EFFECTS OF COW MATURE SIZE ON INTAKE, CALF WEIGHT AND MILK YIELD IN A SPRING-CALVING COMMERCIAL COW/CALF OPPERATION

By

GANT LARRY MOURER

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Oklahoma State University

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Thesis Approved:

Dr. David L. Lalman

Thesis Adviser

Dr. Gerald W. Horn

Dr. Robert P. Wettemann

Dr. Sheryl Tucker

Dean of the Graduate College

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CHAPTER I

Introduction

Recent increases in cow/calf enterprise production costs have resulted in renewed interest in identifying critical factors that influence efficiency of production. Efficiency of production can be separated into biological and economical efficiency and is influenced by many factors such as energy requirements, physiological stage of production, milk production, cow size, breed, input costs, etc. A better understanding of beef cow efficiency is needed in order for producers to make sound management decisions so cow herds cannot only be biologically viable but economically viable as well.

CHAPTER II

LITATURE REVIEW

Cow Maintenance Energy Requirement

It is estimated that 60% of total feed energy to produce a calf from calving to slaughter is required by the cow for maintenance and calf production (Klosterman et al., 1972). The energy required just to maintain a cow and not increase production represents 70 to 75% of the total energy consumed annually (Ferrell and Jenkins, 1985). It is important to have a firm understanding of a cow's energy requirement because of these high inputs to maintain a cow throughout the year. Gross energy of a feed minus the energy lost in feces is termed digestible energy (DE). This DE is used to calculate metabolizable energy (ME) by subtracting DE from gas energy (GE) and urinary energy (UE) expended from the animal or $ME=DE-(UE+GE)$. The 1996 NRC defines "ME is an estimate of the energy available to the animal and represents an accounting progression to assess food energy values and animal requirements". Because, UE and GE are highly predictable from DE, ME and DE are highly correlated. This gives ME and DE many of the same weaknesses. GE comes from microbial fermentation which results in heat production (HE), which is an energy loss not accounted for in ME. (NRC, 1996).

Metabolizable energy is used as a basis for the net energy system. This system was established in 1963 to separate the energy requirements for maintenance (NE_m) and that of body weight gain (NE_g) or other production outputs. NE_m has been defined as the feed energy required for zero body energy change (energy stasis) or feed energy required for zero body weight change (weight stasis) (Ferrell and Jenkins, 1985). Also, NE_m is equal to heat production when animal feed intake is zero. NE_m may vary with BW, breed, sex, age, season, temperature, physiological state and previous nutrition. When NE_m is met by an animal consuming excess energy, the energy can then be used for other functions such as gain (NE_g) or lactation (NE_l). Thus the equation, $ME= NE_m + NE_g + HE$ (NRC, 1996).

Factors affecting Cow Maintenance Energy Requirement and Forage Intake

Body Size

Feed intake is a major variable in the cost of production in commercial cow herds and cow BW or more specifically metabolic BW impacts DMI. The NE_m requirements for beef cattle have been estimated at $.077 Mcal/EBW^{.75}$ where EBW is the average empty body weight in Kilograms (kg) raised to the .75 power, otherwise known as metabolic BW (Kleiber, 1932; Lofgreen and Garrett, 1968). Metabolic BW is used to scale energy requirements for BW of different species of animals, allowing an equal comparison in NE_m between different BW. This is due to the difference in volume and surface area of different sizes of animals. Kleiber (1932) used the example of comparing a 0.03 kg mouse with a 5000 kg elephant, the elephant requires 80,000 kcal of energy/d and the mouse only requires 5 kcal of energy/d. This means the elephant weighs 160,000 times more than the mouse, but only requires 16,000 times more energy to sustain itself as compared with the mouse. When put into context of cows with different BW during the same point in lactation, DMI requirement of a 454 kg cow is 9.8 kg as compared with a 635 kg cow which requires 12.3 kg of DMI. The heavy cow is 30% heavier but only requires 20% more DM to meet NE_m requirement (NRC, 1996).

Physiological State and Genetic Potential for Milk Yield

The available data indicate there is a 20% increase in NE_m requirement of lactating cows over non-lactating cows (NRC, 1996). Canas et al. (1982) suggest that a 24% increase in maintenance energy expenditure during lactation could be explained on the basis of changes in the relative weights of the liver, heart and kidney. The heart, liver and kidney also account for 37% of fasting energy expenditure in heifers, accounting for a large portion of energy loss (Ferrell et al., 1976). Ferrell and Jenkins (1984) studied the requirements of mature, non-pregnant, non-lactating cows and suggested maintenance requirements per unit weight or metabolic body size differed due to genetic potential for milk production which was positively related to maintenance energy requirements. However, the genetic potential for milk production may have a practical maximum because of nutritional limitations which prevent the expression of genetic potential (Brown et al., 2005).

Johnson et al. (2003) found that as genetic potential for milk increased, forage DMI increased. There was a relationship of 0.33 and 0.37 kg increase of DMI for every kilogram increase in milk yield for early and late lactation, respectively. When DMI was compared with stage of production, cows in late gestation, early lactation and late lactation consumed 1.75, 2.51 and 2.12 kg/100 kg of BW, respectively (Johnson et al., 2003; Figure 2.2). During the transition from gestation to lactation there is a decrease in intake prior to parturition. Ingvartsen and Andersen (2000) found in dairy cows that this decrease in intake is caused by many factors that coincide with changes in reproductive status and metabolic signals that play an important role in intake regulation (Figure 2.1).

Age

Research on effects of animal age on forage intake is limited and the majority has been done with sheep. However, NE_m requirements decline with age in both cattle and sheep (NRC, 1996). Graham et al. (1974) found that NE_m requirements decreased exponentially with age and reported a decrease of 8% per year. Corbett et al. (1985) reported a decrease of 3% yr in NE_m. In other studies, influence of age has had little affect on NE_m requirements (Blaxter et al. 1966; Blaxter and Wainman, 1966; Taylor et al., 1981; Birkelo et al., 1989). The NRC (1996) states that “maintenance requirement of mature, productive cows is not less than that of younger, growing animals postweaning”.

The similarities in maintenance requirements of heifers and cows also concurs with data involving DMI and age. A comparison was made between 10 mo old heifers and cows that were 7-9 yr of age. Cows consumed more forage (g/d), but OMI was equal when expressed per unit of BW (Varel and Kreikemeier, 1999). Johnson et al. (2003) reported similar results, finding multiparous cows consumed 19% more forage than primiparous on an absolute basis during early and late lactation. However, when expressed as per unit of BW, DMI of multiparous and primiparous was the same. Cow age class did not influence DMI or OMI (Banta et al. 2007; Table 2.1).

Climate and Season

Climate has a substantial impact on NEm requirement. In a study conducted by Laurenz et al. (1991), Simmental cattle had a 16.1% greater overall daily NEm requirement than Angus cattle; however, both had greater requirements during summer and less during winter. This is the result of the temperature variations of the seasons and also the increase in $EBW^{.75}$ caused by the increase in forage quality and availability during the spring and summer seasons. Nutrient requirements for beef animals are more greatly impacted by temperature as ambient temperature rises or falls beyond the upper or lower critical temperature outside the zone of thermoneutrality. If ambient temperature is above the upper critical limit, the cow's NEm requirement increases as the cow must expel energy to dissipate body heat to maintain constant body temperature. Conversely, if the ambient temperature decreases below the zone of thermoneutrality, the cow must increase heat production to maintain body temperature (NRC, 1996).

Physical and Metabolic Regulation

Dry matter intake of non-supplemented cows grazing low quality forage, which is low in rumen degradability, is highly regulated by rumen fill which negatively affects voluntary intake (Allen, 1996). Stretch and tension receptors within the rumen signal when forage particle size is larger (highly matured lower quality), decreasing DMI

(Allen, 1996). Larger particle size also decreases digestibility, because of high lignin content and low rate of breakdown by cellulolytic microorganisms within the rumen (Allen, 1996). However, if nutrient availability is not limiting and higher quality forages or feeds are available to the animal, a metabolic feedback mechanism within the cow will also send signals of satiety when nutrient absorption (protein or energy) is met, negatively affecting DMI, passage rate and determining meal size. Over longer periods of time, an animal in positive energy balance, will decrease intake due to an increase accumulation of fat. The adipose tissue increases leptin production increasing satiety signals (Illius and Jessop, 1996).

Supplementation

Reasons for feeding supplements to cattle consuming forage-based diets include conservation of forage, improvement of animal performance, increasing economic return, and (or) managing cattle behavior (Kunkle et al., 2000). During the winter grazing period when forage availability is not limiting, the first priority should be to meet the rumen nitrogen (N) requirement by adding protein to the diet. This will increase forage DMI, improve protein / energy ratio of absorbed nutrients and increase acetate utilization (Horn and McCollum, 1987). If forage availability is limiting and forage supplies need to be "stretched" then energy supplementation is required. Energy supplementation may also be needed in order to increase animal performance to a desired level or to meet maintenance energy requirements when environmental effects increase the energy requirement of animals (Horn and McCollum, 1987).

Animal Efficiency

Defined

Beef cow efficiency includes two individual categories; economical and biological. Dickerson (1970) defined economic efficiency of production as *“The ratio of total cost to total animal product from females (e.g., milk, wool and eggs) and their progeny (e.g., meat) over a given period of time.”*

“Biological” inputs were only worthy of consideration if they were associated with an expense. Water is a major “biological” input; however, it is not considered in many studies due to its low cost (Tess and Davis, 2002). Dickerson also used terms such as “cost per unit of value produced” to define his biological objectives (Tess and Davis, 2002).

Biological efficiency simply put, is the number of calves weaned per cow exposed or more specifically, kg of calf weaned per cow exposed. David Notter (2002) defines biological efficiency of cattle production as: *“The capacity to convert physical inputs (feed) into marketable product (beef) under prevailing production conditions.”* He used this definition to present the efficiency of use of grazed forages (“cow efficiency”) and harvested concentrates (“growth efficiency”). This dichotomy is important because the biological traits supporting efficient use of the two resources are markedly different (Notter, 2002). The definition can also be changed to refer to the industry level: *“Population characteristics that provide the flexibility to rapidly adjust the* *characteristics of commercial offspring in response to changes in economic conditions"* (Notter, 2002). This definition allows for many different animal products as well as genotype x environment interactions (Notter, 2002).

Economic Efficiency. Economic efficiency can easily be seen when comparing two different production systems. Anderson et al. (2005) fed cows on either grazed pasture and fed hay during the winter (CON) or grazed pasture and crop residue and fed hay during snow conditions (TRT). The CON steers finished 211 d after weaning in a feedlot. The TRT steers grazed crop residue and pasture in the spring and summer then were finished for 90 days in a feedlot. Treatment steers had increased breakeven and cost per weaned calf at weaning and postweaning vs. the CON when sold on a live basis. The increased cost per weaned calf for CON cows can be attributed to the higher input cost particularly due to the increased hay usage. Hay consumption was calculated at $120.83 per cow for the CON and $90.69 per cow for the TRT. Total profit potential of the systems was greater with the TRT steers when sold on a live basis, but remained equal when steers were sold on the grid due to the lack of the TRT steers to grade low Choice or better (Anderson et al., 2005).

According to Long et al. (1975), small cows have increased value with total live weight sold than medium and large cows and a higher net income in pasture as compared with dry lot situations (Table 2.2). It is also noted that the number of smaller cows used in the analysis was greater than large or medium, due to smaller nutrient requirements and the ability to increase stocking rates for each pasture or dry lot. Measures of

Biological Efficiency. Beef cow biological efficiency has been measured in many ways. Some of which have been calf measurements up to weaning time such as: kg of calf weaned per cow exposed, kg of calf weaned per cow exposed per kg of cow BW or kg of calf weaned per cow exposed per unit of feed energy consumed (Ritchey, 2001). Some studies that have retained ownership have taken efficiency measures up to slaughter, for example: kg slaughter progeny weight per unit of feed energy consumed by cow and slaughter progeny; kg carcass weight per unit of feed energy consumed by cow and slaughter progeny; or kg of edible beef per unit of feed energy consumed by cow and slaughter progeny (Ritchey, 2001). Johnson et al. (2010) found using cow BW in an efficiency ratio is limited in accuracy as compared with total energy intake for several reasons: (1) blanket estimates of feed intake may not be accurate; (2) reproductive efficiency is not accounted for, a 200 kg calf at weaning is better than no calf at all; (3) larger cows have greater intakes even when dry due to visceral organ mass; (4) greater milking cows may be in jeopardy of re-breeding due to partitioning of energy from fat stores to mammary glands in the cow.

Units and Determination of Intake. DM determination of a feedstuff is an important analysis because many other nutrients of that feedstuff are reported on a DM basis, or % DM basis (Galyean, 2010). This procedure consists of drying a feedstuff for 12-24 h in a 100° C oven, removing any moisture that is present (Galyean, 2010). Intakes of feeds and forages are most often reported on a DM basis as well. When water is removed from forage, DM is easily accounted for and an accurate measure of intake is calculated. Researchers will often calculate intake on an organic matter basis (OM) as well. A percentage of ash is determined from a forage sample by placing it in a furnace at 550° C for several hours. To calculate OM, ash is simply subtracted from 100 giving a percentage of OM in a forage. In turn OM can be multiplied by intake for the OM intake calculation (Galyean, 2010). For a more refined measurement of intake, digestibility of a forage by a certain animal can be added to the equation. Digestibility can be calculated by multiplying the ratio of a marker (such as acid detergent insoluble ash) in feed and feces, by the ratio of a specific nutrient (such as DM) in the feed and feces. Digestibility then can be multiplied by intake to arrive at Digestible DMI.

The determination of intake has occurred in many ways. Direct refusals of forage and feed can be collected during research trials to calculate intake. Cows are confined individually and forage is fed at 10% greater than expected intake. Orts are then weighed after a period of time to calculate DMI (Banta, 2008; Winterholler, 2009). Macoon et al. (2003) compares three other methods of intake collection. They inferred intake from animal performance, used chromium as an external marker, and measured herbage disappearance to calculate intake on dairy cows. The authors found that the animal performance and herbage disappearance methods were closely correlated, while increased intakes were reported using chromium as an external marker. Also, if fecal output is known, intake can be calculated because intake and fecal output are highly correlated (Galyean, 2010). This is often difficult because total fecal output must be determined.

Cow Biological Efficiency

To look futher, cow total energy intake was used in a five year study conducted with nine breeds of cattle (Jenkins and Ferrell, 1994). These breeds varied in genetic potential for weight at maturity, observed peak milk yield (Jenkins and Ferrell, 1992), post weaning gain and fat deposition potential (Gregory et al., 1994 a,b; Table 2.3). Jenkins and Ferrell (2002) defined production efficiency as lb calf weaned/lb dry matter consumed/number of cows exposed. Cow exposed is important so that conception rate is included. During the five year study they evaluated DMI and production records on all nine breeds of cattle, four cows of each breed were assigned to one of four DMI levels: 58, 76, 93, or 111 g DM/Wt. Calves were weaned at approximately 200 d of age. Production traits measured included calf birth weights, milk yields, calving rates, weaning weights and cow weights as recorded in Table 2.4. When feed availability was lower, breeds that had moderate genetic potential for growth and milk production were more efficient because of greater conception rates. For breeds with greater genetic potential for growth and milk production, efficiency on lower levels of intake decreased because if the cows were in lactation they did not cycle and therefore did not conceive. However, at the highest levels of feed intake, breeds with the greater genetic potential for growth and milk production were the most efficient, according to their definition, because feed availability was sufficient for expression of their genetic potential. The cows with more growth potential were able to cycle and conception rates increased, while cows with a more moderate growth potential became fatter on higher feed intakes. Both mature size and milk yield highly impact metabolizable energy intake. Jenkins et al., (1991) found metabolizable energy intake was significantly less on breeds that were both smaller in mature weight and had a lower milk yield throughout the preweaning period. Weaning weights were also significantly less as compared with the larger higher milking breeds. However, when weaning weight and mature BW were expressed as an efficiency ratio the more moderate sized breeds were significantly higher, indicating that cows with moderate milk production and mature BW are biologically more efficient.

Breed by environment interaction can also be seen in a study done in the Northern United States (Olson et al., 1982). Four spring calf crops were raised and cows were divided into four groups based on body size for each of the four years this experiment was conducted. Compared with the herd average, small, medium, large and very large cows weaning ratio was -1.5, 3.6, 11.2 and -6.7 weight of calf/cow exposed respectively. Expressed as a ratio to cow metabolic weight, calf weaning weight/cow exposed was 1.63, 1.39, 1.51 and 1.15 respectively. Indicating that, in this particular environment, the small cows were the most efficient of the four groups (Table 2.5). However, this definition of efficiency does not take into consideration an estimation of cow intake, even though level of nutrition was not a limiting factor in this study. In a study conducted in a semi-desert region of New Mexico, cow efficiency was defined as kg of calf BW weaned /kg of organic matter intake by the cow, and found that overall efficiency decreased as cow BW increased (Kattnig et al., 1993). When energy is limited, as in a semi-desert region, cows that have the potential to store fat are more efficient. Lighter cows would be expected to store energy as fat more readily than heavier cows because of a reduction in maintenance requirements. In environments where energy is not limiting, energy-efficient cows may not be the most productive due to excessive fat deposition (Kattnig et al., 1993).

Residual Feed Intake

Residual feed intake (RFI) or net feed intake by animals is an alternative way to measure feed efficiency and was first expressed as a viable option to asses feed efficiency in cattle by Koch (1963). Residual feed intake is the difference in actual feed intake and the expected feed requirements for maintenance of BW and some measure of production (growth or lactation) (Arthur et al. 2001). Use of traditional gain:feed ratios for selection are confounded by variation due to maturity patterns (Lancaster et al. 2009). Selection of progeny by RFI is appropriate due to the fact that it selects for feed efficiency independent of growth and maintenance, RFI also has stronger correlations with feed efficiency later in life which is important when selecting for replacements (Arthur et al. 2001).

Conclusion

Understanding beef cow efficiency is crucial for producers in order for them to make effective management decisions and to increase profitability. If the cow herd can be biologically efficient then the economics of cattle production will be easier for producers to utilize and the increase in profits will sustain beef cattle production in the U.S.

Table 2.1. Effect of cow age class on intake and digestibility (DM basis; Banta et al. 2007)

Item	Cow age class			SEM	*P*-value
	2 yr old	3 yr old	Mature		
No. of cows	6	8	8		
dietary lipid, % of DM	2.9	2.8	2.5		
Hay intake, % of BW/d	1.59	1.62	1.69	0.13	0.68
DMI, % of BW/d	1.9	1.91	1.93	0.14	0.96
Fecal output, % of BW/d	0.89	0.86	0.88	0.07	0.90
DM digestiblity, %	53.0	54.7	54.7	1.23	0.53
NDF Digestibility, %	53.6	56.1	55.4	1.23	0.34
ADF Digestibility, %	50.4	54.6	51.8	1.62	0.14
CP Digestibility, %	64.3	63.4	61.8	2.19	0.63
Crude fat digestibility, %	53.8	52.8	53.7	2.9	0.89
Digestibility DMI, % BW/d	1.01	1.04	1.05	0.08	0.80
OM intake, % of BW/d	1.80	1.80	1.83	0.13	0.95
OM digestibility, %	54.4	56.1	55.9	1.19	0.52
Digestible OM intake, % of BW/d	0.98	1.01	1.02	0.07	0.82

Table 2.2. Number of cows, expenses, live weight production, gross income, net income and relative efficiency for straightbred systems employing S, M, and L, cows within drylot and pasture regimes (Long et. al., 1975).

	Breeding system, Drylot regime			Breeding system, Pasture regime		
Item	S[a]	M[a]	L[a]	S[a]	M[a]	L[a]
Number of Cows	686	587	481	956	782	614
Cumulative per cow expense, $	26754	22893	18759	37284	30498	23946
Nutritional Expense:						
Cows, $	48207	44984	41196	30061	27555	24884
Calves, $	5999	6379	6735	12023	13.79	13512
Replacement heifers, $	9106	8816	8353	6832	6290	5747
Slaughter bulls, $	29247	31641	34494	40783	42173	44047
Slaughter heifers, $	7387	8180	9249	10301	10903	11810
Nutritional sub-total, $	100000	100000	100000	100000	100000	100000
Interest	23880	23132	22098	31564	29511	27010
Total expense, $	150634	146025	140857	168851	160009	150956
Live weight sold:						
Cull Cows, kg	42670	41997	40745	59499	55978	52030
Slaughter bulls, kg	119258	118654	116671	1E+06	158154	148984
Slaughter heifers, kg	45892	45682	44893	63995	60891	57327
Total live weight sold	207820	206333	202309	289789	275023	258341
Contributions to gross income						
Cull cows, $	22530	22174	215513	314416	29556	27472
Slaughter bulls, $	88728	88279	86803	123723	117666	110844
Slaughter heifers, $	34143	33987	33401	47612	45303	42651
Total gross income	145401	144440	141717	202751	192525	180967
Net income or profit,$	-5233	-1585	860	33900	32516	30011
Ruturn on investment, %	5.6	6.6	7.4	14.8	14.9	14.9

[a] S = small size mature cows (430 kg);
M = medium size mature cows (500 kg);
L = large size mature cows (600 kg).

Table 2.3. Breed means for traits of interest for nine breeds (Jenkins and Ferrell, 2002)

Breed	Mature weight, kg[a]	Peak milk yield, kg[b]	Postweaning ADG, kg/d	Fat %[c]
Angus	**553**	**10.2**	**1.3**	**4.00**
Braunvieh	**645**	**15.0**	**1.4**	**2.98**
Charolais	**690**	**10.9**	**1.4**	**2.80**
Gelbvieh	**626**	**11.8**	**1.3**	**2.76**
Hereford	**607**	**9.0**	**1.3**	**4.00**
Limousin	**590**	**9.7**	**1.3**	**2.65**
Pinzgauer	**629**	**10.9**	**1.3**	**3.08**
Red Poll	**505**	**11.1**	**1.3**	**3.83**
Simmental	**653**	**13.4**	**1.4**	**2.86**

[a] Weight adjusted to 25.0% empty body fat.

[b] Yield at time peak lactation as measured by weigh-suckle weigh.

[c] Percentage fat 9-10-11 rib section at 450 days of age.

Table 2.4. Breed means for production traits pooled over intake levels and production years[a] (Ferrel and Jenkins, 2002).

Breed	Cow weight, kg	Yearly dry matter intake, kg	Calving rate[b]	Survival[c]	Birth weight, kg	Weaning weight, kg[d]	Efficiency kg/kg*100[e]
Angus	535	4024	0.95(.22)	0.84(.37)	35	168	3.99
Braunvieh	570	4376	0.82(.33)	0.87(.33)	49	198	3.71
Charolais	675	4497	0.73(.45)	0.94(.22)	47	213	3.46
Gelbvieh	583	4455	0.88(.32)	0.87(.34)	44	190	3.76
Hereford	572	4109	0.81(.40)	0.90(.30)	37	162	3.19
Limousin	566	4232	0.87(.33)	0.93(.26)	42	188	3.87
Pinzgauer	535	4133	0.86(.35)	0.94(.24)	47	201	4.18
Red Poll	474	3960	0.96(.19)	1.00(0)	39	194	4.69
Simmental	590	4346	0.81(.39)	0.80(.40)	47	189	3.53

[a] Based on 16 observations/breed/year for 5 years (4 cows/intake levels withing breed).

[b] Per cow exposed.

[c] Per calf born.

[d] Per calf weaned

[e] (Kg of calf weaned per cow exposed per kg of dry matter consumed)*100.

Table 2.5. Least-square means for preweaning traits (Olsonet. al., 1982)

	Cow size						
Trait	**Small**	**Medium**	**Large**	**Very large**	**Mean**	**SD[a]**	**Cow size effect**
No. of calves	**93**	**83**	**95**	**36**	**307**		
Birth weight, kg	**36**	**36.1**	**38**	**35.1**	**36.3**	**4.8**	*******
Calving difficulty score	**1.3**	**1.2**	**1.2**	**1.3**	**1.3**	**0.94**	
SE coefficient[a] X 100	**10.61**	**11.03**	**10.37**	**16.78**	**6.25**		
No. of calves	**90**	**77**	**87**	**31**	**285**		
Weaning weight, kg	**177.4**	**200.9**	**200.7**	**187.7**	**191.7**	**31.4**	*******
Weaning age, d	**202.3**	**211.9**	**207.1**	**203.2**	**206.1**	**21.4**	******
Preweaning ADG, kg	**0.7**	**0.77**	**0.79**	**0.76**	**0.75**	**0.13**	*******
Adjusted 205-d weaning weight, kg	**182.4**	**197.7**	**201.8**	**191.5**	**193.6**	**27.1**	*******

***P*<.01.

****P*<.001.

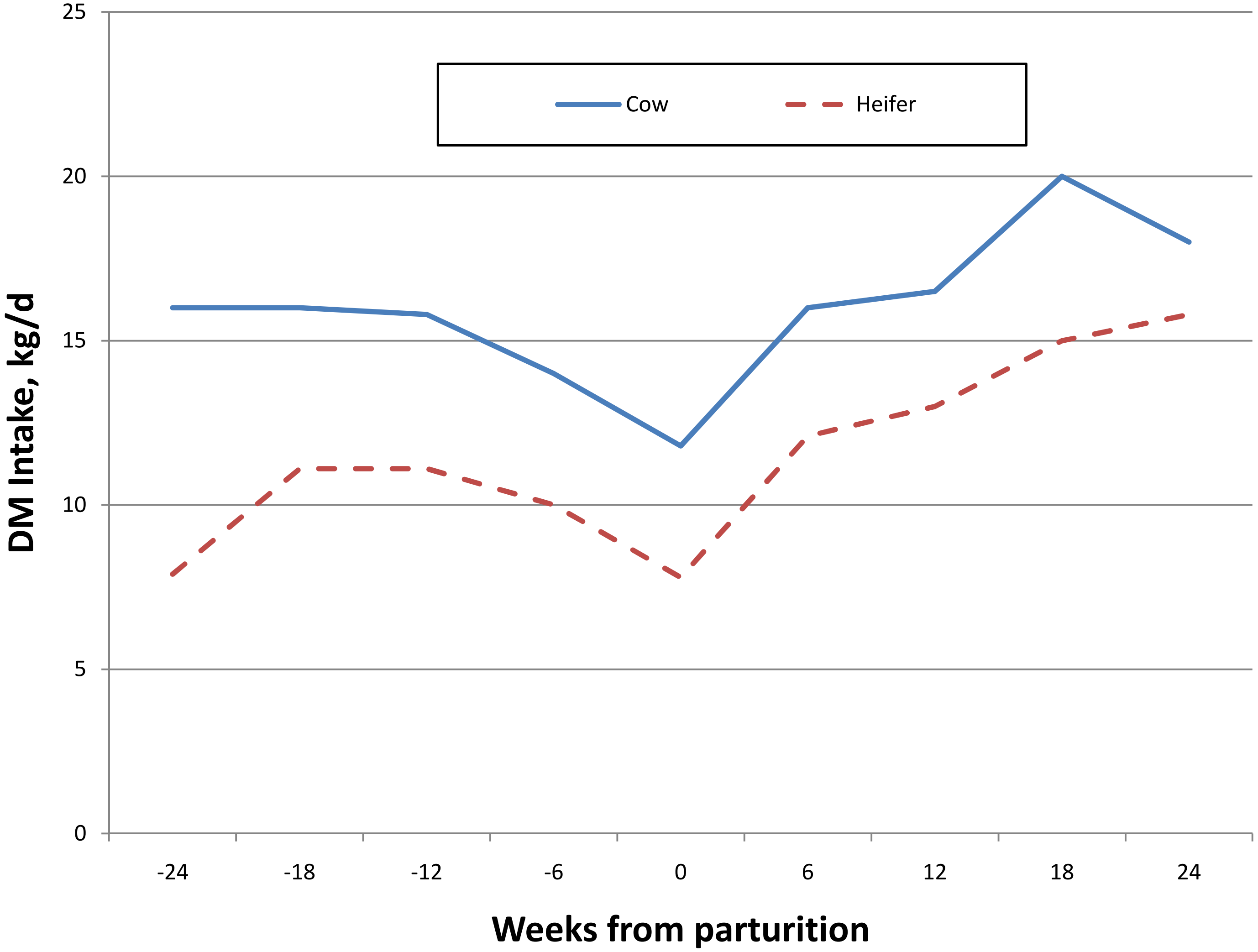

Figure 2.1. The pattern of the transient dip in voluntary DMI around calving in dairy heifers and cows (Ingvartsen and Anderson, 2000)

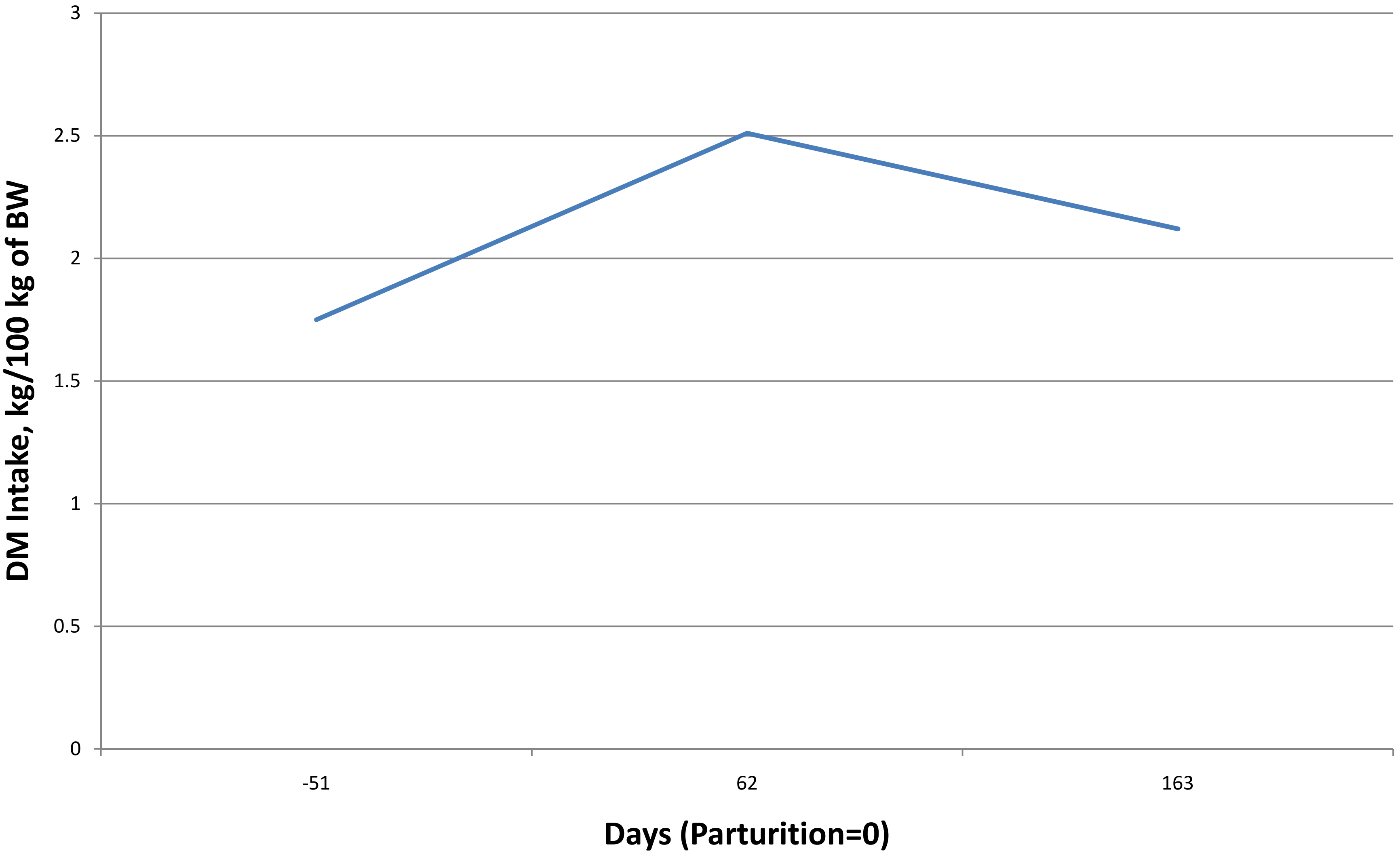

Figure 2.2. Relationship of DM intake to stage of production (Johnson et al., 2003)

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CHAPTER III

EFFECTS OF MATURE SIZE ON INTAKE, CALF WEIGHT AND MILK YIELD IN A SPRING-CALVING COMMERCIAL COW/CALF OPERATION.

G.L. Mourer, C.P. McMurphy, A.J. Sexten, C.D. Dobbs, S.K. Linneen, J.D. Sparks and D.L. Lalman

Department of Animal Science, Oklahoma Agriculture Experiment Station, Stillwater, OK 74078

Abstract: Angus sired spring calving cows (n = 36) were used to evaluate the effect of mature size on forage intake during late gestation (LG; 31 ± 16 d pre calving), early lactation (EL; 38 ± 11 d in milk), and late lactation (LL; 180 ± 11 d in milk). Two blocks of 18 cows each, were selected for heavy and light mature size groups based on their BW at weaning the previous year. Cows were individually fed with ad libitum access to prairie hay and a protein supplement. Cows were adapted to pens and diets for 10 d followed by a 5 d collection period. The mixed procedure of SAS was used with cow size treatment as a fixed effect and block as a random effect. Heavy cows had greater adjusted BW (601 vs. 546 kg; $P < 0.01$), and DMI (8.98 vs. 8.51 kg/d; $P < 0.01$) during LG as compared with light cows. Adjusted BW (565 vs. 512 kg; $P < 0.01$) during EL remained greater for heavy cows compared with light cows, but BCS ($P < 0.01$) was lower for large cows (4.47) than moderate (5.04) and no difference in DMI was observed statistically. During LL cow BW ($P < 0.01$) was greater for large cows (582 kg) than light cows (535 kg) and heavy cows consumed more forage than light cows (11.73 vs. 10.35 kg/d; $P < 0.01$) but no differences were found when DMI was expressed as a percent of mature BW. Cows average calving date was 3/29/2011 and no differences were observed when comparing milk yield between heavy and light cow groups. Efficiency index was calculated (Annual DMI/Adjusted Weaning BW), heavy and light BW treatments were not significantly different. High efficiency cows consumed less forage annually ($P = 0.01$) as compared with low efficiency cows and had 50 kg greater weaning weights ($P = 0.01$). Milk Yield did not differ when comparing high and low efficiency cows. When cow size classifications were determined using kg of BW adjusted to equal age and BCS at weaning, large cows consumed more forage, produced a similar amount of milk, and similar calf weaning weight compared with light cows.

Key Words Mature Cow Weight, Milk Yield, Forage Intake

Introduction

Knowledge of forage intake is important to a commercial cow calf producer for many reasons. It is used so the producer can accurately budget annual forage use and needs. They might use it to determine an appropriate stocking rate so pastures are not over grazed but full grazing potential is still maximized. Also, supplementation of cows may be needed to meet nutritional requirement of the herd and DM intake is needed to establish what that supplementation program may be. Ranch efficiency can also be improved by knowing forage intake of cows and how intake can be reduced but yet still maintain good nutritional status of cow herd.

Using NRC (1996) intake equations, the difference in DM intake can easily be seen when comparing 635 and 544 kg cow. The 635 kg cow consumes 9% more forage daily as compared with the 544 kg cow. Annually, this calculates to 471 kg more for the cow with increased BW.

Mature cow weight has a strong correlation with hot carcass weight of progeny of 0.81 and that hot carcass weight of progeny can be calculated by cow BW * 0.599 (Nephawe et al., 2004). Using this equation the average cow BW in the United States in 1990 was 534 kg in comparison to the average cow BW in 2009 that was 610 kg, a 76 kg increase over the 20 yr period.

Milk production also has impact on intake. A 0.20 kg increase in DM intake is required for every 1 kg increase in milk yield (NRC, 1996). However, Johnson et al.

(2003) found for every 1 kg increase in milk yield a 0.33 kg increase in DM intake was required by Brangus cows.

Over the last 20 years producers have selected for increased milk and growth EPD's. This has likely resulted in cows that require increased nutrients and DM intake. Therefore, the objectives of this study were to determine DMI, milk yield and calf weaning weights of cows varying in mature BW in a commercial cow calf operation, and to establish an efficiency index in which the effects of DMI, milk yield and calf weaning weight can be observed on cows differing in efficiency.

Materials and Methods

Two experiments were conducted at the Range Cow Research Center North Range Unit located approximately 16 km west of Stillwater, Oklahoma to evaluate the effects of mature BW and cow efficiency index on forage DMI, digestibility, weaning weight and milk yield.

Experiment 1

Experiment one was designed to determine if DMI and efficiency differed among cows of light (LBW) and heavy (HBW) BW within the normal variation existing in a commercial cow herd. Cows used in this experiment were selected from a herd of 102 spring-calving commercial Angus cows 7.6 (± 2 yr) of age with a mean calving date of 3/29/2011 (± 40d). Cows were weighed at weaning the fall of 2010 and cows were ranked by BW. The 18 cows with adjusted BW closest to one SD less than the mean were assigned to the LBW treatment group. Similarly, the 18 cows with adjusted BW closest to one SD greater than the mean were assigned to the HBW treatment group. Mean adjusted

BW for HBW and LBW cows were 547 (±35 kg) and 503 (±13 kg), respectively. LBW were in better body condition at 2010 weaning. (*P* = 0.05; Table 3.2).

In February of 2011, 31 (± 16 d) pre calving, cows were assigned to one of two collection periods during late gestation of experiment 1; based on expected calving date and BW treatment. Cow BW and hip height were collected at the beginning of each period. Back fat, rump fat, and rib eye area were determined by ultrasound. Images were taken with an Aloka 500V real-time ultrasound machine (Corometrics Medical Systems, Wallingford, CT) equipped with a 17.2-cm, 3.5-MHz linear transducer. Body condition score (scale 1-9; Wagner et al, 1988) was collected by two independent evaluators and average scores are reported.

In May of 2011 the same 36 multiparous cows were evaluated during late gestation were also used for an early lactation collection, except for two cows that were replaced due to illness. Females were assigned to one of two periods based on their 2011 calving date and based on their BW treatment assignment. Cows averaged 38 (± 11 d) postpartum. Cow BW, hip height, BCS, rib eye, rump fat and back fat were measured the same as late gestation. .

In September of 2011, the same 36 multiparous cows that were used during the late lactation collection of experiment 1, with 4 cows being replaced due to illness. Females averaged 180 (± 14 d) postpartum. During the three collections, prairie hay was provided for ad libitum consumption (Table 3.1), and cows were maintained in individual outdoor 3.7-x9.1-m pens. Supplementation was required and formulated to meet CP, P, Ca and vitamin A requirements. Each 15 d period consisted of 10 d of adaptation to the pens and hay feeders, and 5 d of data collection. Hay intake was measured from d 10 through 15 with hay, orts and supplement sampled at each feeding. Fecal grab samples were collected twice daily at 0800 and 1600 from 10 d through 15 d to predict fecal output from acid detergent insoluble ash concentration. Sub-samples were dried at 100°C for DM determination. Hay, ort, supplement and fecal samples were dried at 50°C and ground in a Wiley Mill (Model-4, Thomas Scientific, Swedesboro, NJ) to pass through a 2 mm screen before analysis. After grinding, hay and supplement samples were composited by period and orts and fecal samples were composited by cow. All composite samples were analyzed for NDF, ADF and acid detergent insoluble ash (Van Soest et al., 1991). Neutral detergent fiber and ADF concentrations were determined using an Ankom Fiber Analyzer (Ankom Technology, Macedon, NY). Acid detergent ash composition was determined as the residue after complete combustion of the ADF residue (Van Soest, et al., 1991). Apparent total tract DM, OM, NDF and ADF digestibilities were calculated for each cow. Additionally, digested DMI (DMI kg/100 kg of BW x DM digestibility) was calculated for each cow. An estimate of daily milk yield was recorded for early and late lactation collections. Milk was collected using a single-cow portable milking machine (Brown et al., 1996). Cows and calves were separated at 1600 h and reunited at 2200 h and allowed to nurse dams ad libitum but < 45 min, with hay and water provided during the entire separation time. Milking of cows started 0700 h the next morning. Ten min prior to milking cows were injected with 1.0 mL of Oxytocin (20 USP units/ml, i.m.; Phoenix Pharmaceutical, Inc., St. Joseph, Mo) to induce milk let-down. Once milk flow ceased from all quarters, the milking apparatus was removed and each quarter was hand stripped to ensure complete empting of each quarter. Milk from the machine and from the hand stripping was combined and weighed immediately after milking. Milk yield was estimated as the net weight of milk adjusted to a 24 h-basis (Brown et al., 1996). After thoroughly mixing, composition was determined by a 50 ml sub-sampling from total milk collection and preserved with 2-bromo-2-nitropropane-1,3-diol and sent for analysis (DHIA Hart of America, Manhattan, Ks) of milk urea N, protein, butterfat, lactose and solids not fat. Milk yield was estimated as the net weight of milk adjusted to a 24 hour basis.

Experiment 2-Analysis of data from Experiment 1

Using the 36 cows selected for experiment 1, an efficiency index (intake / adjusted weaning weight) was calculated and used for allocation to treatment groups in experiment 2. Average DMI of cow by period was multiplied by 120 d then all three periods were summed for an estimated annual intake. The estimated annual intake was then divided by 205 d adjusted weaning weight to calculate the efficiency index for each cow in experiment 1. The mean efficiency index was 16.07 (± 2.27) with a minimum of 12.61 and a maximum of 22.29. Nine cows that were 1 SD or lower, below the mean were selected for high efficiency treatment group (HE) and 9 cows that were 1 SD or greater, above the mean were selected for the low efficiency group (LE); N = 18. High efficiency cows were lower in index number when compared with LE (16.05 vs. 21.87; $P < 0.01$).

Statistical Analysis

Intake, digestibility, milk yield, and weaning weight measurements were analyzed as a complete randomize design using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC) and the Satterwaite approximation for degrees of freedom. The model included mature cow BW class (experiment 1) or cow efficiency index class (experiment 2) as a fixed effect. Collection period and calf age were used in the model as random variables. Calf sex, calf age, and cow age and BCS we added as covariates. When the *P*-value for the F-statistic is ≤ 0.05, least squares means were separated and reported using the LSD procedure of SAS (α = 0.05).

Results and Discussion

Experiment 1

During late gestation HBW cows tended to consume 3.6% more forage than LBW when expressed on an absolute basis (kg/d) (*P* = 0.15; Table 3.3). Forage DMI was similar when expressed relative to BW (kg/100 kg of BW; *P* = 0.24). During early lactation HBW tended (*P* = 0.06) to have higher DMI compared with LBW expressed on an absolute basis (Table 3.3). When DMI was expressed relative to BW a tendency (*P* = 0.07) was found for HBW to consume slightly less than LBW (Table 3.3). Heavy BW cows had increased (*P* =0.01) DMI over LBW during late lactation (Table 3.3).

The increase in DMI from gestation to late lactation found in the current study concurs with Stanely et al. (1993). There was an increase in DMI by animals when measurements were taken 60 d prepartum to 22 d post partum were observed. These researchers also noticed a sharp increase in DMI immediately following parturition with DMI increasing until 22 d with trial termination. This steady increase in DMI after calving can be attributed to lactation energy requirements increasing till peak milk yield which can be 40 - 70d after calving (Totusek et al., 1973; Marston et al., 1992). Marston and Lusby (1995) using Hereford x Angus cows found that cows consumed 1.60 % DM of BW during gestation. However, the cow's intake increased to 2.01 % of BW during lactation; which resulted in a 22.3 % increase in DMI. The current study showed a 26.7% increase in DMI from gestation to early lactation and showed that DMI increases by 0.20 kg/kg milk. The NRC (1996) reports a ratio of 0.20 kg/kg milk while Johnson et al. (2003) reported increased DMI requirements at 0.33 kg/ kg milk. Energy requirements for lactation drive the increase in DMI needed for a cow to sustain BW. The NRC (1996) indicates that NEm requirements are 20% greater for lactating cows as compared with non-lactating cows and DMI can increase 30-50%.

During the late gestation period, DM digestibility was not different (*P* = 0.40) among BW treatment groups and remained similar in early lactation with no differences (*P* = 0.79) in digestibility. Forage digestibility tended (*P* = 0.08) to be 5.6% greater for HBW than LBW while in late lactation.

Body condition score was not statistically different between late gestation and lactation, but BCS was less (*P* = 0.03) in HBW (4.47) as compared with LBW (5.04) during early lactation, but no differences were observed when ultrasound was used to establish rump fat, rib fat and rib eye between treatments (Table 3.2). Milk production and composition was not different among HBW and LBW groups during early or late lactation (Table 3.4). Differences in calf BW at birth were not different (Table 3.2) and weaning BW of calves were similar among BW treatments (Table 3.2).

This similarity in calf weaning BW concurs with work by Olson et al. (1982) where differences in cow BW did not influence calf weaning BW and pre-weaning ADG.

Olson et al. (1982) also found no differences in feedlot performance or carcass characteristics when calves were finished to a common age of 440 d.

Cows with HBW consumed more DM annually than the LBW treatment group (Table 3.3; *P* = 0.01). When an efficiency index was calculated for BW treatment groups, efficiencies were similar. Limited research has been conducted comparing animals of similar breed but several studies have been conducted comparing different breeds with different milk production potentials. Filho et al. (1983) used total TDN intake during lactation to calculate efficiency = (TDN / calf weaning BW) of Angus and Brown Swiss. They observed the larger BW, higher milking Brown Swiss were lower in efficiency at 12.55 compared with Angus cows which had lower weaning BW but offset that lower weaning BW with lower total TDN intake resulting in efficiency index of 7.66.

Research containing efficiencies of cows of similar breed type is limited in comparison with the current study, due to many publications using separate breed types in efficiency comparisons. Ferrell and Jenkins (1994) using data pooled over different energy intakes and a 5 year period found that Angus bred cows weighing 535 kg consumed on average 4,021 kg annually. Annual intake of Charolais cows (675 kg) was 4,494 kg. These researchers calculated efficiency by dividing grams of calf weaned by DMI. The Angus cows estimated efficiency was 40 g/kg DMI while the efficiency index for the Charolais cows was 32 g/kg DMI.

<u>Experiment 2</u> – Analysis of data from Experiment 1

Cows were assigned to treatment groups as previously described. Body weight was similar among HE and LE cow groups during gestation, early lactation and late lactation.

When milk production was expressed relative to BW, HE had a tendency to have increased milk production (*P* = 0.14) over LE, and HE calves tended to be older than LE (43 vs. 33d, *P* = 0.06) in early lactation. Milk composition did not differ during early or late lactation (Table 3.7). Even though no calf birth weight differences were established between HE and LE, HE calves at the early lactation collection period were 29% heavier when compared with LE calf weights (*P* = 0.01). High efficiency cows weaned 19.8% more calf BW than LE (*P* < 0.01).

Rib eye area tended to be different (*P* = 0.09) between HE and LE during late gestation (Table 3.5). Body condition score, rump fat and rib fat measurements did not differ when HE and LE were compared during the late gestation collection period. Twelfth rib back fat tended (P = 0.09) to be greater for LE than for HE in late lactation (0.32 vs. 0.19 cm; Table 3.5). DiCostanzo et al. (1990) found that cows with increased protein mass also had an increase in NEm requirement. Energy requirement to maintain 1 kg of protein is greater than that of fat requiring 192.9 and 20.7 kcal respectively. Therefore, HE cows are lighter muscled through the rib eye and require less ME, lowering DMI and partially contributing to increased cow efficiency.

DMI of LE was 8.7% greater than HE (*P* = 0.01; Table 3.6) during late gestation. When DMI was expressed relative to BW no difference (*P* = 0.09) was seen. The HE cows consumed less forage DM than LE (9.94 vs.11.64 kg; *P* = 0.02) during late lactation (Table 3.6). Annually, HE intake was 3997 kg and LE consumed 4354 kg (*P* = 0.01).

In a study by Herd et al. (1998), researchers established low and high efficiency heifers by obtaining post weaning feed efficiency data in heifers and retaining those heifers in the cow herd. Twenty low efficiency and 20 high efficiency heifers were selected for trial by this post weaning measurement. Low efficiency heifers were smaller but consumed similar amounts of DMI (kg / d) and calves had similar weaning weights. When DMI and weaning BW were used in an efficiency index, high efficiency heifers tended to be more efficient than low efficiency heifers. More efficient heifers post weaning, also were more efficient as cows when efficiency was expressed as a ratio to DMI.

A regression of weaning weight ratio (individual weaning weight / contemporary group average) over annual forage DMI is formulated in figure 3.1. DMI has no significance on weaning weight ratio (*P* = 0.38). This study indicated a relationship when DMI (kg/d) was regressed over milk yield (kg/d) (*P* = 0.01; Figure 3.2); required increase of 0.21 kg of DMI for 1 kg increase in milk yield; which concurs with NRC (1996). Milk yield (kg/d), effects weaning weight ratio (*P* < 0.04) and explains 23% of the variation of weaning weight ratio (Figure 3.3). However, weaning weight ratio has significant influence (*P* = 0.01) on the efficiency index of the cow herd explaining 73% of the variation (Figure 3.4). This is due to the fact that weaning weight is used in the calculation of the efficiency index.

Implications

Cow size did not influence weaning weight in this herd. Heavy BW cows consumed 6% more forage DM annually than LBW and may be more appealing to producers. However, when annual DMI and weaning weight are used in an efficiency index, HBW and LBW had similar efficiency index numbers. This may be due to the minimal number of cows used in the experiment and variation in calf weaning weight.

Efficient cows were not different in mature BW, BCS or hip height, however cows weaned 50 kg more calf and consumed 350 kg less forage DM annually. This results in one animal unit month per year savings in forage DM for cattle producers. Selection of cattle with an increased efficiency index may also be possible by selecting replacements to the herd with increased weaning weight ratio due to their strong correlation. This would increase calf weaning weights while not affecting DMI. This would aid in overall increases of efficiency to commercial cow/calf operations in the Southern Great Plains. More research is needed for calculation of residual feed intake (RFI) on sample cows to further determine efficiency differences among cows with similar breed type.

This study was unique due to the fact that research was conducted within a cow herd managed as a contemporary group of similar breed type. Other published research is limited and data of those publications have been analyzed between breeds of different size, milk production potential and maintenance energy requirements.

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Table 3.1. Chemical composition of hay 2010 and 2011 (DM Basis)

	Hay	
Item	2010	2011
CP. %	6.10	4.80
NDF, %	71.70	71.40
ADF, %	42.00	43.70
ADIA,%	3.00	4.20
TDN, %	55.00	55.00

Table 3.2. Descriptive variables for females used in experiment 1.

	LBW[c]	HBW[c]	SEM	*P*-value
Weaning 2010				
n	18	18		
Weight, kg	470	540	15	0.01
BCS	5.5	4.9	0.31	0.05
Age, yr	7.2	7.9	0.6	0.23
Late Gestation, 2011				
n	18	18		
Weight, kg	554	606	11.4	< 0.01
BCS	5.14	4.84	0.24	0.28
Rump Fat, cm	0.35	0.46	0.07	0.20
Rib Fat, cm	0.28	0.29	0.02	0.89
Rib eye, cm^2	54.2	59.4	2.04	0.08
Early Lactation, 2011				
n	18	18		
Weight, kg	508	569	8.67	< 0.01
BCS	5.04	4.47	0.18	0.03
Rump Fat, cm	0.23	0.39	0.05	0.06
Rib Fat, cm	0.23	0.27	0.03	0.35
Rib eye, cm^2	47	54	2.6	< 0.01
Calf Birth Weight, kg	41	42	0.7	0.34
Late Lactation, 2011				
n	18	18		
Weight, kg	510	560	12	< 0.01
BCS	4.51	4.40	0.23	0.75
Rump Fat, cm	0.29	0.37	0.06	0.32
Rib Fat, cm	0.23	0.28	0.04	0.41
Rib Eye, cm^2	54.0	57.4	3.31	0.19
Calf Weaning Weight, kg[a]	201	209	7	0.44
Annual Intake				
Annual DMI, kg	4113	4380	75	0.01
Efficiency Index[b]	18	19	0.65	0.70

[a] 205 d adjusted weaning weight

[b] Annual intake / 205 d adjusted weaning weight

[c] LBW = light BW group; HBW = heavy BW group

Table 3.3 Forage intake and digestibility experiment 1.

	LBW[a]	HBW[a]	SEM	*P* - Value
Late Gestation, 2011				
Forage DMI, kg/d	9.89	10.26	0.16	0.15
Forage DMI, kg/100kg BW	1.79	1.72	0.04	0.24
Total Digestible DMI, kg/d	5.47	5.51	0.18	0.87
Total Digestible DMI, kg/100 kg BW	1.0	0.91	0.03	0.05
DM Digestibility, %	65	64	1.0	0.40
NDF Digestibility, %	70	69	1.1	0.60
ADF Digestibility, %	66	65	2.9	0.41
Early Lactation, 2011				
Forage DMI, kg/d	12.5	13.3	0.41	0.06
Forage DMI, kg/100kg BW	2.49	2.35	0.07	0.07
Total Digestible DMI, kg/d	6.35	6.75	0.22	0.12
Total Digestible DMI, kg/100 kg BW	1.25	1.19	0.04	0.32
DM Digestibility, %	63	62	5.3	0.79
NDF Digestibility, %	65	65	3.9	0.92
ADF Digestibility, %	59	59	4.9	0.91
Late Lactation, 2011				
Forage DMI, kg/d	11.5	13.1	0.61	0.01
Forage DMI, kg/100kg BW	2.17	2.23	0.09	0.40
Total Digestible DMI, kg/d	4.39	5.59	0.39	0.01
Total Digestible DMI, kg/100 kg BW	0.82	0.96	0.07	0.01
DM Digestibility, %	57	61	1.1	0.08
NDF Digestibility, %	57	61	4.0	0.06
ADF Digestibility, %	54	59	4.4	0.03

[a] LBW = light BW group; HBW = heavy BW group

Table 3.4 Milk yield and composition Experiment 1.

	LBW[a]	HBW[a]	SEM	*P* - Value
Early Lactation, 2011				
Milk Yield, kg	7.78	8.46	1.08	0.48
Milk Yield, kg/100kg BW	1.57	1.47	0.23	0.60
Somatic Cell Count (1000)	124	166	56	0.58
Milk Urea N, mg/dL	2.26	2.08	0.44	0.76
Milk Protein, %	2.82	2.74	0.6	0.38
Fat, %	3.76	3.5	0.26	0.46
Lactose, %	4.93	4.98	0.06	0.59
Solids Not Fat, %	8.7	8.68	0.07	0.83
Late Lactation, 2011				
Milk Yield, kg	4.05	3.96	0.25	0.81
Milk Yield, kg/100kg Bw	0.79	0.63	0.08	0.34
Somatic Cell Count (1000)	272	286	79	0.89
Milk Urea N, mg/dL	1.24	1.3	0.19	0.85
Milk Protein, %	3.43	3.39	0.09	0.78
Fat, %	4.08	3.94	0.22	0.65
Lactose, %	4.94	4.86	0.45	0.19
Solids Not Fat, %	9.34	9.21	0.12	0.42

[a] LBW = light BW group; HBW = heavy BW group

Table 3.5. Descriptive variables experiment 2.

	LE[c]	HE[c]	SEM	*P*-value
Late Gestation, 2011				
n	9	9		
Wt, kg	597	585	12	0.52
BCS	5.15	5.19	0.19	0.93
Rump Fat, cm	0.52	0.39	0.12	0.47
Rib Fat, cm	0.32	0.29	0.05	0.53
Rib eye, cm^2	63	55	3.3	0.09
Early Lactation, 2011				
n	9	9		
Weight, kg	564	547	14	0.39
BCS	5.00	4.75	0.22	0.60
Rump Fat, cm	0.47	0.28	0.13	0.32
Rib Fat, cm	0.29	0.24	0.04	0.52
Rib eye, cm^2	58	48	2.9	0.19
Calf Birth Weight, kg	41	43	0.9	0.52
Calf Weight, kg	65	91	7.5	0.03
Late Lactation, 2011				
n	9	9		
Wt, kg	562	535	13	0.18
BCS	4.51	4.62	0.31	0.87
Rump Fat, cm	0.50	0.25	0.12	0.17
Rib Fat, cm	0.32	0.19	0.05	0.09
Rib eye, cm^2	60	53	3.4	0.18
Weaning Weight, kg[a]	178	222	9	< 0.01
Annual Intake				
Annual DMI, kg / yr	4354	3997	86	0.01
Efficiency Index[b]	22	16	0.5	< 0.01

[a] 205 d adjusted weaning weight

[b] Annual intake / 205 d Adjusted weaning weight)

[c] LE = low efficiency group; HE = high efficiency group

Table 3.6 Forage intake and digestibility experiment 2.

	LE[a]	HE[b]	SEM	*P* - Value
Late Gestation, 2011				
Forage DMI, kg/d	9.04	8.25	0.14	0.01
Forage DMI, kg/100kg BW	1.77	1.63	0.06	0.09
Total Digestible DMI, kg/d	4.8	4.36	0.18	0.1
Total Digestible DMI, kg/100 kg BW	0.8	0.76	0.03	0.48
DM Digestibility, %	63	63	1.7	0.75
NDF Digestibility, %	65	63	1.9	0.42
ADF Digestibility, %	61	59	2.3	0.61
Early Lactation, 2011				
Forage DMI, kg/d	12	11	0.3	0.22
Forage DMI, kg/100kg BW	2.42	2.35	0.10	0.65
Total Digestible DMI, kg/d	5.71	5.13	0.35	0.26
Total Digestible DMI, kg/100 kg BW	1.00	0.98	0.07	0.8
DM Digestibility, %	54	58	1.9	0.17
NDF Digestibility, %	59	58	1.8	0.49
ADF Digestibility, %	51	53	1.9	0.63
Late Lactation, 2011				
Forage DMI, kg/d	11	9	0.5	0.02
Forage DMI, kg/100kg BW	2.30	2.06	0.07	0.06
Total Digestible DMI, kg/d	4.85	4.73	0.37	0.82
Total Digestible DMI, kg/100 kg BW	0.85	0.88	0.06	0.73
DM Digestibility, %	56	59	2.3	0.36
NDF Digestibility, %	56	56	2.1	0.55
ADF Digestibility, %	52	56	2.4	0.27

[a] LE = low efficiency group; HE = high efficiency group

Table 3.7 Milk production and composition experiment 2.

	LE	HE	SEM	*P* - Value
Early Lactation, 2011				
Milk Yield, kg	8.10	8.73	0.75	0.58
Milk Yield, kg/100kg Bw	1.40	1.60	0.00	0.14
Somatic Cell Count (1000)	90	296	70	0.07
Milk Urea N, mg/dL	1.48	2.73	0.40	0.04
Milk Protein, %	2.84	2.98	0.07	0.20
Fat, %	3.91	3.60	0.29	0.47
Lactose, %	4.85	4.93	0.08	0.53
Solids Not Fat, %	8.62	8.86	0.11	0.17
Late Lactation, 2011				
Milk Yield, kg	3.49	3.98	0.29	0.34
Milk Yield, kg/100kg Bw	0.69	0.73	0.00	0.63
Somatic Cell Count (1000)	252	247	102	0.97
Milk Urea N, mg/dL	1.16	1.17	0.16	0.95
Milk Protein, %	3.47	3.33	0.10	0.36
Fat, %	4.20	3.58	0.29	0.14
Lactose, %	4.99	4.87	0.06	0.19
Solids Not Fat, %	9.44	9.16	0.13	0.17

[a] LE = low efficiency group; HE = high efficiency group

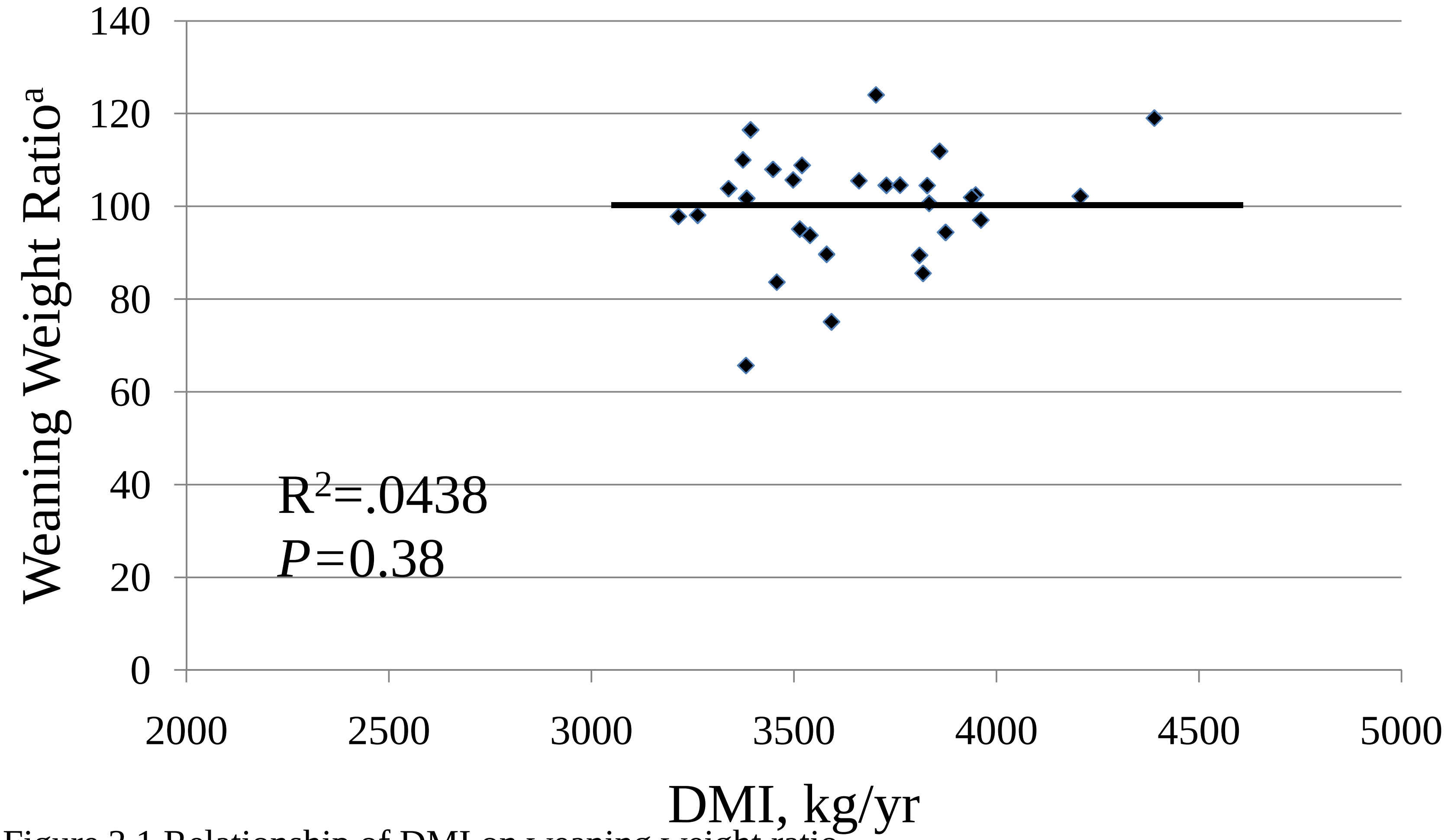

Figure 3.1 Relationship of DMI on weaning weight ratio.

[a] (Indivigual weaning weight / contemerary group average weaning weight)*100

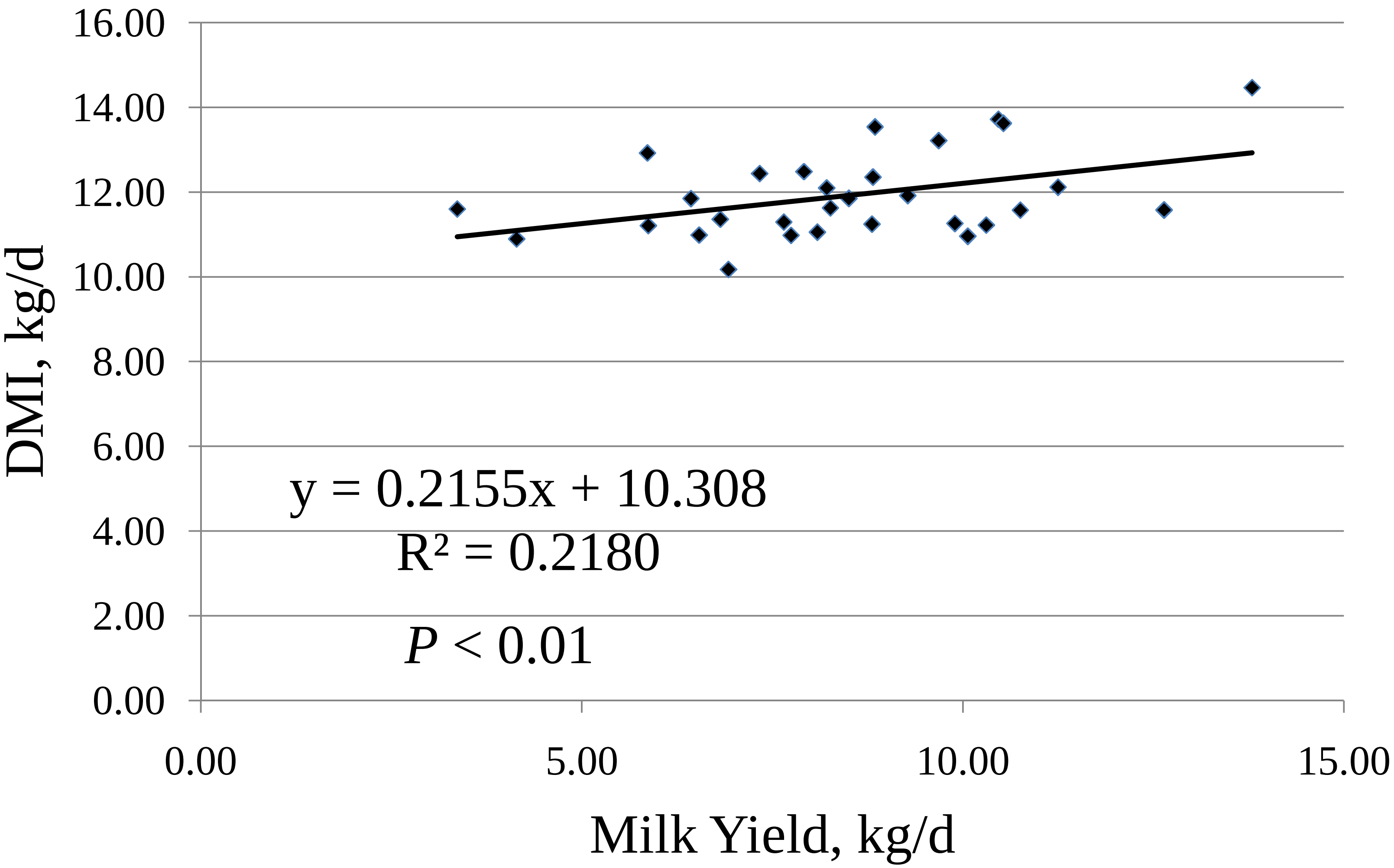

Figure 3.2 Relationship of DMI on milk yield

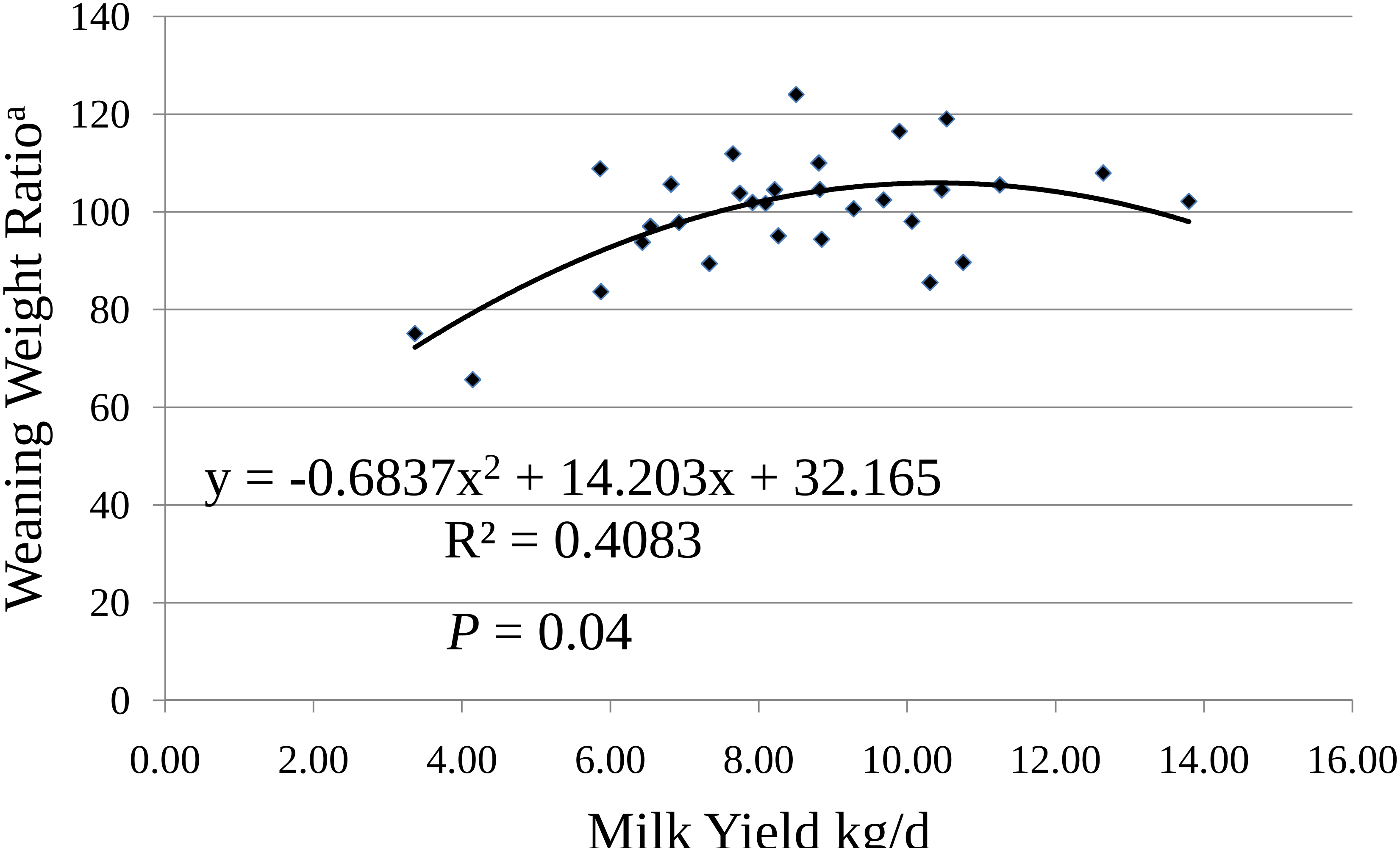

Figure 3.3 Relationship of milk yield on efficiency ratio

[a] (individual weaning weight / contemporary group average weaning weight)*100

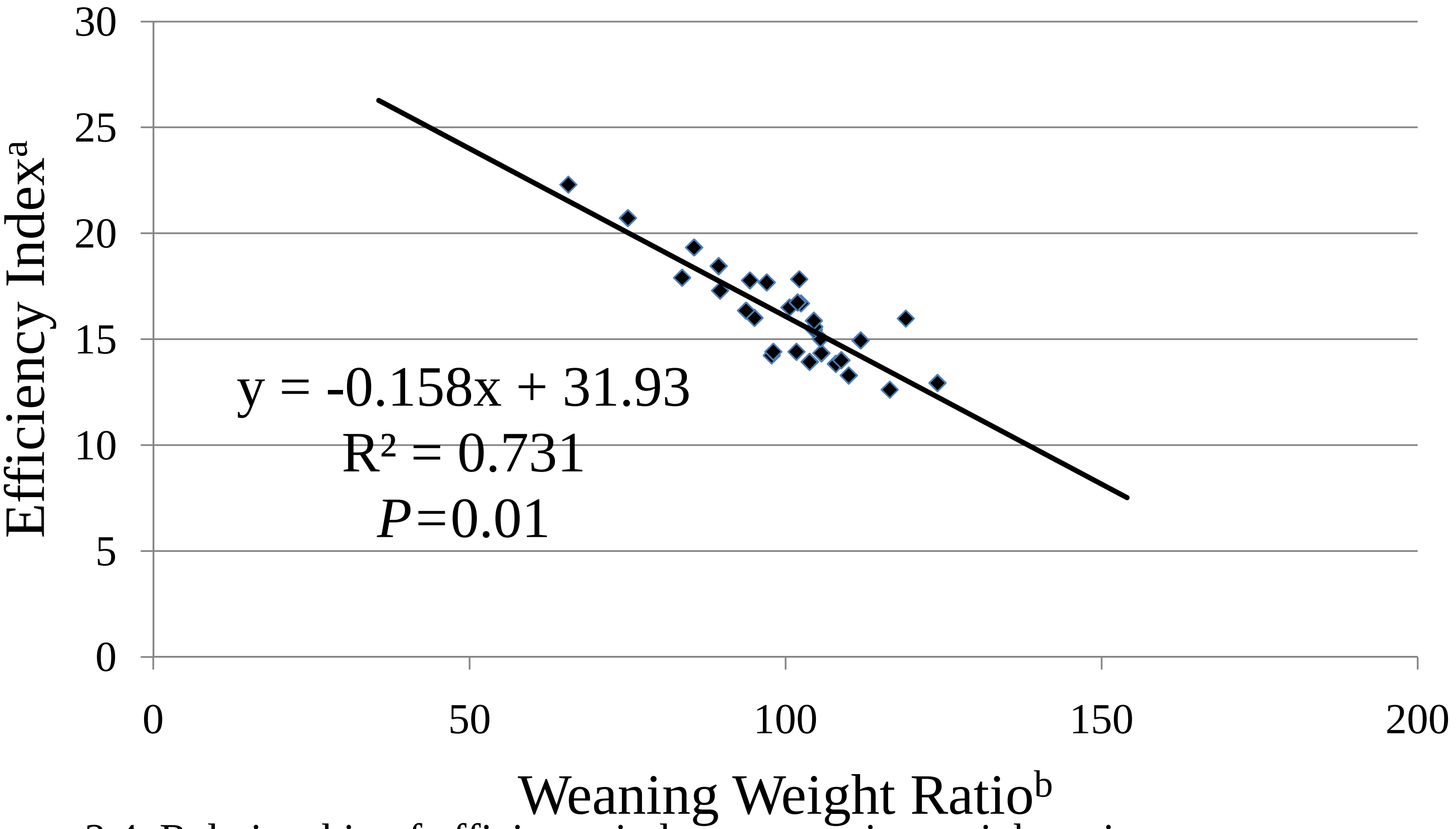

Figure 3.4. Relationship of efficiency index on weaning weight ratio.

[a] adjusted weaning weight, kg / DMI, kg

VITA

Gant Larry Mourer

Candidate for the Degree of

Master of Science

Thesis: EFFECTS OF MATURE SIZE ON INTAKE, CALF WEIGHT AND MILK YIELD IN A SPRING-CALVING COMMERCIAL COW/CALF OPERATION.

Major Field: Animal Science

Biographical:

Personal Data: Born in Enid, Oklahoma, on November 12, 1981, the son of Larry and Renee’ Mourer.

Education: Graduated from Chisholm High School, in Enid, Oklahoma in may 2000; received Bachelor of Science in Animal Science from Oklahoma State University, Stillwater, Ok in 2006; and completed requirements for Master of Science from Oklahoma State University in April of 2012.

Experience: Herdsman, Range Cow Research Center North Range Unit, Oklahoma State University, Stillwater, OK; Assistant Herdsman, Range Cow Research Center North Range Unit, Oklahoma State University, Stillwater, OK; Bunk Reader, TLC Cattle Feeders, Hennessey, OK; Bull Manager, Pied Piper Farms, Hamlin, TX.

Professional Memberships: American Society of Animal Science, Alpha Gamma Rho.

Name: Gant Larry Mourer Date of Degree: Summer, 2012

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: EFFECTS OF MATURE COW SIZE ON INTAKE, CALF WEIGHT, AND MILK YIELD IN A SPRING-CALVING COMMERCIAL COW/CALF OPERATION

Pages in Study: 55 Candidate for the Degree of Master of Science

Major Field: Animal Science

Scope and Methods:

Two experiments were conducted to evaluate the effects of mature BW and cow efficiency on DMI, milk yield, and calf weaning BW on spring calving Angus sired commercial cows. Cows one SD above and one SD below the mean were selected to high (HBW) and low (LBW) BW treatment groups, respectively. Cows were individually fed ad libitum low quality prairie hay. Cows were adapted to pens and diets for 5 days followed by a 5 day collection period.

Findings and Conclusions:

Dry matter intake tended to be higher ($P = 0.15$) at 10.26 kg/d for HBW cows compared with LBW 9.86 kg/d during late gestation. Intakes only tended to be different ($P = 0.06$) during early lactation between HBW and LBW, consuming 13.33 and 12.54 kg/d, respectively. Heavy cows consumed more than LBW during late lactation (11.49 vs. 10.26; $P = 0.01$). No difference in calf weaning BW was found. Annual DMI was 267 kg lower ($P = 0.01$) for LBW as compared with HBW. Efficiency index was calculated by annual intake divided by adjusted calf weaning BW. No difference was seen in efficiency index between HBW and LBW. Using the efficiency index, 9 cows from experiment 1 were selected; one SD above the mean for low efficiency (LE) treatment group and 9 cows one SD below the mean for a high efficiency (HE) cow treatment group. High efficiency cows had lower DMI than low efficiency cows (8.25 vs. 9.04 kg/d; $P = 0.01$) during late gestation. During late lactation, HE cows consumed 14.6 % less forage ($P = 0.02$) than LE. Dry matter intake was 3997 kg/yr for HE as compared with LE cows at 4354 kg/ yr ($P = 0.01$). Weaning BW was higher ($P < 0.01$) for HE than LE (222 vs. 178 kg). Heavy BW cows consumed more forage and weaned the same size calf as LBW, while at the same time having similar efficiency index numbers. High efficiency cows consume less forage and wean more calf.

ADVISER’S APPROVAL: Dr. David L. Lalman