNL facilities in Mead and Mitchell, NE.

Calves at both locations (n= 80) were randomized into early-weaning and normal-weaning groups. Early-weaned calves were sorted according to the dam's body weight category into 3 pens of 5 to 7 calves at each location. This occurred on September 25, 2012 at Mitchell and September

27 at Mead. The calves in the normal-weaning group remained in confinement with their dams in 3 pens of 5-7 pairs corresponding to the same body weight categories of the dam. The average age of calves at the beginning of the weaning trial phase was 86.6 days (range 59 to 149 days). The weaning trial phase ended when the normal-weaning group was weaned on January 22, 2013 at Mead and January 24 at Mitchell. The average age of the calves at the end of the weaning trial phase was 205.6 days (range 176 to 270 days). No calves were removed from the study during the weaning trial phase.

No morbidity or mortality was reported from Mitchell during the weaning trial phase. At Mead, 10 of 39 calves (26%) were treated for BRD during the weaning trial phase. Of the BRD cases, seven were in the early-weaned treatment group (cumulative incidence = 35%) and three were in the normal-weaned group (cumulative incidence = 19%). Cases of BRD clustered in time with initial cases began to occur 15 days after initiation of the weaning trial phase and secondary cases, occurring approximately 30 days after initiation of the study (*Figure 2*). The average age that calves were pulled for BRD was 109.6 days (range 89 to 155 days, *Figure 3*). Even though there were meaningful differences in BRD incidence between weaning treatments, the difference could have been due to chance. The incidence of BRD was not significantly associated with birthdate of the calves, gender, or age of the dam.

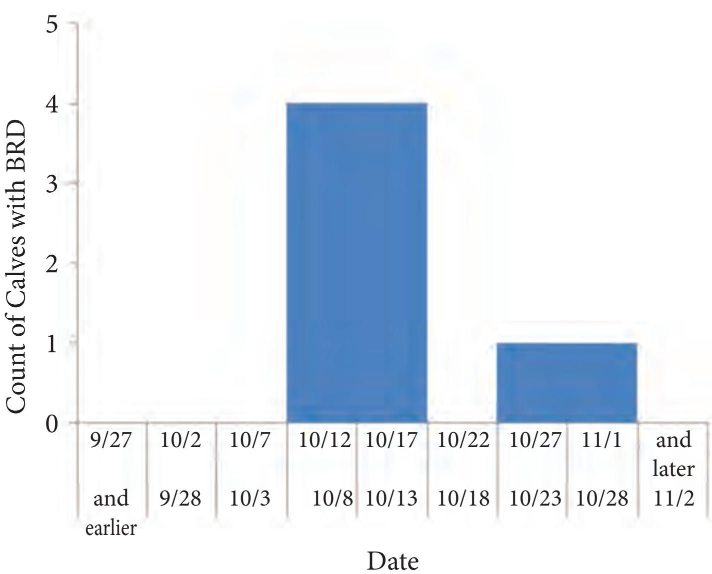


Figure 2. Epidemic curve for 10 calves diagnosed with BRD at the Mead facility. The weaning phase was initiated on September 27.

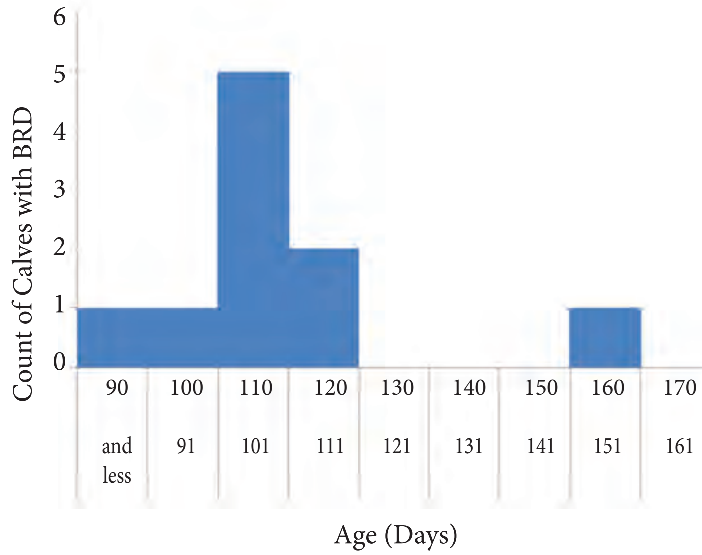


Figure 3. Distribution of age, in days, when 10 calves at the Mead facility were diagnosed with BRD. Seven of the cases occurred in early-weaned calves. Nine of the 10 cases occurred in calves 3 to 4 months of age.

Conclusions

Few cattle producers have experience managing confined cows and calves. However, confinement systems may have economic advantages under some conditions. Economics should not be the sole basis for making decisions about the care of animals. However, the cost of health care remains an important financial constraint to most cattle producers, and therefore, an important consideration in the development of confinement systems. Recognizing and understanding potential health problems in advance allows the cattle producer to make long-term and near-term plans to minimize risk. The hazards to cows and calves in confinement cow-calf systems include health problems at calving, dangers from the environment, and contagious diseases, as exemplified in the UNL cow-calf confinement study. To some extent health risks can be mitigated, though not eliminated, by anticipating their occurrence, managing known risk factors, and assuring that everyone on the team understands what is being done and why.

Literature Cited

Anderson, D. C. et al. 2003. The effect of scours on calf weaning weight. Prof.Anim.Sci. 19: 399-403.

Atwill, E. R., E. M. Johnson, and M. G. Pereira. 1999. Association of herd composition, stocking rate, and duration of calving season with fecal shedding of Cryptosporidium parvum oocysts in beef herds. J.Am. Vet.Med.Assoc. 215: 1833-1838.

Barrington, G. M., J. M. Gay, and J. F. Evermann. 2002. Biosecurity for neonatal gastrointestinal diseases. Vet. Clin.North Am.Food Anim.Pract. 18: 7-34.

Collins, J. K., C. A. Riegel, J. D. Olson, and A. Fountain. 1987. Shedding of enteric coronavirus in adult cattle. Am.J.Vet.Res. 48: 361-365.

Cortese, V. S. 2009. Neonatal immunology. Vet.Clin.North Am.Food Anim.Prac. 25: 221-227.

Crouch, C. F., and S. D. Acres. 1984. Prevalence of rotavirus and coronavirus antigens in the feces of normal cows. Can.J.Comp.Med. 48: 340-342.

Crouch, C. F., H. Bielefeldt Ohman, T. C. Watts, and L. A. Babiuk. 1985. Chronic shedding of bovine enteric coronavirus antigen-antibody complexes by clinically normal cows. J.Gen.Virol. 66: 1489-1500.

McAllister, T. A., M. E. Olson, A. Fletch, M. Wetzstein, and T. Entz. 2005. Prevalence of Giardia and Cryptosporidium in beef cows in southern Ontario and in beef calves in southern British Columbia. Can. Vet.J. 46: 47-55.

Moore, P. G. 1977. The Manager's Struggles with Uncertainty. J.R.Stat.Soc.Ser.A. Gen. 140: 129-165.

Mortimer, R. G. 1993. Problems handling dystocia. In: Range Beef Cow Symposium, Cheyenne, WY.

National Animal Health Monitoring System (U.S.). 2008. Beef 2007-08. United States Dept. of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services, National Animal Health Monitoring System, Fort Collins, CO.

Rae, D. O. 2006. Assessing performance of cow-calf operations using epidemiology. Vet.Clin.North Am.Food Anim.Pract. 22: 53-74.

Ralston, B. J., T. A. McAllister, and M. E. Olson. 2003. Prevalence and infection pattern of naturally acquired giardiasis and cryptosporidiosis in range beef calves and their dams. Vet.Parasitol. 114: 113-122.

Rice, L. E. 1994. Dystocia-related risk factors. Vet.Clin. North Am.Food Anim.Prac. 10: 53-68.

Sanderson, M. W. 2006. Designing and running clinical trials on farms. Vet.Clin.North Am.Food Anim.Pract. 22: 103-123.

Sanderson, M. W., and D. R. Smith. 2005. Biosecurity for beef cow/calf production. In: C. P. J. and S. M. W. (eds.) Beef Practice: Cow-Calf Production Medicine. p 81-88. Blackwell Publishing, Ames, IA.

Smith, D. R. 2009. Management of Neonatal Diarrhea in Cow-Calf Herds. In: D. E. Anderson and D. M. Rings (eds.) Current Veterinary Therapy Food Animal Practice. p 599-602. Saunders Elsevier, St. Louis, MO.

Smith, D. R. 2012. Field disease diagnostic investigation of neonatal calf diarrhea. Vet.Clin.North Am.Food Anim. Prac. 28: 465-481.

Smith, D. R., D. M. Grotelueschen, T. Knott, S. Clowser, and G. Nason. 2008. Population dynamics of undifferentiated neonatal calf diarrhea among ranch beef calves. Bov.Pract. 42: 1-8.

Smith, D. R., D. M. Grotelueschen, T. Knott, and S. Ensley. 2004. Prevention of neonatal calf diarrhea with the sandhills calving system. Proc.Am.Assoc.Bov.Pract. 37: 166-168.

Swift, B. L., G. E. Nelms, and R. Coles. 1976. The effect of neonatal diarrhea on subsequent weight gains in beef calves. Vet.Med.Small Anim.Clin. 71: 1269-1272.

Watanabe, Y., C. H. Yang, and H. K. Ooi. 2005. Cryptosporidium infection in livestock and first identification of *Cryptosporidium parvum* genotype in cattle feces in Taiwan. Parasitol.Res. 97: 238-241.

COW-CALF SYMPOSIUM

Economics of Confining Cows and Calves

Terry Klopfenstein, Karla Jenkins,
Jason Warner, Rick Rasby
and Kate Brooks
Department of Animal Science
University of Nebraska–Lincoln

Economics of Confining Cows and Calves

Terry Klopfenstein, Karla Jenkins, Jason Warner, Rick Rasby and Kate Brooks
Animal Science, University of Nebraska–Lincoln

The beef industry is suffering from a shortage of forage including grazing land. Because of ethanol production from corn, corn production has increased creating two important feed resources. The obvious resource is the distillers grains, and to a lesser extent gluten feed. Both of these feeds are excellent sources of protein and energy in forage based diets.

The less obvious feed resource resulting from the ethanol industry is the corn residue resulting from the increased corn production. The ratio of grain to forage has remained relatively constant over the past 30 or 40 years so as more corn is produced, more corn residue is produced as well. For example, we produce about 42 million tons of corn residue in Nebraska annually. By my calculations, the most the current cattle industry could use is 4.7 million tons. So the opportunity for the cattle industry is to utilize the corn residue and ethanol byproducts in an economical manner.

Certainly, there are other feed resources available. The very simple, straightforward way to economically evaluate feed resources is to determine the cost per unit of energy — we are using TDN (*Table 1*). Corn was priced at $7.50 and $5.50/bu. Interestingly, hays at the prices we used, were higher per lb of TDN than corn. Distillers grains and corn or wheat residues were generally similar and much less expensive than corn or hay. Synergy is a blend of gluten feed and distillers and would be economical but limited to the Columbus, NE area. The dry commodities were priced based on reported values in Feedstuffs Magazine. Dry gluten feed appears to be a good buy and midds might be a good buy in some cases.

Corn silage is an alternate method of harvesting corn residue compared to baling. The price of silage increases relative to corn as corn price declines. At $7.50/bu corn the silage was a very economical source of energy but somewhat less economical at $5.50. At cheaper corn, the silage may not be a good option.

Based on this analysis, we have used wet distillers grains and corn or wheat residue as the diet for our confined cows. The ratio has ranged from 30 to 60% distillers (dry matter basis). Because cost per unit of TDN is similar between the distillers and residue, the cost is similar on a per day basis for the different ratios of distillers to residue.

Confinement Cow System

We established a confinement cow system in April of 2012 with 42 cows at each Scottsbluff and Mead, NE. We purchased bred cows that were bred to calve in June and July. Our logic for summer calving was less mud in the feedlot and calves weaned (January) at a better calf market. We replaced culled cows in April, 2013, with bred cows from the same source the original herd was originated from. The cows were bred in the feedlot by natural service and calves weaned at 205 days of age. Diets were a mixture of corn stalks or wheat straw and wet distillers grains. Some wet beet pulp was used at Scottsbluff. Quantity of feed fed to the cows and calves was recorded so feed costs can be accurately estimated.

Systems Scenarios

For economic analysis, seven cow/calf systems are used. Three systems represent production in the Nebraska Sandhills (Griffin et al., 2012). Four years of data were reported on each of March, June, and August calving herds. The June and August calving dates fall on either side of the June/July dates in the confinement cow system. Two additional systems represent Eastern Nebraska production systems (Anderson et al., 2005; Warner et al., 2013). The first system is based on summer grass, corn stalk grazing and hay feeding. The second system (Warner et al., 2013) is an experimental system where the pairs are double stocked and the other ½ the feed supplied is distillers grains and cornstalks.

The final two systems are the total confinement system described previously and an hypothetical system based on a combination of the confinement system and the June and August calving systems in the Sandhills. In those June and August calving systems, calves remained on the cows

Table 1. Feedstuff Costs Per Pound of TDN

	TDN	*% Corn Price*	*$/lb DM*		*$/lb TDN*	
Corn	83	100	$.158[1]	$.116[2]	$.190	$.140
CGF	100	87	$.129	$.095	$.129	$.095
Soyhulls	70	88	$.131	$.096	$.187	$.137
Midds	75	76	$.113	$.083	$.151	$.111
Beet Pulp	90	92	$.137	$.100	$.152	$.111
Synergy	105	85	$.134	$.099	$1.28	$.094
Distillers Grains	108	100	$.158	$.166	$.144	$.106
Straw[3]	43	—	$.064	$.044	$.149	$.103
Stalks[3]	43	—	$.064	$.044	$.149	$.103
Corn Silage[4]	70	—	$.091	$.075	$.130	$.107
Alfalfa[3]	55	—	$.139	$.084	$.253	$.152
Hay[3]	53	—	$.128	$.072	$.241	$.136

[1]$7.50/bu.
[2]$5.50/bu.
[3]Ground, straw/stalks $115 and $80/ton, alfalfa $250 and $150/ton, grass hay $230 and $130/ton
[4]Corn silage 8.5 and 9.5 x corn price.

while the pairs grazed cornstalks until April 1. Therefore, the calves were weaned at greater ages than 205 days. The hypothetical system then is confinement feeding from April 1 to October 1, calving in June and July and stalk grazing from October 1 to April 1. During stalk grazing the pairs are supplemented with 3 lb (dry matter) of distillers grains to meet the protein needs of the lactating cow and of the calf, assuming some consumption by the calf. The June and August calving pairs in the Sandhills were only supplemented with 1 lb of supplement daily and calf performance was good. However, 1 lb/d of supplement appears to be less than the requirement.

Economic Analysis

A spreadsheet was developed with the inputs from the seven systems (*Table 2*). Assumptions:

1. Cow ownership cost is similar across systems. We assume $200/cow plus $50/cow for breeding.
2. We assumed bred cows were purchased in April and cull cows sold in March. Therefore, the same number of cows was maintained year around.

Table 2. Seven Cow/Calf Systems

	GSL[1]	*GSL[1]*	*GSL[1]*	*D/H[2]*	*D/H[3]*	*Conf.[4]*	*Conf.[5]*
	March	*June*	*August*	*Supp*		*—*	*Stalks*
Grass, d	180	215	215	170	85	—	—
Stalks[6], d	120	195	180	105	105	—	209
Hay, lb dm	1645	—	—	1500	1500	—	—
Stalks, lb dm	—	—	—	—	1485	2738	1295
Dist. Gr/lb dm	45	150	150	105	848	4106	1943
Wean wt., lb	521	557	504	471	509	480	580

[1]Gudmundsen Sandhills Lab, March, June and August Systems.
[2]Dalbey Halleck System, Southeastern, NE.
[3]One half grass replaced with distillers and stalks.
[4]Confinement system.
[5]Confinement six months, stalk grazing six months.
[6]Includes days assigned to calves.

3. Of cows pregnant, we assumed 95% weaning rate based on data from our first year with the confinement project and the data from the Sandhills.

4. All calves were marketed, no replacement heifers retained. Sale weight was based on actual weight at weaning and not adjusted to 205 days because three of the systems were designed to leave calves on the cows for more than 205 days (late weaning? An interesting concept).

5. Costs were varied to predict calf breakeven prices in the seven different scenarios. The base prices are listed in *Table 3* based on $5/bu. corn and current grass prices.

Table 3. Base Prices for Economic Analysis

Grass, $40/mo/pair	$1.33/day
Cornstalk grazing	$.60/day
Distillers grains[1], $190/ton	$.105/lb dm
Hay, $130/ton	$.0722/lb dm
Baled stalks/straw, $80/ton ground	$.0444/lb dm
Labor/yardage[2]	$.10/d
Mineral	$10/yr
Cow cost	$250/yr

[1]Based on 100% of corn at $5/bu, 90% dm price.
[2]$.10/d for cows in conventional systems; $.20 for cows supplemented on pasture and $.45/d for cows in feedlot.

Economic Outcomes

In the conventional systems, breakeven prices for calves, including both steers and heifers ranged from $1.352/lb to $1.575/lb (*Table 4*). The Sandhills system using June calving had the lowest breakeven, likely because no hay was used and cornstalk grazing is economical. The highest breakeven of these four scenarios was the Eastern Nebraska system, likely because of the amount of hay fed. These differences are relatively small, and with the assumptions we have made, may not be very different. Interestingly, the June calving system is completely opposite the confinement system in terms of philosophy — no harvested feeds versus 100% harvested feeds. The average breakeven of the four conventional systems was $1.47/lb.

The complete confinement system had a breakeven of $2.14/lb which is obviously greater than $1.47. It is also greater than the current or projected price of calves. Therefore, we have developed the hypothetical confinement/stalk grazing system. The breakeven of $1.36/lb is within a reasonable range. This system seems logical because the beef industry is short on grass and long on cornstalks. Yardage is an important consideration in these confinement systems. Is $.45/d too much for a dry cow and is $.45/d too little for a pair? If one charges $.45/d for a calf in addition to the cow it would add $.192 to the breakeven for the total confinement system and $.07/lb to the breakeven for the confinement/stalk grazing system.

Table 4. Breakeven Calf Prices at Several Price Scenarios

	GSL[1]	*GSL*	*GSL*	*D/H*	*D/H*	*Conf.*	*Conf.*
	March	*June*	*August*	*Supp*		*—*	*Stalks*
Base prices[2]	1.478	1.352	1.475	1.575	1.556	2.142	1.357
Dist[3], 85/5	1.476	1.347	1.470	1.572	1.528	1.998	1.301
Dist[4], 85/4	1.475	1.342	1.465	1.568	1.498	1.845	1.241
Grass[5], $50	1.600	1.485	1.623	1.701	1.588	1.998	1.301
Grass[6], $72	1.864	1.777	1.945	1.974	1.686	1.845	1.241
Stalks[7], $115	1.478	1.352	1.475	1.575	1.628	2.284	1.413

[1]See *Table 2* for system descriptions.
[2]Base prices from *Table 3*.
[3]Distillers grains at 85% of $5/bu corn.
[4]Distillers grains at 85% of $4/bu corn.
[5]Grass at $50/mo.
[6]Grass at $72/mo.
[7]Baled stalks at $115/ton ground.

Changing Variables

The price of distillers grains is a primary factor in the cost of confinement or partial confinement systems. The same is true for any other commodities being fed. Distillers grains and commodities such as gluten feed, soyhulls and midds tend to follow corn price. Therefore, as corn price declines or increases, the price of distillers grains follows. During the past year, distillers grains have been between 95 and 105% the price of corn. This high value is likely due to the lack of supply of corn, less alcohol production and lower supply of distillers grains. When corn was $4 to $6/bu, distillers grains tended to be 80% to 90% the price of corn. As corn price has declined from $7.50 to $4.50, the price of distillers grains has declined but it is not clear if the price will decline to 80% to 90% that of corn.

The calf breakeven declined by $0.144/lb in the confinement system when distillers grains were priced at 85% the price of corn (*Table 4*). If corn priced declined to $4/bu and distillers was priced at 85% the price of corn, then the calf breakeven declined another $0.153/lb but the breakeven was still $0.40/lb above the conventional systems. The hypothetical confinement/stalk grazing system also responds to distillers grains (corn) price because of the amount of distillers grains fed in both the confinement phase and the stalk grazing phase. This system appears to be very competitive with conventional systems.

In the base system, the price of grass is based on survey work by our Ag. Econ. Dept. and was $40/mo/pair. Grass is scarce and the price will likely increase. If the price is increased to $50/mo/pair, breakevens increase to about $1.60/lb. The price would need to increase to $72/mo/pair to create breakevens similar to breakevens for the confinement system with distillers grains priced at 85% of $4/bu corn.

The other two feed resources that could change in price are the baled corn residue and stalks for grazing. The supply of corn residue greatly exceeds demand. Therefore, if supply/demand economics work, the price of baled residue should not change dramatically. An increase of baled stalk price from $80/ton ground to $115, increased the calf breakeven in the confinement system by $0.142/lb.

Stalk grazing is very economical. It enhances the economics and makes the hypothetical confinement/stalk grazing system appear to be very economical. Based on supply/demand economics, stalk grazing should remain very competitive. Many factors affect this practice. Most corn fields are owned/managed by farmers who do not own cattle. Cows at GSL must be trucked 80 miles to corn stalk fields because there is little or no corn in the Sandhills. This cost could be $30 to $60 for a cow or pair and would add $0.10/lb or more to the breakeven. Alternatively, cows kept in a feedlot would likely be in a corn producing area and cornstalks may be within short trucking or even driving distance. This potentially enhances the competitiveness of the confinement/stalk grazing system.

Summary

The cow/calf industry is challenged by diminished forage resources, especially summer grazing. There is an abundance of corn residue available for use in confined feeding situations. Distillers grains and gluten feed work very well as supplements to residues and may be the least expensive sources of energy. However, the cost of feeding cows in confinement for 365 days/year is too high for it to compete with conventional systems. We have proposed an hypothetical system based on six months in confinement and six months grazing stalks. This system appears to be very competitive with conventional system.

References

Anderson, R. V., R. J. Rasby, T. J. Klopfenstein, and R. T. Clark. 2005. An evaluation of production and economic efficiency of two beef systems from calving to slaughter. J. Anim. Sci. 83:694-704.

Griffin, W. A., L. A. Stalker, D. C. Adams, R. N. Funston, and T. J. Klopfenstein. 2012. Calving date and wintering system effects on cow and calf performance I: A systems approach to beef production in the Nebraska Sandhills. Prof. Anim. Sci. 28:249-259.

Warner, J. M., A. J. Doerr, C. J. Schneider, G. E. Erickson, R. J. Rasby, T. J. Klopfenstein. 2013. Supplementing modified distillers grains plus solubles mixed with low quality forage to replace grazed intake of cow-calf pairs. Abstract. Amer. Soc. 91, Supplement 2:50.

COW-CALF SYMPOSIUM

Defining Value and Requirements in Cow Rations: What is a Calorie Worth?

Jason E. Sawyer and Tryon A. Wickersham
Department of Animal Science
Texas A&M University
Texas A&M AgriLife Research
College Station, Texas

Defining Value and Requirements in Cow Rations: What is a Calorie Worth?

Jason E. Sawyer and Tryon A. Wickersham
Department of Animal Science
Texas A&M University
Texas A&M AgriLife Research
College Station, Texas

Introduction

In the United States and globally, extensive beef cattle production systems are challenged by increasing competition for land, access to capital, and a resulting increase in total costs of production. Particularly in the United States, these pressures may be increasing the sensitivity to risk in cow-calf enterprises. When these pressures are exacerbated by weather perturbations, overall production has declined and has shown reduced response to economic signals to expand. This reduction in primary production impacts productivity and performance of the entire beef supply chain.

Global population dynamics, including both population increases and increasing affluence of consumers in developing nations, indicate a likely increase in protein and beef demand. The confluence of a declining production base and increasing global demand suggest a need for innovation in production management to improve the overall sustainability of beef production systems and to enhance the competitiveness of beef producers.

Through the generosity of the Kenneth S. and Caroline McDonald Eng Foundation, we have initiated a program of work to foster innovation in beef production systems. The primary goal of this program is to enhance the overall competitiveness of US beef production systems. Key strategies to achieve this goal are:

1) Improve the economic and environmental sustainability by increasing the efficiency of primary production systems

2) Increase land-use efficiency of extensive systems

3) Develop and describe decision support systems to optimize management change

System Framework

As managers contemplate methods to increase the performance of cow-calf enterprises, a key consideration is development of a "model" of the system that will allow effective decision making. The ranch system, from the perspective of cow calf production, can be viewed as a transaction in calories. The ranch produces calories each production cycle that are consumed by livestock and converted into salable product. It is our objective to utilize this mental model to develop a method by which producers can effectively describe the "value" of a calorie, evaluate the cost of calories from the ranch and from exogenous sources, and utilize this comparison to make decisions regarding expansion and/or intensification of the cow-calf enterprise. Additionally, the development of this mental model of cow-calf production allows identification of knowledge gaps that should be filled in order to refine projections and identify future opportunities to enhance production efficiency.

As an initialization process, the production of consumable calories is estimated as being in balance with the demand from a properly stocked cow-calf operation. Under this scenario, the ranch produces 100% of the caloric requirement for production; deficiencies in protein and/or minerals are met with supplementation strategies. Thus, estimating the energy requirements yearlong for the cow herd is a proxy for consumable calorie production. Note that in most ranching systems, the production of calories (plant growth) and their consumption (grazing, feeding of harvested forages grown on-site) do not necessarily occur simultaneously. Calories may be produced in excess of demand in one period, and consumed in excess of production in another, to achieve effective use yearlong. This premise is foundational to most rangeland or grazing management strategies (i.e., stockpiling forage).

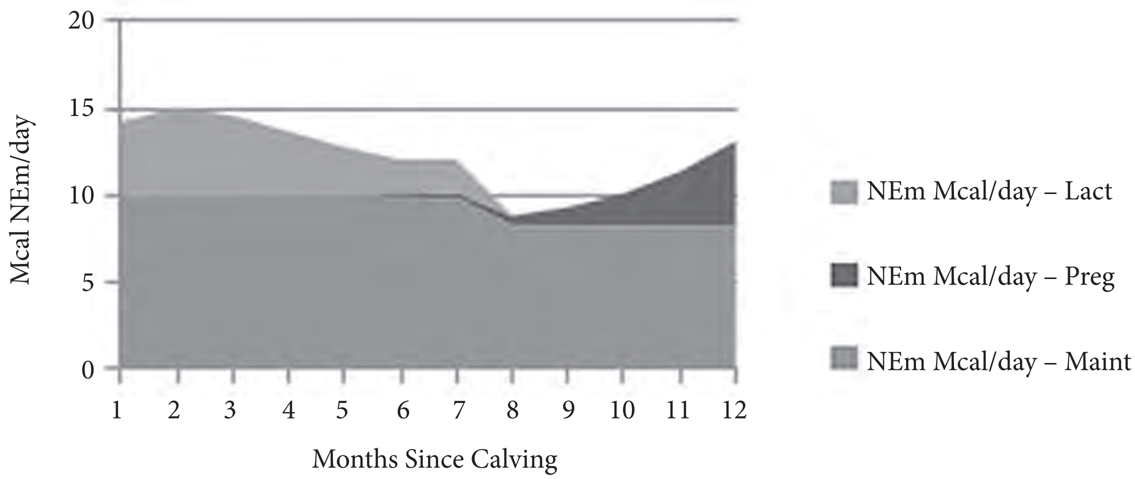


Figure 1: Energy requirements of a 1,200 lb. Brangus cow throughout a production cycle.

Figure 1 shows the energy requirements for maintenance, lactation, and pregnancy during a production year (beginning at calving) for a 1,200 lb. Brangus cow derived from NRC models (2000). The marked reduction in lactation, maintenance and total requirements at the end of month 7 results from weaning at 205 d post calving. The escalation in energy requirements from month 8 through 12 is a result of fetal growth. At calving the subsequent year, requirements escalate again due to lactation. Consistent with the framework we describe, we will consider these requirements as the base demand for calories in the system. When totaled for the production year, the cow has a calorie demand of 4,474 Mcal NEm.

The values above do not include any additional energy requirement for activity in a grazing system. Estimates of this energy demand for activity vary widely among standard models, and comparative experiments to establish this value are limited and may be an important area of future research. Currently, the NRC (2000) uses an equation to estimate energy requirements for grazing activity based on forage intake, forage energy density, severity of terrain, forage availability per unit area, and cow size. Using typical values in this equation yields estimated energy demand due to grazing activity of 2.0 to 2.4 Mcal/d, or 730 to 876 Mcal/cow annually. This represents an additional 15% to 24% increase in total daily energy demand, dependent on month of determination. For purposes of this article, we will assume an increase of 2.2 Mcal/d yearlong, resulting in a total caloric demand for the baseline system of 5,277 Mcal/cow annually. For a 'balanced' system, this represents the caloric production capacity of the ranch on an annual, per cow basis.

Establishing the Value of a Calorie

Using this base framework of a balanced system, the value of a calorie can be estimated as the revenue generating potential of the energy unit net of costs of production. *Table 1* depicts a budget for a cow calf operation in West Central Texas (Thompson, 2013); this is representative of a 500-cow rangeland based operation with no reliance on exogenous calories to meet energy demands. In this budget, weaning rate is based at 85%, cow culling rate at 15%, replacement females retained to offset culling loss (resulting in a loss of revenue), and bulls culled at 25% of the battery each year. Land costs are shown per cow unit per year, as if the land were rented.

For this base case, the value of produced calories is equal to the per cow revenue ($667.02) divided by the energy demand per cow (5,277 Mcal, from above), or 12.64 cents per Mcal NEm. One approach to estimating the cost of these calories is equal to the total cost divided by total calories supplied, or $569.41 / 5,277 = 10.79 cents per Mcal. Alternatively, the fixed cost base per calorie might be considered the true cost of "acquiring" the calories, and the variable cost portion of the total calorie cost might be considered the cost of "harvesting" them. From this perspective, the costs of acquiring any additional calories would be equivalent to the purchase of land and improvements and fixed costs associated with them. Assuming that variable costs remained constant, the maximum value of land purchased (i.e., breakeven value of purchased calories) would be approximately $3,350 per AU (5% interest, 30 year note, 100% debt). In the region of Texas reflected in this budget, purchase costs are approximately 10 times this amount.

Table 1. Cow-calf enterprise budget for West Central Texas, Extension District 7 (adapted from Thompson, 2013).

Revenue	*Head*	*Qty.*	*$/Unit*	*$/Cow*	*Enterprise Total*
Steer	0.43	5.25	$ 156.00	$ 352.17	$ 176,085.00
Heifer	0.27	4.75	$ 148.00	$ 189.81	$ 94,905.00
Cull Cow	0.15	10	$ 74.00	$ 111.00	$ 55,500.00
Cull Bull	0.01	18	$ 78.00	$ 14.04	$ 7,020.00
Total Revenue				***$ 667.02***	***$ 333,510.00***
Variable Costs					
Supplies		1	$ 18.35	$ 18.35	$ 9,175.00
Marketing Expenses		1	$ 23.35	$ 23.35	$ 11,672.85
Supplements		1	$ 78.00	$ 78.00	$ 39,000.00
Vet. Supplies		1	$ 16.50	$ 16.50	$ 8,250.00
Fuel		1	$ 67.00	$ 67.00	$ 33,500.00
Repairs		1	$ 47.50	$ 47.50	$ 23,750.00
Labor		1	$ 63.00	$ 63.00	$ 31,500.00
Utilities		1	$ 24.00	$ 24.00	$ 12,000.00
Interest		1	$ 12.66	$ 12.66	$ 6,331.79
Livestock Depr.		1	$ 13.20	$ 13.20	$ 6,600.00
Total Variable Costs				***$ 363.56***	***$ 181,779.64***
Fixed Costs					
Brush Control		1	$ 6.67	$ 6.67	$ 3,335.00
Equipment Depr.		1	$ 52.18	$ 52.18	$ 26,090.00
Property Insurance		1	$ 27.00	$ 27.00	$ 13,500.00
Land Costs (rent)		1	$ 120.00	$ 120.00	$ 60,000.00
Total Fixed Costs				**$ 205.85**	**$ 102,925.00**
Total Costs				**$ 569.41**	**$ 284,704.64**
Returns				**$ 97.61**	**$ 48,805.36**

The value of additional calories can be estimated based on the expected change in revenue relative to the change in calorie supply. Because one AU is expected to yield $667.02 in revenues, and the energy change has been established, the gross value of purchased calories does not change unless revenue is increased for the additional units, or if caloric demand is reduced (efficiencies are gained). Thus, the scarcity of additional lease land (at or below $217 per AU) due to competing demands, and the apparent disparity in production value and purchase price for additional owned land make expansion difficult or impossible even if current margins are positive. Therefore, expansion of the primary production base is constrained and the system is very brittle in the face of market or weather shocks.

Changing the System

An alternative to expanding the calorie base through land purchase or rental is intensification and purchase of exogenous calories (produced off-site and imported). The costs of acquiring exogenous calories include the purchase of ingredients and additional depreciation expense of required equipment or improvements; the costs of "harvesting" them would costs of mixing and delivering feed. If these added calories are delivered to additional cows above the base herd size, then the total costs of additional calories must also include the non-feed variable costs reflected in the base per additional cow. Using the framework of the system as calorie driven allows for this decision to be addressed.

Table 2. **Energy demand (Mcal NEm/cow) by month for 1200 lb. Brangus cows in a reallocated system.**

Item	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Jan*	*Feb*	*Total*
Days	31	30	31	30	31	31	30	31	30	31	31	28	365
Base energy demand	509	519	520	476	464	442	427	342	346	382	421	429	5277
Reallocated forage energy	727	740	742	679	662	630	609	488	—	—	—	—	5277
Required exogenous energy	—	—	—	—	—	—	—	—	493	545	600	612	2250

Table 2 shows the caloric demand per cow in the base scenario, and an alternate scenario in which cows graze from calving to weaning and are placed into an intensive system for 120 d between weaning and calving. Note that the increase in total energy demand (sum of reallocated forage energy and required exogenous energy) reflects increased capacity (head count) of the new system — energy requirements of individuals have not changed.

In this model, it is assumed that produced calories are transferrable within the production year. Therefore, placing cows into confinement releases a portion of the calories produced; these calories can be utilized by additional cows during the lactation period. All calories required during the dry period are imported from outside sources. The confinement period includes Nov through Feb, releasing 1,578 calories from forage. This represents an increase in harvestable forage from Mar through Oct, an increase of 42.6% of the base supply during those months. Adding cows to harvest this released supply results in an equivalent increase in demand, bringing the forage system back into balance. The new total number of cows (i.e., 1.426 in this example) results in a re-estimated demand during the 120-d confinement period of 2,250 Mcal that must be purchased. The new system total demand is 7,527 calories to support the 42.6% increase in cow numbers (see *Table 2*).

A portion of the energy demand in the base scenario is associated with grazing activity. If this requirement is reduced or eliminated during confinement feeding periods, then the apparent increase in total caloric demand is not a direct increase as depicted above. Rather, the reduction in demand will result in an increase in system efficiency (outputs are held constant while inputs per productive unit are reduced). However, as noted previously, the lack of direct data make this assumption difficult to validate. In *Table 3*, recalculated to a per cow basis (rather than 1.426 cows), models reflecting no change in activity requirement, a 50% reduction in activity requirement, or a 100% reduction in activity requirements are shown. These changes result in 8.4% and 16.7% reductions in confinement period energy demand, respectively.

Assuming that the activity requirement is truly eliminated by placing cows into confinement, the increase in cattle numbers and resulting increase in output is greater than the increase in added inputs, increasing system efficiency. Base system efficiency (lbs. of calf sold per Mcal energy consumed) increases by approximately 5.2% on an energy utilization basis. Perhaps more importantly, production efficiency per unit of land (the constraining resource) is increased by over 42%, as total output increased without a corresponding increase in the land area of the ranch.

Table 3. Energy (Mcal NEm/cow) required for 1200 lb. Brangus cows in a 120-d confinement feeding period supported by exogenous energy purchases, and modified by reductions in energy required for grazing activity.

Scenario	*Forage Energy*	*Exogenous Energy*	*Total Energy*	*Exogenous Change*	*System Change*
No activity req. change	3699	1578	5277	0.0%	0.0%
Reduce activity req. 50%	3699	1446	5146	-8.4%	-2.5%
Reduce activity req. 100%	3699	1314	5013	-16.7%	-5.0%

Table 4. Comparison of enterprise budgets for 500-cow extensive system and 713-cow strategically intensified system.

Revenue	*$/Cow*	*Enterprise Total (500 cows)*	*$/Cow*	*Enterprise Total (713 cows)*
Steer	$ 352.17	$ 176,085.00	$ 352.17	$ 251,179.43
Heifer	$ 189.81	$ 94,905.00	$ 189.81	$ 135,378.84
Cull Cow	$ 111.00	$ 55,500.00	$ 111.00	$ 79,168.91
Cull Bull	$ 14.04	$ 7,020.00	$ 14.04	$ 10,013.80
Total Revenue	***$ 667.02***	***$ 333,510.00***	***$667.02***	***$ 475,740.99***
Variable Costs				
Supplies	$ 18.35	$ 9,175.00	$ 18.35	$ 13,087.83
Marketing	$ 23.35	$ 11,672.85	$ 23.35	$ 16,650.93
Supplements	$ 78.00	$ 39,000.00	$ 54.68	$ 39,000.00
Vet. Supplies	$ 16.50	$ 8,250.00	$ 16.50	$ 11,768.35
Fuel	$ 67.00	$ 33,500.00	$ 67.00	$ 47,786.64
Repairs	$ 47.50	$ 23,750.00	$ 47.50	$ 33,878.59
Labor	$ 63.00	$ 31,500.00	$ 54.26	$ 38,700.00
Utilities	$ 24.00	$ 12,000.00	$ 24.00	$ 17,117.60
Interest	$ 12.66	$ 6,331.79	$ 12.66	$ 9,032.10
Livestock Depreciation	$ 13.20	$ 6,600.00	$ 13.20	$ 9,414.68
Purchased Energy	—	—	$ 142.16	$ 101,393.27
Total Variable Costs	***$ 363.56***	***$ 181,779.64***	***$473.66***	***$ 337,830.00***
Fixed Costs				
Brush Control	$ 6.67	$ 3,335.00	$ 4.68	$ 3,335.00
Equipment Depreciation	$ 52.18	$ 26,090.00	$ 44.27	$ 31,574.00
Property Insurance	$ 27.00	$ 13,500.00	$ 18.93	$ 13,500.00
Land Costs (rent)	$ 120.00	$ 60,000.00	$ 84.12	$ 60,000.00
Total Fixed Costs	**$ 205.85**	**$ 102,925.00**	**$ 152.00**	**$ 108,409.00**
Total Costs	**$ 569.41**	**$ 284,704.64**	**$ 625.66**	**$ 446,239.00**
Returns	**$ 97.61**	**$ 48,805.36**	**$ 41.36**	**$ 29,501.98**

The Value of Change

The strategic intensification of the modeled system results in apparent efficiency gains. The value of the energy required to drive this change can be estimated as the increase in total revenues derived from the change divided by the increase in energy required for the new system. Revenues per cow do not change in this framework, as we have assumed no changes in per cow productivity. Total revenue increases are therefore directly related to the increase in total capacity of the system. *Table 4* compares the original enterprise budget with 500 cows to the new enterprise budget with 713 cows.

Drawing from the data in *Tables 3* and *4*, the value of total calories in both the base case and the new case can be compared. Perhaps more importantly, the value (and thus breakeven cost) of the required exogenous energy can be computed. In the original case, the gross value of energy was 12.64 cents per Mcal ($667.02 / 5277 Mcal). Because of reductions in the per cow energy demand due to transition to the partial confinement system, the total value of energy in the new system is greater ($667.02/5013 Mcal, or 13.31 cents per Mcal). The value of the exogenous energy is equal to the change in total revenues ($142,231) per change in total energy required in the system (936,939 Mcal) or 15.18 cents per Mcal. For context, this is the breakeven equivalent for purchasing and delivering the exogenous energy.

While transitioning to the intensive system increased the apparent value of energy, this transition also created additional costs. While variable costs were forecast to stay relatively constant on a unit basis, unit variable cost estimates were reduced for supplements (fewer days on pasture to receive) and for labor expense. However, these reductions were not sufficient in this budget to offset key driver of cost in this setting, the purchase cost of additional energy to support the confinement period. Increases in total costs for fuel, labor, and other variable costs was deemed sufficient to handle the additional resource expenditure required to support this system, but definitive data are lacking.

Fixed costs were expected to decline on a unit basis, as there are more animals to dilute total costs. Fixed costs include purchase and immediate placement of a tractor, feeding equipment and feed bunks to support development of an intensive system. Notable, all fixed costs declined. Despite the reduction in unit costs, they were not sufficient to overcome the increased costs of feeding.

Clearly, these values are estimates and should not be taken as an exhaustive report of the system. The key object is to develop a framework from which strategies can be developed, evaluated, and acted upon.

Key Takeaways

Establishing the framework for a continuing effort to improve the efficiency of primary production systems is essential for identification of critical knowledge gaps. With this framework, the value of intensification can be clearly demonstrated; however, the cost of implementation may be high. The reality that in many regions of the United States, increasing competition for land is a constraint on expansion of production systems is also evident, and land use efficiency appears to be improved with intensification. Opportunities to improve system energetic efficiency may exist, but insufficient data regarding plasticity of cow requirements in confinement systems exist to make definitive forecasts. Additional research is also needed to develop tools to optimize formulation, manufacturing and delivery systems for feedstuffs in these systems to capitalize on low cost, locally available ingredients. Ultimately, we will collectively enhance the competitiveness of beef production systems through discovery and innovation in beef systems.

Literature Cited

NRC. 2000. Nutrient Requirements of Beef Cattle, 7th revised edition. National Academies Press, Washington, D.C.

Thompson, B. 2013. Estimated Costs and Returns per Breeding Female — West Central Extension District 7. Texas A&M AgriLife Extension Service, College Station, Texas.

COW-CALF SYMPOSIUM

Variation in Feed Efficiency of Growing Heifers and Implications for Intensified Cow-Calf Production

Gordon Carstens
Department of Animal Science
Texas A&M University
College Station, Texas

Variation in Feed Efficiency of Growing Heifers and Implications for Intensified Cow-Calf Production

Gordon Carstens
Department of Animal Science
Texas A&M University
College Station, Texas

Introduction

Global demand for food has been projected to increase 70% by 2050 in order to support a growing population that is becoming more urbanized and affluent. As disposable incomes increase in developing countries, people will elect to include more animal-protein foods in their diet. This rising demand for animal protein will require a concomitant increase in the supply of cereal grains as well as protein and forage feedstuffs to support livestock production systems. Unfortunately, the increase in demand for livestock feed has coincided with a reallocation of cropland resources to support the production of biofuels from cereal grains, which has created higher and more volatile costs of feed inputs in recent years (*Figure 1*). As ruminant animals are capable of utilizing low-quality feedstuffs not directly usable by humans or non-ruminant animals, beef producers are poised to play a key role in meeting future global demands for animal-based protein foods. However, the biological efficiency of converting feed to meat is much lower in ruminant animals compared to pork and poultry, due primarily to inherent disadvantages in reproductive rates that greatly increase the cost of maintaining the cow herd. In fact, the cow herd consumes 82% of total feed inputs in calf-fed production systems, and 64% of total feed inputs in yearling-fed systems (Basarab et al., 2012). Thus, since 70 to 75% of total energy requirements for beef production are used for maintenance, more then half of total feed energy inputs needed to produce beef is associated with the energetic costs of supporting maintenance energy requirements of cows. Numerous studies have reported breed differences in cow maintenance energy requirements, and there is evidence to demonstrate that substantial genetic variation in maintenance requirements exist within breeds (Taylor et al., 1986; Hotovy et al., 1991). However, the opportunity to select for lower maintenance requirements is limited by our inability to easily measure this trait. Moreover, numerous studies have demonstrated that positive genetic relationships exist between maintenance requirements and genetic merit for productive traits like milk production and growth (Taylor et al., 1986; Frisch and Vercoe, 1981). Thus, the necessity to focus our efforts on selection for efficiency of feed utilization in postweaning animals, with the expectation that appropriate selection for feed efficiency in growing cattle will generate progeny that are efficient in all sectors of the industry. While feed efficiency traits have been fairly well characterized in growing cattle, there is a critical need to better understand the associations between genetic merit for feed efficiency in postweaning animals and life-cycle efficiency of the cow herd.

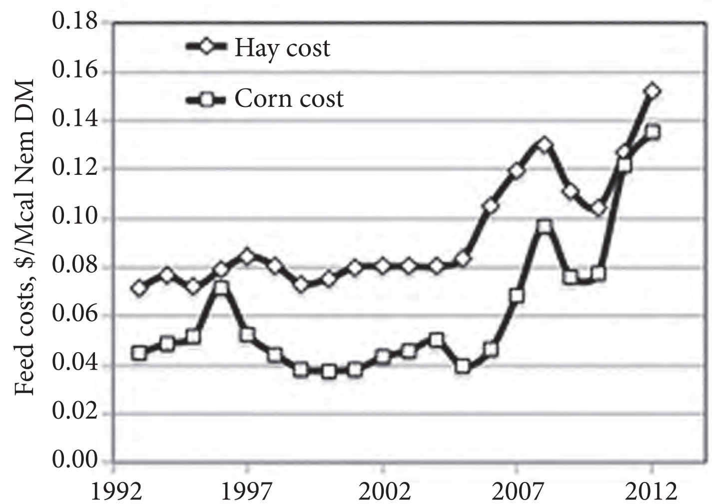


Figure 1. Costs of grass hay and corn grain based on 1.12 and 2.16 Mcal NEm/kg DM, respectively (Livestock Marketing Information Center).

Genetics of Efficiency in Beef Cattle

Regulation of feed intake and efficiency of feed utilization by animals involves a complex set of biological processes and metabolic pathways that are influenced by an animal's genotype as well as numerous management and environmental factors. Feed intake is associated with animal size and productivity in positive manner, such that single-trait selection for enhanced growth potential will increase energy requirements and appetite resulting in minimal favorable change in efficiency of feed utilization (Castilhos et al., 2010). Conversely, selection for lower feed intake will reduce genetic merit for growth resulting in undesirable affects on productivity. Most of the early research on the genetics of efficiency focused on ratio-based traits like feed:gain ratio (**F:G**). Because F:G is strongly correlated (r_g > -0.50) with growth traits in a negative manner, favorable postweaning selection for F:G will increase genetic merit for growth and mature size of breeding females (Herd and Bishop, 2000). Although selection for F:G would be expected to improve efficiency of feedlot progeny, there would be minimal effects on efficiency of progeny destined to become replacement females. Archer et al. (2002) reported that F:G measured in postweaning Angus heifers was highly correlated with mature weight (r_g = -0.54), but weakly correlated with feed intake (r_g = 0.15) in mature cows. These studies demonstrate that selection to improve F:G in growing cattle will lead to indirect selection for increased cow mature size and feed costs, with minimal affects on efficiency of feed utilization in mature cows.

An alternative approach to measuring feed efficiency involves partitioning feed energy inputs into maintenance and production components. Linear regression methods are used to compute expected feed intake based on an individual animal's BW and performance, with residual feed intake (**RFI**) defined as the difference between actual and expected feed intake. In growing animals, RFI quantifies inter-animal variation in feed intake that is unexplained by differences in BW and growth rate — efficient animals are those that consume less feed than expected for a given BW and growth rate. Residual feed intake has been shown to be moderately heritable and genetically independent of BW and level of production in poultry, pigs and beef and dairy cattle. In selection studies with poultry, pigs and beef cattle, progeny from parents divergently selected for RFI had substantial differences in feed intake, while maintaining similar body size and productivity. Because RFI is independent of body size and level of production, RFI better reflects inherent variation in metabolic processes associated with efficiency of feed utilization than ratio-based feed efficiency traits. In growing beef cattle, variation in RFI has been linked to differences in heat production, methane production, composition of gain and digestibility demonstrating that numerous biological processes are responsible for genetic variation in RFI. Herd and Arthur (2009) estimated that approximately one-third of the biological variation in RFI could be explained by inter-animal differences in digestion, heat increment, composition of gain and activity, with the remaining two-thirds of variation in RFI linked to differences in energy expenditures associated with biological processes like protein turnover, ion pumping and mitochondrial function. Moreover, in beef cattle the energetic costs associated with eating, chewing and ruminating can account for 10 to 33% of the total metabolizable energy derived from forages (Susenbeth et al., 1998). Multiple studies have shown that duration and frequency of feeding events were positively correlated with RFI, but minimally associated with F:G (Nkrumah et al., 2007; Lancaster et al., 2009b). Using slaughter-balance technique, Basarab et al. (2003) found that heat production was 10% higher in steers with high compared to low RFI phenotypes. Nkrumah et al. (2006) reported that steers with low RFI produced 21% less heat than steers with high RFI. Collectively, these studies demonstrate that inter-animal variation in whole-animal energy expenditure represents a substantial proportion of the observed differences in RFI, and indicate that this trait is highly associated with maintenance energy requirements.

Differences in body composition may also contribute to variation in RFI as lean tissue requires less energy per unit of gain than fat. In Angus bulls fed moderate-energy diets, Lancaster et al. (2009ab) found weak positive correlations between RFI and final ultrasound backfat depth, such that more efficient bulls and heifers were leaner. Slightly higher positive correlations between RFI and carcass fat traits have been reported in finishing steers (Basarab et al., 2003; Nkrumah et al., 2004), suggesting that differences in carcass composition may account for more of the variation in RFI of cattle that are fed high-energy diets then cattle fed low-energy diets. Differences in energy expenditures associated with growth of visceral organs such as liver, gastrointestinal tract and heart can also contribute to observed differences in RFI, as the metabolic activity of these tissues is much higher than carcass tissues. Basarab et al. (2003) found that steers with low RFI had 8% lower liver and total gastrointestinal tract weights compared to steers with high RFI phenotypes. In steers fed a high-grain diet, Nkrumah et al. (2006) found that steers with low RFI phenotypes had 28% lower methane energy losses and 6% higher apparent digestibilities compared to steers with high RFI phenotypes. Krueger et al. (2009) found that low-RFI Brangus heifers fed a roughage-based diet had 3% higher apparent digestibilities than heifers with high RFI. Based on observed differences in feed intake and apparent digestibilities for nitrogen and phosphorus between heifers with divergent phenotypes for RFI, Krueger et al. (2009) estimated that fecal excretion rates for nitrogen and phosphorus were 36 and 32% lower, respectively, in heifers with low compared to high RFI. Thus, improvements in feed efficiency will help mitigate the environmental impact of livestock production systems through reductions in nutrient excretions and methane-gas emissions (Basarab et al., 2013).

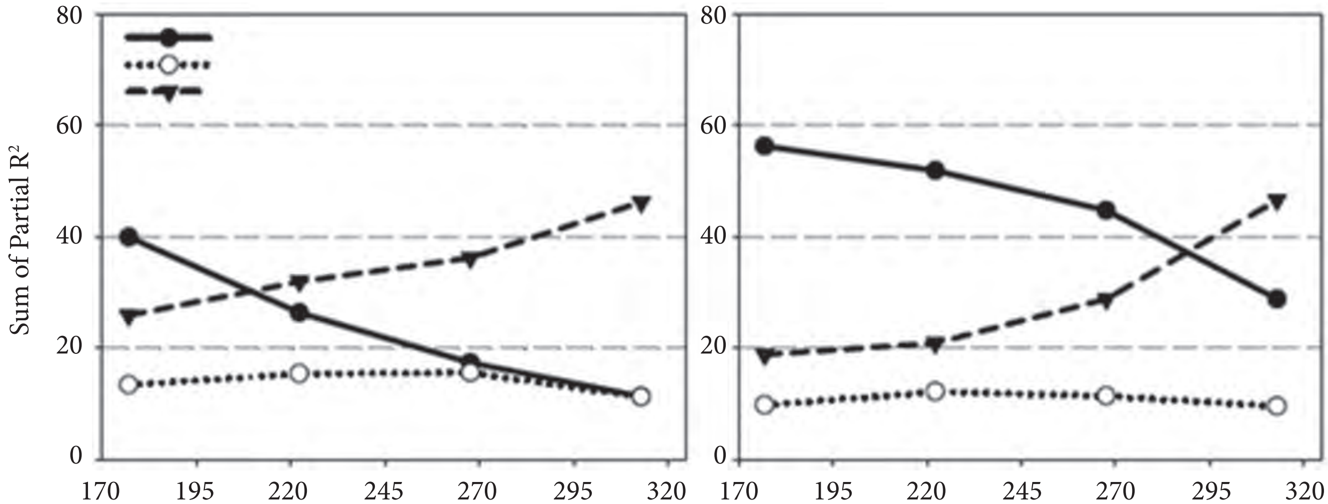


Figure 2. Comparison of variation in net revenue explained by productivity, feed efficiency and carcass quality related traits at various ration and base carcass price ($142 and $172/cwt for panels A and B, respectively) scenarios.

Responses to Postweaning RFI Selection

Feedlot Performance and Feed Efficiency. Few studies to date have examined direct and correlated responses to selection for RFI on performance and profitability of feedlot cattle. In an Australian study, Angus cattle were divergently selected for postweaning RFI for approximately 2 generations (Arthur et al., 2001). Significant divergence between selection lines was reported with direct selection responses in RFI equating to 0.55 lb DM/d per year. Progeny from parents selected for low RFI were similar in yearling BW and ADG, but consumed 11% less feed and had 15% lower F:G than progeny from high-RFI parents. Walter et al. (2012) examined phenotypic variation in performance, feed efficiency and carcass traits in Angus-based composite steers (N = 508) fed a high-grain diet. Steers classified as having low phenotypes for RFI (± 0.50 SD from mean RFI) consumed 16% less feed and had 18% lower F:G ratio then high-RFI steers. As expected, ADG and hot carcass weight were not affected by RFI. Steers with low RFI had significantly greater ribeye area and less backfat depth resulting in lower USDA yield grades (3.08 vs 3.25) compared to high-RFI steers. However, USDA quality grades (386 vs 398) were also lower for steers with low RFI. Despite the reduction in QG, carcass value based on grid-formula adjustments for carcass weight, YG and QG were not affected by RFI classification. Compared with high-RFI steers, net revenue favored the low-RFI steers by almost $64/head.

In this same study, Hafla et al. (2012b) evaluated interrelationships among productivity, feed efficiency and carcass traits to determine their relative contributions in explaining inter-animal variation in net revenue (**NR**). Using 3-year average prices for ration ($222/ton), carcass ($142/cwt), carcass premiums/discounts (e.g., choice-select spread; $6.25/cwt) and feeder calves obtained at the time of study, NR was found to be positively correlated with initial BW, ADG, carcass weight and QG (r_p = 0.28, 0.34, 0.49 and 0.27), and negatively correlated with DMI, F:G, RFI and YG (r_p = -0.18, -0.56, -0.53 and -0.29, respectively). Stepwise regression analysis revealed that nearly 74% of variation in NR was explained by these variables, with productivity (initial BW, ADG, carcass weight), feed efficiency (DMI, RFI) and carcass quality (YG, QG) related traits accounting for 26.4, 32.0, and 15.4% of NR variation, respectively.

To determine the sensitivity of input-output prices on factors affecting variation in NR, various ration ($177, $222, $267 and $312/ton), and carcass price scenarios ($142 and $172/cwt) were evaluated (Figure 2). As ration costs increased, the proportion of NR variation attributed to feed efficiency traits increased, while that attributed to productivity traits decreased.

At the higher carcass price scenarios, the proportion of explained variation in NR attributed to productivity-related traits increased relative to variation explained by the feed efficiency traits. With the choice-select spread of $6.25/cwt (average of 3-year study) held constant for these price scenarios, the variation in NR explained by carcass quality traits was minimally affected by change in ration price, and was slightly reduced when carcass price increased. Increases in choice-select spread would be expected to increase the proportion of NR variation explained by carcass quality traits relative to productivity and feed efficiency related

Table 1. Effects of heifer residual feed intake (RFI) classification on performance and forage intake in pregnant Bonsmara females

Trait	Heifer RFI Classification		SE
	Low RFI	*High RFI*	
Performance and forage intake[†]			
Initial BW, lb	1,069	1,056	18
BW gain, lb/d	0.64	0.81	0.13
Forage DMI, lb/d	24.2[a]	29.3[b]	1.21
Forage DMI, % mid-test BW	2.14[a]	2.61[b]	0.10
Change in BCS during study	-0.16	-0.09	0.08
Rump fat depth, in	0.46	0.44	0.04
Other traits			
Bunk visit frequency, bouts/d	116	119	7
Bunk visit duration, min/d	149[a]	198[b]	13
Heart rate, beats/min	66.1[a]	71.1[b]	1.7
Lying bout frequency, bouts/d	10.4	10.1	0.3
Step count, steps/d	105	98	6

[†]BW and BW gain were corrected for conceptus weight.
[a,b]Means without common superscripts differ at $P < 0.05$.

traits. These results demonstrate the relative importance of genetic merit for performance, feed efficiency and carcass quality in contributing to profitability of feedlot progeny of similar breed type and management background, which can be dynamically altered by changing input-output price scenarios.

Cow Efficiency and Productivity. Few studies have been conducted to determine if favorable selection for post-weaning RFI will improve life-cycle efficiency of mature beef cows. Archer et al. (2002) measured postweaning RFI in Angus, Hereford and Shorthorn heifers and again in the same females following the birth of their 2nd calf. During this study, the mature cows were open and nonlactating, and were fed the same diet provided to heifers during the postweaning tests. Strong genetic correlations were observed between postweaning RFI of heifers, and feed intake and RFI (r_g = 0.64 and 0.98) of mature open cows, although the corresponding phenotypic correlations were lower (r_p = 0.34 and 0.40, respectively). A low negative genetic correlation between heifer RFI and mature cow weight (r_g = -0.22) was observed, indicating that favorable selection based on postweaning RFI will improve efficiency of feed utilization in cows with minimal affects on mature size. In a more recent study, Herd et al. (2011) reported a positive phenotypic correlation (r_p = 0.38) between postweaning RFI in heifers and RFI in open, dry cows that were fed *ad libitum*.

Basarab et al. (2007) examined the phenotypic relationships between RFI of progeny that were fed a high-grain diet and the efficiency of their dams while fed a high-roughage diet. Cows that produced calves with low RFI phenotypes consumed 11% less feed (23.8 vs 26.8 lb/d) than cows that produced calves with high RFI phenotypes. The RFI of cows were positively correlated (r_p = 0.30) with RFI of calves, but the low magnitude of this association suggests that RFI measured in cows fed a roughage diet may be a different trait than RFI measured in finishing calves. In this study, mature BW were similar between cows that produced progeny with divergent RFI phenotypes. Arthur et al. (2005) examined the effects of divergent selection for RFI over about 1.5 generations on maternal productivity of Angus cows. As expected, mature cow weights were similar for cows divergently selected for RFI, although cows selected for low RFI had lesser rump-fat depth at the start of the breeding season. No differences in calf birth or weaning weights were observed between the two RFI selection lines.

To determine if RFI classification of growing heifers was associated with efficiency of forage utilization in productive cows, Hafla et al. (2013) measured postweaning RFI in Bonsmara heifers for 2 consecutive years (N = 115), with the most and least efficient (N = 48) heifers retained for breeding. During the postweaning tests, heifers with low RFI consumed 20% less feed than high-RFI heifers, while maintaining similar body size and gain. Pregnant 1st and 2nd parity females were subsequently fed chopped hay in pens equipped with electronic feeders to measure forage intake. Pregnant females that were efficient (low RFI) as heifers subsequently consumed 17% less forage and spent 25% less time consuming forage (duration of bunk visit events) then their contemporaries that were inefficient (high RFI) as heifers (*Table 1*). Postweaning RFI classification did not affect gain in BW, gain in body condition score or ultrasound measurements during the study. Physical activity as assessed by lying-bout frequency and duration, and daily step counts was not affected by heifer RFI classification, although heart rates were 7% lower in pregnant females with low RFI as heifers. Significant interactions between parity and heifer RFI classification were not observed in this study. In a study involving 6 *Bos indicus* and *Bos tarus* breed types, Black et al. (2013) measured feed intake of 74 3-year-old females during first lactation that were previously determined to have divergent RFI phenotypes as heifers. Heifers with low RFI consumed 21% less feed then high-RFI heifers, with no differences in BW or daily gains observed. Lactating females with low RFI as heifers consumed 10% less feed (87% bermudagrass silage based diet) than females that were inefficient as heifers. Remarkably, heifer RFI classification had no effect on milk production, change in BW gain or body fat reserves during the 70-d study. In both studies, age at first or second calving was not affected by RFI classification as heifers. Results from these studies indicate that postweaning RFI in heifers is favorably associated phenotypically with efficient utilization of feed by gestating and lactating cows, with minimal affects on productivity or reproductive performance.

Associated Responses to Postweaning RFI Selection

Cow Reproductive Traits. Australian researchers were the first to examine the associations between selection for RFI and reproductive performance in beef cattle (Arthur et al., 2005). In Angus cattle, the effects of divergent selection for RFI on reproductive traits were examined across 3 breeding seasons. While differences in pregnancy, calving and weaning rates were not observed between selection lines, low-RFI cows calved 5 d later than cows selected for high RFI. However, the delay in calving date did not affect weaning weight, or weaning weight per cow exposed to breeding. Retrospectively, Basarab et al. (2007) examined the reproductive performance of crossbred cows (10 breeding seasons) that had produced progeny with divergent RFI phenotypes. Pregnancy, calving and weaning rates was similar between cows that produced progeny with divergent RFI phenotypes, but cows that produced low-RFI progeny calved 5 days later than cows that produced high-RFI progeny. In agreement with the previous studies, Donoghue et al. (2011) found that Angus females selected for low-RFI calved 8 days later then those selected for high RFI even though pregnancy and calving rates were similar. In all 3 studies, significant interactions between RFI line and mating year were not detected, indicating that observed differences in calving date in favor of high-RFI cows were likely due to delays in onset of puberty rather then to delays in return to estrus during the post-partum interval. In support of these findings, Crowley et al. (2011) reported that RFI of performance-tested bulls was genetically correlated in a negative manner (r_g = -0.29) with age at first calving, but not with calving to first service (r_g = -0.03) or calving intervals (r_g = 0.01). Thus, it appears that favorable selection for RFI may delay the onset of puberty in heifers, thereby increasing age at first conception without negatively affecting subsequent reproductive performance.

It has been well established that adequate body fat reserves are critical to hasten the onset of puberty in developing heifers. Given that numerous studies have demonstrated that low-RFI steers, bulls and heifers typically have less fat reserves compared to their high-RFI contemporaries, it would not be surprising to find negative associations between RFI and age of puberty. Lancaster et al. (2009a) reported that gain in rib-fat depth was 21% less in Brangus heifers with low RFI compared to those with high RFI. However, age of puberty, the proportion cycling by the end of the test, and pregnancy rate were not affected by RFI group in this study (Lancaster et al., 2008). In British-breed type heifers, Shaffer et al. (2011) found that RFI was positively correlated with rib-fat depth (r_p = 0.27), and negatively associated with age at puberty, such that for each unit reduction in RFI the onset of puberty was delayed by 7.5 d. Despite the negative relationship between RFI and age at puberty, pregnancy rates were similar between heifers with divergent phenotypes for RFI in this study. Donoghue et al. (2011) used serial ultrasonography to measure onset of puberty in heifers divergently selected for RFI. While not significant, the proportion of heifers that attained puberty was numerically lower in low-RFI heifers. Rump-fat depth was greater in heifers with high RFI, and irrespective of selection line, those heifers determined to have reached puberty had greater rump-fat depth than heifers that had not cycled. The lower fat reserves in heifers selected for low RFI likely contributed to the 8-day delay in age at first calving observed in this study.

In contrast to these studies, Basarab et al. (2011) found that crossbred heifers with low postweaning RFI had lower conception rates from day 12 to 37, and tended ($P = 0.09$) to have lower overall pregnancy rates (76.8 vs 86.3%) than high-RFI heifers. To determine if variation in body fat reserves contributed to the negative relationship between RFI and pregnancy outcome, postweaning RFI was adjusted for rib-fat depth. Heifers with low fat-adjusted RFI still had significantly lower conception rates from day 22 to 32 of the breeding season, but overall pregnancy rates (79.6 vs 83.7%) were no longer significantly different from heifers with high fat-adjusted RFI. Basarab et al. (2011) further surmised that test protocols designed to measure RFI in heifers from 8 to 12 mo of age may favor the selection of slightly later maturing animals based on the premise that heifers reaching puberty by the start of the test have increased energy expenditures associated with sexual development compared to their contemporaries that reach puberty at the end of the test. When RFI was adjusted for variation in both rib-fat depth and feeding behavior (frequency of feed bunk events), significant differences in overall pregnancy rate (80.8 vs 83.3%) were no longer observed. Collectively, these results imply that inter-animal variances in body fat reserves and activity associated with stage of sexual development may need to be considered when measuring RFI in breeding animals to ensure that favorable selection for RFI does not negatively affect long-term reproductive performance of beef cows.

Bull Reproductive Traits. The effects of favorable selection for postweaning RFI on bull fertility have yet to be extensively investigated. Hafla et al. (2012a) examined the relationships between RFI in bulls, and sperm motility and morphology of fresh semen. Bulls with low RFI phenotypes had similar sperm motility compared to bulls with high RFI. However, sperm morphology was weakly correlated with RFI, such that bulls with low RFI tended to have a lower proportion of normal sperm (74.0 vs 77.2%). Although Wang et al. (2012) found that sperm morphology was not affected by RFI classification of bulls, the proportion of bulls not meeting the minimum requirement for sperm motility tended ($P = 0.07$) to be greater in bulls with low RFI than those with high RFI. In this same study, bull fertility was also evaluated using a multi-sire natural-mating system involving bulls with divergent RFI. Despite finding decreased sperm motility in the low-RFI bulls, the number of progeny produced per sire was actually higher for low-RFI bulls (18.3 vs 11.8), as 2 of the high-RFI bulls failed to sire any progeny. In the studies cited above, RFI was not phenotypically correlated with scrotal circumference, which is known to be positively associated with sperm-producing ability and age of puberty of heifer progeny. Likewise, several Australian and Canadian studies have found that scrotal circumference was genetically independent of RFI in growing bulls. These results suggest the possibility that the low-RFI bulls may have been slower to reach puberty resulting in lower sperm quality at the time semen samples were collected. As with developing heifers, postweaning RFI in bulls may need to be adjusted for variation in backfat depth to prevent indirect selection for later maturing bulls.

Implications and Conclusions

There is substantial genetic variation in feed intake unrelated to variances in body size and productivity in beef cattle, which can be quantified by RFI. Adoption of multi-trait selection indexes to identify cattle with superior genetic merit for RFI will improve life-cycle efficiency and profitability of production systems through reductions in maintenance energy requirements and the costs of feed inputs with minimal effects on other economically relevant traits. To minimize the risk of indirect selection for later maturity in replacement heifers or reductions in quality grade of slaughter progeny, RFI should be adjusted for ultrasound backfat depth. While numerous seedstock operations and commercial bull test centers now have electronic measurement systems to collect individual feed intake data, this infrastructure capacity will need to be expanded to provide greater access to sires with accurate breeding values for feed efficiency. Advances in genomic technologies will continue to improve the accuracy and reduce the cost of identifying feed-efficient sires across multiple breeds and production environments. Development of decision-support tools that integrate these technologies with individual-animal phenotype data on feed efficiency and other economically important traits will improve profit margins of beef cattle production systems. Moreover, substantial reductions in manure nitrogen and phosphorus excretion, and greenhouse gas (e.g., methane) emissions are achievable through implementation of these selection indices (Basarab et al., 2013). Finally, more research is needed to examine effects of selection for postweaning RFI on life-cycle efficiency under more restrictive environmental conditions (e.g., low forage quality), and with *Bos indicus* breed types to more fully understand potential genotype by environmental interactions that most likely exist.

Literature Cited

Archer, J.A., A. Reverter, R.M Herd, D.J. Johnston and P.F. Arthur. 2002. Genetic variation in feed intake and efficiency of mature beef cows and relationships with post-weaning measurements. Proc. 7th World Congress Genetics Applied Livest. Prod. 31:221-224.

Arthur, P.F., J.A. Archer, R.M. Herd and G.J. Melville. 2001. Response to selection for net feed intake in beef cattle. Proceedings Assoc. Advancement Anim. Breeding and Genetics. 13:135-138.

Arthur, P.F., R.M. Herd, J. Archer. 2005. Maternal productivity of Angus cows divergently selected for postweaning residual feed intake. Aust. J. Exp. Agric. 45:985–993.

Basarab, J.A., D. McCartney, E. Okine, V. Baron. 2007. Relationships between progeny residual feed intake and dam productivity traits. Can. J. Anim. Sci. 83:189-204.

Basarab, J.A., M.G. Colazo, D.J. Ambrose, S. Novak, D. McCartney and V.S. Baron. 2011. Residual feed intake adjusted for backfat thickness and feeding frequency is independent of fertility in beef heifers. Can. J. Anim. Sci. 91:573-584.

Basarb, J.A., K.A. Beauchemin, V.S. Baron, K.H. Ominski, L.L. Guan, S.P. Miller and J.J. Crowley. 2013. Reducing GHG emissions through genetic improvement for feed efficiency: effects on economically relevant traits and enteric methane. Anim. 7:303-315.

Black, T.E., K.M. Bischoff, V.R.G. Mercadante, G.H.L. Marquezini, N. DiLorenzo, C.C. Chase, Jr, S.W. Coleman, T.D. Maddock and G.C. Lamb. 2013. The relationships among performance, residual feed intake, and temperament assessed in growing beef heifers and subsequently as three-year-old lactating beef cows. J. Anim. Sci. 91:2254-2263.

Castilhos, A.M., Branco, R.H., Corvino, T.L.S., Razook, A.G., Bonilha, S.F.M., Figueiredo, L.A. 2010. Feed efficiency of Nellore cattle selected for postweaning weight. R. Bras. Zootec. 39:2486-2493.

Crowley, J. J., R. D. Evans, N. McHugh, D. A. Kenny, M. McGee, D. H. Crews Jr., and D. P. Berry. 2011. Genetic relationships between feed efficiency in growing males and beef cow performance. J. Anim. Sci. 89:3372–3381.

Donoghue, K.A., P.F. Arthur, J.F. Wilkins, and R.M. Herd. 2011. Onset of puberty and early-life reproduction in Angus females divergently selected for post-weaning residual feed intake. Anim. Prod Sci. 51:183–190.

Hafla, A.N., P.A. Lancaster, G.E. Carstens, D.W. Forrest, T.D.A. Forbes, M.E. Davis, R.D. Randel and J.W. Holloway. 2012a. Relationships between feed efficiency, scrotal circumference and semen-quality traits in yearling bulls. J. Anim. Sci. 90:3937-3944.

Hafla, A.N., J.T. Walter, G.E. Carstens, J.C. Bailey, L.O. Tedeschi, J.G. Moreno, D.S. Hale, R.K. Miller, J.E. Sawyer and D.P. Anderson. 2012b. Impact of between-animal variation in performance, carcass-quality and feed efficiency on profitability of Angus-based composite steers. Proc. Plains Nutrition Council Conference, AREC 2012-26:125-126.

Hafla, A.N., G.E. Carstens, T.A. Forbes, L.O. Tedeschi, J.C. Bailey and J.T. Walter. 2013. Relationships between residual feed intake in heifers and forage utilization, body composition, feeding behavior, physical activity and heart rate of pregnant beef females. J. Anim. Sci. (*Accepted*).

Herd, R.M. and P.F. Arthur. 2009. Physiological basis for residual feed intake. J. Anim. Sci. 87(E. Suppl.):E64–E71.

Herd, R.M., P.F. Arthur and J.A. Archer. 2011. Associations between residual feed intake on ad-libitum, pasture and restricted feeding in Angus cows. Proceedings of the Association for Advancement of Animal Breeding and Genetic. 19:47-50.

Herd, R.M. and S.C. Bishop. 2000. Genetic variation in RFI and its association with other production traits in British Hereford cattle. Livest. Prod. Sci. 63:111-119.

Hotovy, S.K., K.A. Johnson, D.E. Johnson, G.E. Carstens, R.M. Bourdon and G.E. Siedel. 1991. Variation among twin beef cattle in maintenance energy requirements. J. Anim. Sci. 69:940–946.

Krueger, W.K., G.E. Carstens, R.R. Gomez, P.A. Lancaster, L.J. Slay, L.O. Tedeschi, R.C. Anderson and T.D.A. Forbes. 2009. Relationships between RFI and apparent nutrient digestibility in growing beef cattle. Beef Cattle Research in Texas. Pp 121-126.

Lancaster, P. A., G. E. Carstens, P. Chen, D. W. Forrest, T. H. Welsh, Jr., R. D. Randel and T.D.A. Forbes. 2008. Relationship between residual feed intake and reproductive performance in Brangus heifers. J. Anim. Sci. 86(E-Suppl. 2):199.

Lancaster, P.A. G.E. Carstens, D.H. Crews, Jr., T.H. Welsh, Jr., T.D.A. Forbes, D.W. Forrest, L. O. Tedeschi, R.D. Randel and F.M. Rouquette. 2009a. Phenotypic and genetic relationships of residual feed intake with performance and ultrasound carcass traits in Brangus heifers. J. Anim. Sci. 87:3887-3896.

Lancaster, P.A., G.E. Carstens, F.R.B. Ribeiro, L.O. Tedeschi, D.H. Crews, Jr. 2009b. Characterization of feed efficiency traits and relationships with feeding behavior and ultrasound carcass traits in growing bulls. J. Anim. Sci. 87:1528–1539.

Nkrumah, J.D., J.A. Basarab, Z. Wang, C. Li, M.A. Price, E.K. Okine, D. Crews Jr., S.S. Moore. 2007. Genetic and phenotypic relationships of feed intake and measures of efficiency with growth and carcass merit of beef cattle. J. Anim. Sci. 85:211–2720.

Shaffer, K.S., P. Turk, W.R. Wagner, and E.E.D. Felton. 2011. Residual feed intake, body composition, and fertility in yearling beef heifers. J. Anim. Sci. 89:1028–1034.

Taylor, C.S. R.E. Thiessen and J. Murray. 1986. Inter-breed relationships of maintenance efficiency to milk yield in cattle. Anim. Prod. 43:37.

Walter, J.T., A.N. Hafla, G.E. Carstens, J.C. Bailey, J.W. Behrens, J.G. Moreno, D.S. Hale, R.K. Miller, J.E. Sawyer, and D. Anderson. 2012. Effects of residual feed intake on feedlot performance, feed efficiency, carcass traits and net revenue in Angus-based composite steers. J. Anim. Sci. 90(Suppl 1): 17.

Wang, Z., M.G. Colazo, J.A. Basarab, L.A. Goonewardene, D.J. Ambrose, E. Marques, G. Plastow, S.P. Miller and S.S. Moore. 2012. Impact of selection for residual feed intake on breeding soundness and reproductive performance of bulls on pasture-based multisire mating. J. Anim. Sci. 90:2963–2969.

COW-CALF SYMPOSIUM

Improving Forage Use Efficiency Cow/Calf Semi-Confinement Systems

David Lalman, Sara Linneen, Dillon Sparks, Adam McGee, Alyssa Rippe, and Clint Rusk
Department of Animal Science
Oklahoma State University
Stillwater, Oklahoma

Improving Forage Use Efficiency Cow/Calf Semi-Confinement Systems

David Lalman, Sara Linneen, Dillon Sparks, Adam McGee, Alyssa Rippe and Clint Rusk
Department of Animal Science
Oklahoma State University
Stillwater, Oklahoma

Introduction

Historical drought, escalating land values, and dramatic increases in most input costs have created a new paradigm in the cow/calf segment of the beef industry. Practices that were previously acceptable, even if wasteful, may be no longer tolerable if profitability is strong motivation. Therefore, our group has recently initiated a series of experiments to evaluate technologies or practices that appear to have promise in improving harvested forage use efficiency. Each of these technologies has been available in one form or another for many years, although adoption has remained low. Technologies evaluated to date and summarized here include hay feeder design, monensin supplementation, and these technologies combined with limiting access to forage and ammoniation.

Bale Feeder Design and Monensin Supplementation

Experiment 1

Fifty six crossbred beef cows (BW= 224.1 ± 22.7 lb; BCS= 5.2 ± 0.53) were used in a split-plot design with four periods. The whole plot included two supplement treatments, while the subplot included four hay feeder designs. Cows were weighed and allotted by BW to one of four previously grazed 2.03 ha paddocks equipped with a 12.2 x 7.6 m2 concrete feeding pad. Paddocks were randomly assigned to one of two supplement treatments which included a 36% CP cottonseed meal based pellet with 0 (**C**; control) or 200 mg/head of monensin (**M**; Rumensin 90®; Elanco Animal Health; Greenfield, IN), fed at a rate of 0.6 lb/head daily.

The four bale feeder designs used in the experiment can be seen in *Figure 1*. Each paddock was randomly assigned one of the four feeder designs which included: a conventional open bottomed steel ring (OBSR), a sheeted bottomed steel ring (RING), a polyethylene pipe ring (POLY), and a modified cone feeder (MODC).

The effects of supplement treatment and feeder treatment on hay waste are shown in *Table 1*. There were no supplement × feeder treatment interactions on hay waste. Supplement did not affect hay waste ($P = 0.77$). However, hay waste was significantly affected by feeder design ($P < 0.01$). The MODC feeder was the most efficient feeder treatment, saving 57.9 % more hay than the RING feeder which was next closest feeder. The RING feeder resulted in

Table 1. Effects of feeder design and supplement on hay waste

	Feeder[1]					Supplement[2]			*P*-value[3]	
Item	MODC	OBSR	POLY	RING	SEM	C	M	SEM	Feeder	Supplement
No.	7	7	7	7		14	14			
Dry waste, lb	63.3[a]	226.81[b]	239.4[b]	123.2[c]	22.64	165.3	161.0	24.9	< 0.01	0.90
Wet waste, lb	7.69	56.15	55.45	46.78	15.65	44.03	39.02	11.1	0.13	0.75
Total waste, lb	71.23[a]	283.3[b]	294.52[b]	169.8[c]	21.94	209.4	200.0	24.7	< 0.01	0.79
Orts weight, lb	226.9[a]	80.53[b]	66.03[b]	99.36[b]	23.79	138.1	98.24	22.07	< 0.01	0.22
Waste, % bale wt[4]	5.31[a]	20.54[b]	21.04[b]	12.6[c]	1.62	15.21	14.54	1.9	< 0.01	0.81

[1]MODC = modified cone feeder; OBSR = conventional open bottom steel ring feeder; POLY = polyethylene pipe ring feeder; RING = sheeted bottom steel ring feeder.
[2]C = 36% CP cottonseed meal based pellet with 0 mg/head of monensin; M = 36% CP cottonseed meal based pellet with 200 mg/head of monensin.
[3]Observed significance levels for main effects.
[4]Hay waste expressed as a percentage of mean bale wt.

Figure 1. Round bale feeder types: (a) modified cone feeder; MODC, (b), conventional open bottom steel ring feeder; OBSR, (c) polyethylene pipe ring feeder; POLY, and (d) sheeted bottom steel ring feeder; RING.

over twice the amount of waste as the MODC. However, the RING feeder wasted significantly less hay than both the OBSR and the POLY feeders ($P < 0.01$). Both the OBSR and the Poly feeder wasted 74.1 and 74.8 % more hay than the MODC feeder respectively ($P < 0.01$). However, no differences were found between the OBSR and POLY feeders ($P = 0.62$).

Neither supplement nor feeder type had an impact on DMI ($P = 0.47$). For this study DMI as a percent of cow BW was 1.70, 1.67, 1.72, and 1.78 % for MODC, OBSR, POLY, and RING respectively.

The effects of supplementing with monensin on cow performance are shown in *Table 2*. There were no supplement × feeder treatment interactions so they were removed from the model. Also, there were no effects of feeder treatment on performance since all cows in the experiment were exposed to all feeder designs ($P = 0.47$). There were no effects ($P > 0.28$) of supplementation on initial

Table 2. Effects of supplemental monensin on cow performance

	Supplement[1]			
Item	C	M	SEM	*P*-value[2]
No.	28	28		
Initial wt, lb	1082	1091	20.9	0.79
Initial BCS	5.15	5.21	0.10	0.70
Final wt, lb	1118	1155	23.4	0.28
Final BCS	5.28	5.81	0.14	0.01
Change in wt	35.5	65.3	10.1	0.04
Change in BCS	0.13	0.57	0.12	0.01
ADG, lb/d	0.62	1.12	0.18	0.04

[1]C = 36% CP cottonseed meal based pellet with 0 mg/head of monensin; M = 36% CP cottonseed meal based pellet with 200 mg/head of monensin.
[2]Observed significance levels for main effects.

Table 3. Effects of feeder design and supplement on apparent digestibility

	Feeder[1]					Supplement[2]			P-value[3]	
Item	MODC	OBSR	POLY	RING	SEM	C	M	SEM	Feeder	Supplement
NO.	7	7	7	7		24	24			
Apparent Digestibility, %										
DM	54.56	56.03	55.64	57.01	1.98	53.48	58.14	1.41	0.85	0.03
OM	57.00	58.68	58.20	59.28	1.91	56.06	60.52	1.36	0.86	0.03
NDF	57.93	58.01	57.92	60.18	1.72	55.70	61.32	1.22	0.74	< 0.01
ADF	45.09	47.44	47.08	49.03	2.48	43.83	50.49	1.76	0.74	0.01
CP	50.56	52.46	53.07	55.75	2.28	50.88	55.04	1.62	0.46	0.08

[1]MODC = modified cone feeder; O = conventional open bottom steel ring feeder; P = polyethylene pipe ring feeder; R = sheeted bottom steel ring feeder.
[2]C = 36% CP cottonseed meal based pellet with 0 mg/head of monensin; M = 36% CP cottonseed meal based pellet with 200 mg/head of monensin.
[3]Observed significance levels for main effects.

weight, initial BCS, or final weight. The final BCS of cows supplemented with C was statistically less than that of cows supplemented with monensin ($P = 0.01$). Change in weight, which was calculated as final weight less initial weight, was greater for cows supplemented with monensin ($P = 0.04$). Change in BCS was greater for cows supplemented with monensin than those that were not ($P < 0.01$). ADG during the 58 d feeding period was also significantly different for monensin supplemented cows than control supplemented cows ($P < 0.04$).

The effects of feeder design and supplementation of beef cows with monensin on digestibility is displayed in *Table 3*. There were no feeder × supplement interactions. Feeder design did not significantly affect digestibility ($P > 0.05$). Cows supplemented with monensin had greater DM, OM, NDF, and ADF total tract apparent digestibility ($P < 0.05$). There was a tendency for monensin supplemented cows to have greater total tract apparent CP digestibility ($P = 0.08$).

Differences in hay feeder design do not restrict DMI, but can significantly affect the amount of feed wasted and subsequently the amount of hay fed. Supplementing gestating cows with monensin may in increases in cow performance during the feeding period with no change in DMI.

Experiment 2

Spring calving Angus and Angus x Hereford cows and heifers (N = 84; initial BW = 1177 ± 150 lb; initial BCS = 5.27 ± 0.6; initial age = 4.8 ± 2.9 yr) were randomly allotted to one of two treatment combinations in a completely randomized design. Treatment supplements included 1) Cottonseed meal supplement with no monensin (**C**); 2) Monensin added to control to supply 200 mg·head-1·d-1 (**M;** Rumensin 90®; Elanco Animal Health; Greenfield, IN). Supplement was fed at a rate of 2 lb/head/d for duration of the study. Prior to, during, and after the treatment period, cows were managed as a contemporary group. Cows had ad libitum access to prairie hay (CP, 4.5%; TDN, 55%; crude fat, 2.8%; DM basis). The experiment was initiated on March 11, 2013 and terminated on May 11, 2013, resulting in a 60 d treatment period.

Cows were fed individually at 1200 daily in a barn containing 31 individual feeding stalls to ensure that each cow received the assigned amount of feed. Each d the cows were gathered from a small sacrifice pasture adjacent to the feeding barn and placed into a feeding stall, restrained, and allowed 20 min to consume their dietary supplement. Individual cow BW and body condition score (BCS; scale 1-9; Wagner et al., 1988) were determined at study initiation and conclusion. Milk production was measured through weigh-suckle-weigh procedure on April 19, 2013 and May 10, 2013. For this procedure, only calves 30 d of age or older were included. The cow-calf pairs included in the first collection were also included in the second collection.

There were no significant differences (P > 0.33) in cow BW or BCS at any time during the study. There were also no differences due to treatment (P > 0.19) in cow BW or BCS change from d 0 to calving, calving to d 60, or d 0-60. Calf birth BW was not affected by dam dietary treatment (P = 0.24; *Table 1*); however, calves from dams consuming monensin weighed significantly more at d 25 and 60 of the study. Calves from dams fed monensin also had greater (P = 0.04) ADG from birth to the end of the study. Milk production did not differ between cows on either of the treatments regardless of d postpartum (P > 0.26; *Table 2*).

Table 1. Effects of feeding monensin to beef cows on calf growth performance

	Treatment[1]			
Item	C	M	SEM	*P*-Value
No.	42	42		
Birth weight, lb	84.6	87.3	2.30	0.24
D45 weight, lb	132.1	142.4	4.39	0.02
D60 weight, lb	156.2	166.8	4.96	0.04
D0-60 ADG, lb	1.20	1.33	0.06	0.04

[1]Treatment supplements included 1) Cottonseed meal supplement with no monensin (C); 2) Monensin added to control to supply 200 mg·head^{-1}·d^{-1} (M). Supplements were fed at a rate of 2.00 lb·head^{-1}·d^{-1} for duration of the study.

Table 2. Effects of feeding monensin to beef cows on cow milk production

	Treatment[1]			
Item	C	M	SEM	*P*-Value
Group 1	42	42		
D postpartum: 28-38	84.6	87.3	2.30	0.24
No. of cows	13	19	4.39	0.02
Milk production, lb	31.1	33.1	2.7	0.47
D postpartum: 49-59	1.20	1.33	0.06	0.04
No. of cows	11	19		
Milk production, lb	17.97	20.75	2.4	0.26
Group 2				
D postpartum: 29-45				
No. of cows	24	31		
Milk production, lb	23.6	25.1	1.8	0.41

[1]Treatment supplements included 1) Cottonseed meal supplement with no monensin (C); 2) Monensin added to control to supply 200 mg·head^{-1}·d^{-1} (M). Supplements were fed at a rate of 2.00 lb·head^{-1}·d^{-1} for duration of the study.

In summary, cow performance was not impacted by monensin supplemented during late gestation and early lactation, nor was milk production significantly influenced. Nevertheless, early season calf performance was improved when dams received monensin supplementation during late gestation and early lactation.

Stacking Technologies in Semi-Confinement Forage Feeding Systems

Experiment 3

Seventy two gestating Angus and Angus x Hereford cows (1,172 ± 130 lb) were allotted by 12 h shrunk BW and assigned to one of two treatments. Treatment 1 (CONT; control) included 24 h access to an open bottom steel ring feeder containing low quality prairie hay (6.2% CP, 54% TDN) and 1.0 lb/d of a 38% CP cottonseed meal-based supplement. Treatment 2 (LIMIT; limited) included limited access to a modified cone feeder containing the same low quality prairie hay. A similar protein supplement (38% CP) containing monensin (Rumensin 90®; Elanco Animal Health; Greenfield, IN) was fed at the rate of 1.0 lb/d to deliver 200 mg of monensin daily. Wire panels were placed around the concrete pads to allow access for 7 h daily; starting at 0800 h. Cattle were assigned to one of six pens measuring three acres each with three replications (pens) per treatment and twelve cows per pen. Each pen was previously grazed to remove standing forage and four pens included a 40 x 25 ft2 concrete pad.

There was no difference between treatments for d 0-84 BW change ($P = 0.33$; *Table 1*), d 0-84 body condition score (BCS) ($P = 0.28$; data not shown) and off test BW ($P = 0.86$). These results suggest that both feeding systems provided nutrients close to the cows' requirements.

Table 1. The effect bale feeder type, monensin supplementation, and limit feeding on cow performance

Item, lb	Treatment[1] CONT	Treatment[1] LIMIT	SEM	P-value
BW				
Allotment	1,172	1,174	31.1	0.93
d0	1,208	1,203	31.4	0.87
d84	1,223	1,226	31.7	0.94
off test[2]	1,183	1,189	30.6	0.86
BW change				
d0-d84	10.0	22.9	13.0	0.33
d0-off test	-23.9	-14.1	11.8	0.41

[1]Control = 38% CP cottonseed meal based pellet with 0 mg/hd monensin, 24 h to prairie hay, open bottom steel ring feeder; Limit = 38% cottonseed meal based pellet with 200 mg/head of monensin, 7 h access to prairie hay, modified cone feeder.
[2] Off Test = Weight taken 7 d after completion of feeding to adjust for gut fill

Cattle receiving the CONT treatment had more ($P < 0.01$; *Table 2*) wet, dry waste, and total waste than cattle receiving the LIMIT treatment. Total hay waste was reduced by the LIMIT treatment by 181 lb per bale fed. Difference in percent of bale weight wasted was highly significant ($P \leq 0.01$) between treatments.

Table 2. The effect of bale feeder type, monensin supplementation, and limit feeding on hay waste

Item, lb	Treatment[1] CONT	Treatment[1] LIMIT	SEM	*P*-value
Hay fed	1,389	1,394	32.3	0.89
Orts	175	240	40.9	0.14
Wet waste	155	102	9.0	0.01
Dry waste	191	63	18.2	0.01
Total waste	346	165	15.9	0.01
Bale weight wasted, %	24.9	11.9	1.32	0.01

[1]Control = 38% CP cottonseed meal based pellet with 0 mg/hd monensin, 24 h access to prairie hay, open bottom steel ring feeder; Limit = 38% cottonseed meal based pellet with 200 mg/head of monensin, 7 h access to prairie hay, modified cone feeder.

Cattle receiving the CONT treatment wasted 24.9% of the original bale weight, while cattle receiving the CONT treatment wasted only 11.9% of bale weight. The combination of technologies in the LIMIT treatment is an effective method in reducing hay waste, resulting in a decrease in total waste of 52%.

Table 3. The Effect of bale feeder type, monensin supplementation and limit feeding on net disappearance

Item, lb	Treatment[1] CONT	Treatment[1] LIMIT	SEM[3]	*P*-value
Hay fed	28,131	24,527	1,971.9	0.14
Orts	1,371	2,391	709.2	0.22
Net disappearance[2]				
Per pen	26,760	22,136	1,369	0.03
Per cow	2,230	1,845	114.1	0.03
Per cow/d	26.6	22.0	1.36	0.03

[1]Control = 38% CP cottonseed meal based pellet with 0 mg/hd monensin, 24 h access to prairie hay, open bottom steel ring feeder; Limit = 38% cottonseed meal based pellet with 200 mg/head of monensin, 7 h access to prairie hay, modified cone feeder.
[2] Net disappearance is calculated by subtracting orts from hay fed.
[3]Limit = 38% cottonseed meal based pellet with 200 mg/head of monensin, 7 h access to prairie hay, modified cone feeder

Net disappearance per cow was 4.6 lb/d (*Table 3*) less for cattle receiving the LIMIT treatment. Total hay savings due to the combination of technologies in the LIMIT treatment for the entire experiment (87 d) per pen (n = 12) was 4,624 lb. Net disappearance is a function of both cow intake and hay waste, which makes it an effective indicator of hay feeding efficiency. The combination of modified cone feeder, limit feeding, and M supplementation in the LIMIT treatment was an effective method to reduce net disappearance, resulting in improved hay feeding efficiency.

Experiment 4

Sixty nine bales of prairie hay were ammoniated in September 2012. Anhydrous ammonia was injected into the covered hay stack at the rate of 2.5% of hay DM weight.

Thirty six lactating Angus and Angus x Hereford cows (1,164 ± 139 lb) were allotted by 12 h shrunk BW and assigned to one of two treatments. Treatment 1 (CONT; control) included 24 h access to an open bottom steel ring feeder containing round bales of prairie hay (5.5% CP, 50% TDN) and 2.5 lb/d of a 38% CP cottonseed meal-based supplement. Treatment 2 (LIMIT; limited) included limited access to a modified cone feeder containing ammoniated prairie hay (13.7% CP, 58% TDN) and 1.0 lb/d of a 20% CP wheat middlings and cottonseed meal based supplement with 200 mg/d per head inclusion of monensin (Rumensin 90®; Elanco Animal Health; Greenfield, IN).

Wire panels were placed around the concrete pads to allow access for 6 h daily; starting at 0800 h. Cattle were assigned to one of four pens measuring approximately three acres each with two pens per treatment. Each pen was previously grazed to remove standing forage and included a 40 x 25 ft^2 concrete pad.

Two waste collection periods were completed during the experiment. Prior to collection, cement pads were cleared of hay and debris, and all hay remaining within the feeders was removed, weighed, and sampled. A fresh round bale was weighed, core sampled, and placed in each feeder. Hay waste was measured at 1300 h daily for the time required for 85% of the hay within each feeder to be consumed. All hay outside of the feeders at the time of collection was considered waste. Waste was separated into wet and dry subgroups to account for differences in dry matter due to fecal and urine contamination.

Cattle were weighed and allotted based on allotment BW. The following d cattle were weighed again (d 0) and placed on treatment. A BW and body condition score (1 to 9 scale; Wagner et al., 1988) was recorded on all cattle on d 0, d 32, and d 62. BW was taken on calves on d 0, d 32, and d 62. Cattle and calves were removed from treatments on d 62 and were comingled on pasture until a final weight was taken 7 d later to adjust for differences in fill between cattle receiving either treatment.

Diets were designed to meet protein requirements, but weight loss in lactating beef cattle consuming ad libitum low quality hay was expected. Cattle receiving both treatments lost BW, -71.6 and -86.1 lb for CONT and LIMIT treatments, respectively. There was no difference between treatments for d 0-62 BCS change ($P = 0.17$; *Table 1*) and d 0-off test BW change ($P = 0.14$; *Table 1*). These results suggest that the LIMIT treatment maintained similar cow performance as the CONT treatment.

Table 1. Effect of bale feeder type, monensin supplementation, limit feeding, and hay ammoniation on cow performance, cow body condition score, and calf performance

	Treatment[1]			
Item	CONT	LIMIT	SEM	*P*-value
Cow BW change, lb				
d0-62	-5.2	-68.0	10.19	0.01
d0-off test[2]	-71.6	-86.1	9.70	0.14
Cow BCS change				
d0-62	-0.13	-0.41	0.20	0.17
Calf BW change, lb;				
d0-62	106.6	84.6	4.29	0.01
d0-off test	103.0	88.5	5.06	0.01

[1]Control = 38% CP cottonseed meal based pellet with 0 mg/hd monensin, ad libitum access to prairie hay, open bottom steel ring feeder; Limit = ammoniated hay, 20% cottonseed meal based pellet with 200 mg/head of monensin, 6 h access to prairie hay, modified cone feeder.
[2]Off Test = Weight taken 7 d after completion of feeding to adjust for gut fill.

Calf BW was not different between treatments on d 0 ($P = 0.96$) or off test ($P = 0.47$). Calves receiving the LIMIT treatment gained less BW between d 0-62 ($P = 0.01$; *Table 1*) and d 0-off test ($P = 0.01$). Calves receiving the LIMIT treatment gained 14.5 lb less than calves receiving the CONT treatment.

The LIMIT treatment resulted in less wet waste, dry waste and total waste ($P \leq 0.01$; *Table 2*). Total waste was decreased ($P < 0.01$) in the LIMIT treatment by 188 lb per bale fed. Total waste in the CONT treatment was 295 lb, compared to only 107 lb of waste in the LIMIT treatment. Cattle receiving the CONT treatment wasted 21.9% of bale weight while cattle receiving the LIMIT treatment wasted only 7.3% of bale weight.

Table 2. Effect of bale feeder type, monensin supplementation, limit feeding, and hay ammoniation on hay waste

	Treatment[1]			
Item, lb	CONT	LIMIT	SEM	*P*-value
Hay fed	1360	1480	62.1	0.10
Orts	124	288	49.4	0.02
Wet waste	152	66	20.7	0.01
Dry waste	143	41	17.4	0.01
Total waste	295	107	14.8	0.01
Bale weight wasted, %	21.86	7.25	1.85	0.01

[1]Control = 38% CP cottonseed meal based pellet with 0 mg/hd monensin, ad libitum access to prairie hay, open bottom steel ring feeder; Limit = 20% cottonseed meal based pellet with 200 mg/head of monensin, 6 h access to prairie hay, modified cone feeder.

There was a large decrease ($P < 0.01$; *Table 3*) in hay fed between treatments. The cattle receiving the LIMIT treatment were fed 5,279 lb less per pen than cows receiving the CONT treatment. Net disappearance was measured as hay fed minus orts. Net disappearance between treatments was highly significant ($P < 0.01$). The LIMIT treatment resulted in a decrease in net disappearance per d of 13.3 lb per cow. This resulted in a total hay savings of 6,584 lb per pen over the 62 d experiment.

Table 3. Effect of bale feeder type, monensin supplementation, limit feeding, and hay ammoniation on net disappearance

	Treatment[1]			
Item, kg	CONT	LIMIT	SEM	*P*-value
Hay fed	22,763	17,484	129.8	0.01
Orts	1,239	2,544	209.6	0.02
Net disappearance				
Per pen	21,524	14,940	147.7	0.01
Per cow	2,690	1,867	18.5	0.01
Per cow/d	43.4	30.1	0.30	0.01

[1]Control = 38% CP cottonseed meal based pellet with 0 mg/hd monensin, ad libitum access to prairie hay, open bottom steel ring feeder; Limit = 20% cottonseed meal based pellet with 200 mg/head of monensin, 6 h access to prairie hay, modified cone feeder.

Conclusion

A larger number of cow/calf operations may be able to take advantage of semi-confinement advantages if the efficiency of feeding harvested forages could be improved. These experiments suggest that there is substantial room for improvement in utilization of one of the nation's largest agricultural crops. Several technologies appear to have moderate to dramatic impacts on the amount of forage wasted, animal productivity, or both. Implementation of one or more of these underutilized technologies could greatly improve the efficiency of semi-confinement systems where management, facilities and other resources require the use of harvested forage.

Literature Cited

Bevers, Stan. 2010.Southwest Cow-Calf SPA Key Measures Summary (Long Term Average). Accessed Jan. 21, 2011. *http://agrisk.tamu.edu/library/pdf/pdf/SW%20Key%20Measures%20Summary%20_Long%20Term%20Average_.pdf*.

Miller, A. J., D. B. Faulkner, R. K. Knipe, D. R. Strohbehn, D. F. Parrett, and L. L. Berger. 2001. Critical control points for profitability in the cow-calf enterprise. Prof. Anim. Sci. 17:295-302.

Wagner, J.J., K.S. Lusby, J.W. Oljten, J. Rakestraw, R.P. Wettemann, and L.E. Walters. 1988. Carcass composition in mature Hereford cows: estimation and effect on daily metabolizable energy requirements during winter. J. Anim. Sci. 66:603-612.

COW-CALF SYMPOSIUM

Advertisements

IMPROVE YOUR FEED EFFICIENCY

INCREASE YOUR VALUE

In your beef production herd:

Rumensin is a cost-effective tool that improves feed efficiency* in mature beef cows and ADG in replacement heifers. This allows you to reduce the feed resources needed to maintain your herd's body condition, and to optimize gain in growing heifers.

Because it improves feed efficiency*, Rumensin helps you improve profitability by allowing beef cows to maintain their body condition on 5 to 10 percent less feed.[1] Or, looked at another way, you can increase your stocking rate by 5 to 10 percent with Rumensin, when actively monitoring and adjusting stocking rates based on body condition scores.

Rumensin is the only ionophore approved for use in mature, reproducing beef cows, as well as the only ionophore approved for the prevention and control of coccidiosis in all of the following classes of cattle: calves, stockers, replacement heifers and mature beef cows.

Performance in replacement heifers[2]

For pennies per head per day, producers with the Rumensin edge realize more weight gain in beef replacement heifers, resulting in fewer days to first estrus (Table 1). This is important because heifers that breed earlier in the first breeding season generally breed earlier throughout their lifetimes.[3]

Table 1.

Rumensin treatment*	Avg. day of trial at first estrus	ADG, lbs	Improvement, lbs/hd/d (%)
0	152[a]	1.43[a]	—
150	139[b]	1.57[b]	0.14 (9.8%)

[ab]Means within a column without a common superscript differ ($P < 0.001$).

*Rumensin fed at 0 or 150 mg/hd/day of monensin.

Elanco

Rumensin® ™

Making science work for you.

Rumensin® directions for use:	
Growing cattle on pasture or in drylot (stockers, feeders, and dairy and beef replacement heifers)	
For increased rate of weight gain:	Feed 50 to 200 mg/hd/d of monensin in at least 1.0 lb of Type C medicated feed. Or, after the 5th day, feed 400 mg/hd/d every other day in at least 2.0 lbs of Type C medicated feed. The Type C medicated feed must contain 25 to 400 g/ton of monensin (90% DM basis).
For the prevention and control of coccidiosis:	Feed at a rate to provide 0.14 to 0.42 mg/lb of body weight/d of monensin up to a maximum of 200 mg/hd/d. The Type C medicated feed must contain 25 to 400 g/ton of monensin (90% DM basis).
Free-choice supplements:	Approved supplements must provide not less than 50 nor more than 200 mg/hd/d of monensin.
Mature reproducing beef cows	
For improved feed efficiency when receiving supplemental feed:	Feed continuously at a rate of 50 to 200 mg/hd/d of monensin. Cows on pasture or in drylot must receive a minimum of 1.0 lb of Type C medicated feed/hd/d. Do not self-feed.
For the prevention and control of coccidiosis:	Feed at a rate of 0.14 to 0.42 mg/lb of body weight/d of monensin up to a maximum of 200 mg/hd/d.

Consumption by unapproved species or feeding undiluted may be toxic or fatal. Do not feed to veal calves. The label contains complete use information, including cautions and warnings. Always read, understand and follow the label and use directions.

***When receiving supplemental feed.**

[1] Rumensin (monensin sodium) Freedom of Information Summary (NADA 95-735).
[2] Ten-Trial Summary, Effect of Rumensin on Average Daily Gain of Replacement Heifers. Elanco Animal Health. Data on file.
[3] Patterson, D. J., R. C. Perry, G. H. Kiracofe, R. A. Bellows, R. B. Stagmiller, and L. R. Corah. 1992. Management considerations in heifer development and puberty. J Anim Sci 70:4018.

USBBURUM00099

ZINPRO
PERFORMANCE MINERALS®

BETTER SCIENCE MEANS BETTER RESULTS



Our time-tested and proven products are the only true performance minerals on the market. As the most research-proven trace minerals in the industry, Zinpro Performance Minerals® deliver improved performance and greater profitability to beef cow/calf, transition and feedlot operations. Benefits of including these essential trace minerals in beef cattle diets include:

- Better reproduction
- Heavier weaning weights
- Improved hoof integrity
- Increased daily gain
- Improved feed efficiency
- Enhanced immune response

For more than 40 years, an uncompromising commitment to superior science and product quality standards puts Zinpro in a class by itself. For more information, visit **www.zinpro.com**.

Zinpro Corporation | 800-445-6145

BETTER EQUIPPED BETTER RESULTS

ABS offers the most comprehensive and convenient genetic service toolbox in the industry by combining reliable, high accuracy genetics and expert support at less cost than buying bulls. ABS' Pasture to Plate™ program is straight forward yet customizable to your operation and specific needs.

- ✔ **Appointment breeding**
- ✔ **Portable facilities**
- ✔ **Predictable, high accuracy genetics**
- ✔ **Professional Representative service**
- ✔ **Marketing assistance**
- ✔ **Reliable, feed efficiency tested genetics backed by 15 years of ABS' Real World Data through the Angus Sire Alliance**

ABS is the source for commercial, profit-driven genetics and your partner for reproductive success. ABS is better equipped to deliver better results for alternative cattle feeding operations. To learn more about the ABS genetic service toolbox, contact your local ABS Representative or call 1.800.ABS.STUD.

"If we are going to continue to have increases in beef consumption, we have to keep price down, yet people have to make money feeding cattle. One of the ways that we can do that is by improving feed efficiency."

Dr. Duane Warden, Warden's Farm

"When I AI on that day in July, I'm accomplishing more than I am on any one given day throughout the rest of the entire year. When the cows leave that barn, six out of every 10 of them are pregnant and I know that next year, they will give birth to some of the industry's best calves."

Joel Koch, Koch & Sons Farms Inc., SD

1.800.ABS.STUD
ABSBEEF.COM

INNOVATION through Biolite™

A natural, clay-free feed ingredient with a high cation exchange and a natural affinity for ammonia. The most proven and widely accepted zeolite in the feed industry.

Unique, calcium-based clinoptilolite zeolite discovered by St. Cloud Mining and Dr. K.S. Eng on the Eng (-K-) Ranch, Sierra County, New Mexico. Extensively researched since the 1990s, with about 250,000 ton sold.

St. Cloud Mining is the largest North American producer of natural zeolites used in animal feeds, soil amendments, odor control, water filtration and radionuclide capture.

Tests have shown:

- *highly effective rumen buffer, reducing acideosis and metabolic problems*
- *may improve livestock performance and reduce metabolic and sulfur toxicity, especially in natural diets*
- *binds aflatoxins and ergovaline*
- *manure higher in retained nitrogen and mare valuable as a fertilizer*
- *mitigates environmental waste and runoff issues; reduces odors*
- *anti-caking flow agent*

Biolite ™ contact:
Annie Powell, 575-743-2100
St. Cloud Mining contact:
Joe McEnaney, 203-209-6084, stcloudmining.com

She earns her keep.
She'll earn more with Akaushi.

Year in, year out, she'll bring her coupon to the weaning pens, from Florida to Montana, earning your respect as well as an industry's. She can earn you more. With an Akaushi sired calf at side you'll receive a $100 guaranteed premium above market. The highest paid in the industry.

Keep the replacement females and enter the path through our Akaushi A4 upgrading program to purebred Akaushi.

Today, she has more earning potential than ever before because of the demand for Akaushi beef. Don't hold back, maximize her profitability. It's time the both of you earned more.

Call us today to get your Akaushi Bull or Semen.

Akaushi.

any breed. any cross. anytime.

Let's talk.

TSCRA
Fort Worth, TX
Booth #206

赤牛
AMERICAN AKAUSHI ASSOCIATION

2nd Annual
Convention
Nov. 8, 9, & 10
Bastrop, TX

830/540-3912
Bubba Bain, Executive Director
bbain@akaushi.com / akaushi.com

PRINCE®

PRINCE AGRI PRODUCTS, INC.

Advancing Nutrition for Healthy Animals®

Why PRINCE?

- Value Added Products and Technical Solutions
- Dynamic Quality Assurance® Program
- State-of-the-art Manufacturing Plants
- Flexible, confidential nutritionist service and support

PRINCE offers a complete line of high-quality, science-based nutrition ingredients that will exceed your expectations.

Trace Mineral Premixes • Macro Minerals
Copper Carbonate
Organic Trace Materials • Lysine & Other Amino Acids
Organic Selenium
Direct-fed Microbials • High Quality Saponin Products

Nutrafito Plus™ AB20®

Provia 6086™ Advanced Formula OmniGen-AF® NUTRITIONAL SUPPLEMENT

PRINCE DQA Dynamic Quality Assurance® FAMI-QS IFEEDER™ INSTITUTE FOR FEED EDUCATION & RESEARCH SUPPORTER

With over 150 years of experience, let our Dynamic Quality Assurance program go to work for you.

CERTIFIED SAFE FEED SFSF SAFE FOOD FACILITY

Prince facilities at Omaha-NE & Quincy-IL hold valid certification under the AFIA Safe Feed/Safe Food program (visit www.afia.org/sfsf).

Call 800-677-4623 or visit www.princeagri.com for more information

FORMULATED FOR WINDY DAYS, RAINY DAYS AND PAY DAY.
Optimize overall herd health, breed back rates and profit potential with new Wind and Rain® from Purina. This new formula encourages intake consistency without overeating—all while standing up to wind loss and rain damage. See your Purina dealer, call 1-800-227-8941, or visit cattlenutrition.com.
Purina. Building better cattle.®
NOW WITH STORM™ TECHNOLOGY
STORM FORMULA
MORE WEATHER RESISTANT
PURINA WIND AND RAIN® CATTLE MINERAL
©2012 Land O'Lakes Purina Feed LLC.


DON'T BREED WITHOUT IT!
Cow/Calf Industry
Trial data from KANSAS STATE UNIVERSITY indicated that cows injected with MULTIMIN® 90 at pregnancy diagnosis and again 30 days before start of breeding had:
Increased conception to Fixed Time AI from 51.2% to 60.2% (P=0.05)
Increased overall pregnancy rate from 89.9% to 93%
Greater body condition score gain between calving and breeding (P=0.04)
Improved calving distribution – 77.5% of calves were born during the first 20 days of the calving season (P=0.01)
Videos at YouTube "Multimin USA" Channel
MULTIMIN 90
MULTIMIN® 90
pre-treatment supports an existing well-designed oral feed program to help optimize health and reproduction in beef cattle.
SUPPORTS BEEF PRODUCTION FROM BREEDING TO CALVING
Protected by U.S. Patent #7,285,292.
Copyright © 2012. All Rights Reserved.
AT201303-01
www.multiminUSA.com
1.866.269-6467 | 1.970.372.2302
℞ REQUIRED

The Plains Nutrition Council was formed in 1970 by a group of professionals located primarily in the southern high plains region. Since that time the organization has grown and now has members from a wide area. The Council is an educational and professional organization for persons who work and serve in allied industries, consultation practices, research, extension, and education with a primary focus in beef cattle. The goal of the Council is to enable its members to more effectively cooperate with each other and to serve the livestock industry more successfully. The Council provides a forum for discussion, evaluation, and promulgation of current research in the field of nutrition and management. Joint efforts with related organizations in animal health, veterinary medicine, animal agriculture, and other groups allied to the livestock industry are encouraged.

The Plains Nutrition Council coordinates and hosts educational and professional development activities for its members and others annually. In addition, the organization supports and sponsors professional development activities coordinated by other organizations and institutions. The signature event is the annual spring conference that draws professionals and graduate students with interests in beef cattle nutrition and management from the USA, Canada, Mexico, and South America. At this event, the Dr. Kenneth and Caroline McDonald Eng Foundation, in conjunction with Plains Nutrition Council, recognize the research efforts of graduate students presenting their work at the conference.

The Plains Nutrition Council
6500 Amarillo Blvd West

Amarillo, Texas 79106

Dr. Kenneth and Caroline McDonald Eng Foundation

COW-CALF SYMPOSIUM

Dr. Kenneth and Caroline McDonald Eng Foundation
P.O. Box 272
Winston, New Mexico 87943
Phone: 575-743-6331
Fax: 575-743-0087
engnm@hotmail.com