STUDIES ON THE NUTRIENT REQUIREMENTS OF KOREAN NATIVE CATTLE

I. EFFECT OF ENERGY LEVELS ON PERFORMANCE AND ENERGY INTAKE OF GROWING AND FINISHING KOREAN NATIVE CATTLE

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Summary

Growing and finishing Korean native bulls were used to investigate the effects of different dietary energy levels on performance and energy intake. Experimental observations were made over three weight categories (200 to 250 kg, 250 to 350 kg and 350 to 450 kg). Three diets (2.4, 2.6 and 2.8 Mcal ME/kg DM) were used for each weight category. Crude protein levels of the diets were 12, 11 and 10 % for the respective weight groups.

Dietary energy level did not significantly affect daily body gain within a weight range but daily body gain during the entire experiment was higher ($P < .05$) in bulls receiving 2.6 Mcal energy diet than in those fed 2.4 and 2.8 Mcal energy diets. The following equation was developed to predict daily body gain(Y) from energy levels(X) of ration.

$$Y = 13.475X - 2.5949X^2 - 16.355$$

Increasing energy levels significantly ($P < .05$) decreased daily feed intake. The following equation was developed to predict daily feed intake(Y) from energy levels(X) of ration.

$$Y = -30.013X + 5.4401X^2 + 49.119$$

Feed intake per metabolic body size during the entire feeding period ranged from 100.9 to 110.8 g and was lower in bulls fed 2.6 and 2.8 Mcal energy diets than in those fed 2.4 Mcal energy diet. Increasing energy levels significantly ($P < .05$) improved feed efficiency. The following equation was developed to predict feed efficiency (Y) from energy levels(X) of ration.

$$Y = -118.34X + 22.448X^2 + 162.85$$

Daily energy intake during the entire experiment ranged from 18.90 to 19.99 Mcal and there was no significant difference among energy levels. Daily energy intake per metabolic body size during the feeding period ranged from 248.6 to 260.8 kcal and was slightly higher in bulls receiving 2.8 Mcal than in those fed 2.4 and 2.6 Mcal energy diets. Energy required per kg body gain ranged from 17.25 to 19.11 Mcal and was slightly lower in bulls receiving 2.6 Mcal energy diet than in those fed 2.4 and 2.8 Mcal energy diets.

(**Key words:** Korean Native Cattle, Energy Level, Body Gain, Feed Intake, Feed Efficiency, Energy Intake)

Introduction

Korean native cattle have been raised as a draft animal for farming and transportation for several thousand years. However, in recent years, their value as a draft animal has been decreased due to mechanization of farming while their value for beef has been increased.

The number of Korean cattle was estimated as 2.37 million heads in 1986. However, there is no feeding standard on the nutrient requirements suitable for the feed situation in Korea and available for Korean cattle. So, Korean cattle have been raised mainly on the standards adopted from NRC(1984), ARC(1980) or Japan(1975).

It is essential to offer a diet balanced in all nutrients in order to maximize the ability of cattle to grow. Supplying energy and protein in proper amounts is especially important. Meyer et al.

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(1965) and Kappel et al. (1972) reported that when steers were offered diets with different levels of energy, body gain, feed intake and feed efficiency were decreased as the energy levels decreased. Prior et al. (1977) reported that increasing energy intake increased average daily gain and improved feed efficiency. Ferrell et al.(1978) also reported that dietary energy densities significantly influenced final live weight and feed intake. Kim et al.(1974) reported that when Korean bulls were fed diets containing 55 to 70 % of TDN, daily body gain was significantly affected by the energy levels. Song et al.(1974) reported that when Korean bulls were offered diets containing three levels(64, 71, 78 %) of TDN, bulls fed 71 % TDN diet gained more body weight and consumed less feed intake than other diets. However, Barber et al. (1981) reported that an increase in dietary energy did not result in greater body gain.

The objectives of this experiment were to investigate the effects of energy levels on performance and energy intake of Korean bulls.

Materials and Methods

Twelve Korean bulls (avg. weight of 170 kg) were randomly assigned to one of three treatments. Three treatments were 2.4, 2.6 and 2.8 Mcal ME/kg DM. Experimental observations were made over three weight categories such as category 1(200 to 250 kg of body weight), category 2(250 to 350 kg of body weight) and category 3(350 to 450 kg of body weight).

Bulls were fed three energy diets (2.4, 2.6 and 2.8 Mcal ME/kg DM) and crude protein levels of the diets was 12, 11 and 10 % for the weight categories 1, 2 and 3, respectively. Four bulls were assigned to each treatment and four replications were included for all treatments. Concentrate mixtures were formulated by energy levels as shown in table 1; rice straw cut by 3 to 5cm long was used as a roughage. The content of crude protein, crude fiber, NFE and ash of rice straw was 4.50, 28.0, 30.0 and 15.1%, respectively and ME content was 1.36 Mcal/kg. All bulls were fed ad libitum and separately concentrates and roughage throughout the whole experiment. All bulls were individually housed. Before starting the feeding trial, a vermicide(Valbazen-B) was given to all bulls. Drinking water was available at all times.

Bulls were weighed and feed intakes were recorded every two weeks. Data were analyzed

TABLE 1. COMPOSITION OF CONCENTRATES[1] (%)

Ingredients	Category 1			Category 2			Category 3		
	T1	T2	T3	T1	T2	T3	T1	T2	T3
Yellow corn	44.00	64.00	81.00	60.00	70.00	78.00	60.00	67.00	70.00
Wheat bran	40.00	29.00	6.50	20.00	25.00	12.00	20.33	27.00	21.50
Rice bran	14.00	–	–	18.00	–	–	17.50	2.30	–
Soybean oil meal	–	5.00	9.00	–	3.00	6.00	–	1.50	3.80
Oyster shell meal	1.50	1.50	1.50	1.50	1.50	1.50	1.60	1.60	1.55
Tallow	–	–	1.50	–	–	2.00	–	–	2.55
Salt	0.40	0.40	0.40	0.40	0.40	0.40	0.50	0.50	0.50
Mineral[2]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Vitamin[3]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Chemical Composition									
C.P. (%)	12.09	12.08	12.05	11.22	11.22	11.24	10.11	10.11	10.11
ME(Mcal/kg)	2.44	2.63	2.82	2.49	2.65	2.81	2.48	2.61	2.80
Ca (%)	0.49	0.48	0.47	0.48	0.47	0.47	0.47	0.47	0.47
P (%)	0.68	0.47	0.40	0.81	0.42	0.37	0.82	0.45	0.34

[1]T1; 2.4 Mcal, T2; 2.6 Mcal, T3; 2.8 Mcal.
[2]Mineral supplement(mg/kg); $MnSO_4$(Mn), 40,000; $FeSO_4$(Fe), 50,000; $CuSO_4$(Cu), 10,000; $ZnSO_4$(Zn), 60,000; KI(I), 1,000; Se, 100; $CoSO_4$(Co), 100.
[3]Vitamin mixture (IU/g); Vit. A, 5,000,000; Vit. D3, 1,000,000; Vit. E, 1,000.

according to the procedure described by Steel and Torrie(1960) for analysis of variance and least significant difference test of data.

Results and Discussion

Energy effects on body gain

Daily body gain is presented in table 2. When Korean bulls were fed diets with three energy levels, daily body gain within weight groups was highest for bulls receiving 2.6 Mcal ME diet although these differences among the different dietary energy levels were not significant. Daily body gain throughout the entire experiment was 1.04, 1.14 and 1.03 kg for the 2.4, 2.6 and 2.8 Mcal ME diets, respectively and was significantly ($P < .05$) influenced by energy level of the ration. Bulls fed 2.6 Mcal ME diet had a higher body gain than bulls fed other diets. The following equation was developed to predict daily body gain (Y) from energy levels (X) of ration.

$$Y = 13.475\ X - 2.5949\ X^2 - 16.355$$

The regression line of energy level(X) of ration against daily body gain(Y) of Korean native cattle is presented in figure 1. Expected daily body gain of bulls can be calculated using this equation when ME content of ration is known.

These findings are in agreement with the results of Song et al. (1974) who reported that daily body gain was greater in bulls fed 2.6 and 2.8 Mcal ME diets than in bulls fed 2.4 Mcal ME diet, and of Jung et al. (1984) who reported that growing male Korean native cattle weighing about 200 kg require 2.50 to 2.60 Mcal ME/kg of DM to reach 500 to 550 kg body weight within 10 months.

TABLE 2. INFLUENCE OF DIFFERENT ENERGY LEVELS ON BODY GAIN OF THE GROWING AND FINISHING BULLS (KG)

Items	Energy levels (ME, Mcal/kg)			SE[1]
	2.40	2.60	2.80	
		Category 1 (200-250 kg)		
Initial body wt.	203.20	196.00	201.80	
Final body wt.	248.50	243.70	251.60	
Mean body wt.$^{0.75}$	58.30	57.10	58.40	
Total body gain	45.30	47.70	49.80	1.12
Daily body gain	1.03	1.33	1.13	0.07
		Category 2 (250-350 kg)		
Initial body wt.	248.50	243.70	251.60	
Final body wt.	341.00	345.30	344.80	
Mean body wt.$^{0.75}$	71.10	71.10	71.80	
Total body gain	92.50	102.30	93.30	2.03
Daily body gain	1.24	1.36	1.24	0.02
		Category 3 (350-450 kg)		
Initial body wt.	341.00	345.30	344.80	
Final body wt.	441.00	453.00	449.30	
Mean body wt.$^{0.75}$	87.90	89.30	89.00	
Total body gain	100.00	99.80	105.00	2.38
Daily body gain	0.91	0.99	0.96	0.02
		Entire experiment (200-450 kg)		
Mean body wt.$^{0.75}$	76.00	76.50	76.60	
Overall body gain	237.80	257.00	245.00	3.94
Daily body gain	1.04^{b}	1.14^{a}	1.03^{b}	0.01

[1]Standard error of mean.

^{a,b}Means in the same row with different superscripts are significantly different ($P < .05$).

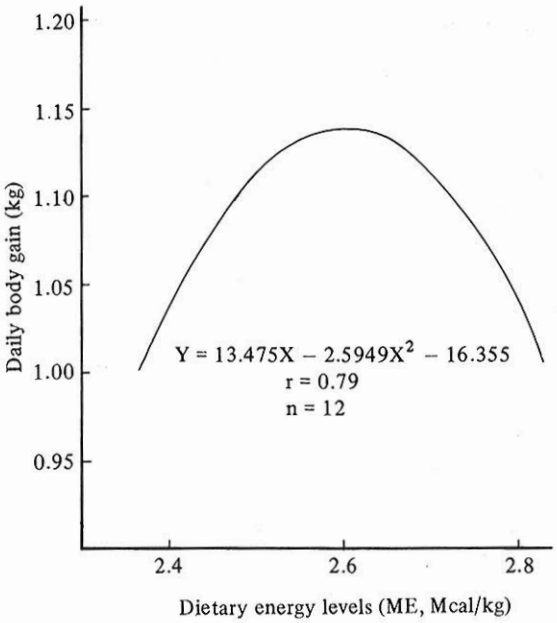

Figure 1. Relationship between energy levels and daily body gain during the entire feeding period.

However, these findings are different from the results of Shul (1962), Kim (1976), Kim (1978) and Ferrell et al. (1978) who reported that daily body gain increased with increasing the dietary energy levels.

Daily body gain according to fattening period (weight range) was highest at mid fattening, followed by early fattening. These results are consistent with those of Song et al. (1976), Kang and Thak (1982) and Thak et al (1984) who reported that daily body gain of growing and fattening male Korean native cattle was highest (1.18 to 1.24 kg) between 250 and 350 kg of body weight and decreased thereafter.

Energy effects on feed intake and feed efficiency

Daily feed intake and feed efficiency are presented in table 3. Daily feed intakes for the 2.4, 2.6 and 2.8 Mcal ME diets during the category 1(200-250 kg) were 7.28, 6.69 and 6.89 kg, respectively and was lowest in 2.6 Mcal energy level compared to 2.4 and 2.8 Mcal energy levels. However, daily feed intake was not significantly influenced by energy levels of ration during the category 1. However, daily feed intake during the category 2 was 8.34, 7.90 and 7.78 kg for the 2.4, 2.6 and 2.8 Mcal ME diets, respectively and decreased with increasing energy levels. Daily feed intake of bulls fed 2.6 and 2.8 Mcal ME diets was significantly lower ($P < .01$) than for bulls receiving the 2.4 Mcal ME diets. The following equation was developed to predict daily feed intake(Y) from energy levels(X) of ration during the category 2.

$$Y = -21.547X + 38.768X^2 + 37.717$$

Daily feed intake during the fattening from 350 to 450 kg was 8.94, 8.76 and 8.56 kg for the 2.4, 2.6 and 2.8 Mcal ME diets, respectively and was similar to trends observed over the 250 to 350 kg weight range. Bulls receiving 2.6 and 2.8 Mcal ME diets consumed significantly lower ($P < .05$) feed intake than for bulls fed 2.4 Mcal ME diet. The following equation was developed to predict daily feed intake(Y) from energy levels(X) of ration over the weight range of 350 to 450 kg.

$$Y = 1.1571X - 0.4064X^2 + 8.5012$$

Daily feed intake over the entire fattening period was 8.42, 7.86 and 7.73 kg for the 2.4, 2.6 and 2.8 Mcal ME diets, respectively and was significantly lower ($P < .05$) in bulls fed the 2.6 and 2.8 Mcal ME diets than for bulls fed the 2.4 Mcal ME diet. The following equation was developed to predict daily feed intake (Y) from energy levels(X) of ration over the entire fattening period.

$$Y = -30.013X + 5.4401X^2 + 49.119$$

The regression line of energy level(X) of ration against daily feed intake(Y) of Korean native cattle is presented in figure 2. Expected daily feed

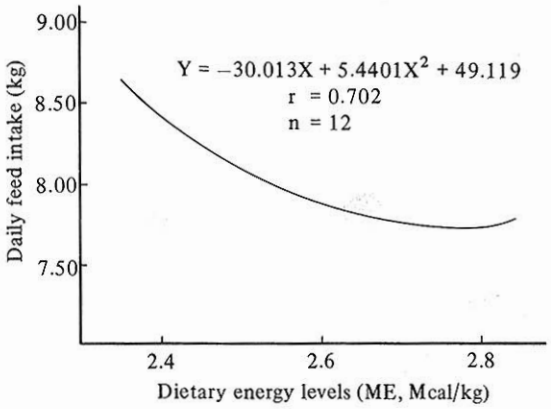

Figure 2. Relationship between energy levels and daily feed intake during the entire feeding period.

TABLE 3. INFLUENCE OF DIFFERENT ENERGY LEVELS ON FEED INTAKE AND FEED EFFICIENCY OF THE GROWING AND FINISHING BULLS

Items	Energy levels (ME, Mcal/kg)			SE[1]
	2.40	2.60	2.80	
		Category 1 (200-250kg)		
Daily concentrate intake(kg)	6.01	5.67	5.59	
Daily roughage intake(kg)	1.27	1.02	1.30	
Daily feed intake(kg)	7.28	6.69	6.89	0.12
Feed intake/$W^{0.75}$(g)	125.00	117.20	117.90	
Feed/gain	7.09A	6.19B	6.09B	0.15
		Category 2 (250-350 kg)		
Daily concentrate intake(kg)	7.03	6.85	6.66	
Daily roughage intake(kg)	1.30	1.05	1.12	
Daily feed intake(kg)	8.34A	7.90B	7.78^{B}	0.08
Feed intake/$W^{0.75}$(g)	117.20	111.10	108.40	
Feed/gain	6.77^{A}	5.84^{B}	6.26^{B}	0.15
		Category 3 (350-450 kg)		
Daily concentrate intake(kg)	7.69	7.69	7.36	
Daily roughage intake(kg)	1.25	1.03	1.20	
Daily feed intake(kg)	8.94^{a}	$8.76^{a,b}$	8.56^{b}	0.06
Feed intake/$W^{0.75}$(g)	101.70	98.10	96.20	
Feed/gain	9.88	8.84	9.09	0.20
		Entire experiment (200-450 kg)		
Daily concentrate intake(kg)	7.16	6.83	6.57	
Daily roughage intake(kg)	1.28	1.03	1.16	
Daily feed intake(kg)	8.42^{a}	7.86^{b}	7.73^{b}	0.12
Feed intake/$W^{0.75}$(g)	110.80	102.80	100.90	
Feed/gain	8.13^{a}	7.08^{b}	7.39^{b}	0.18

[1] Standard error of mean.

^{a,b}Correspond to significant difference ($P < .05$).

^{A,B}Correspond to significant difference ($P < .01$).

intake of Korean cattle can be calculated using this equation when the ME content of ration is known. These results are different from those of Song et al.(1974), Kim (1976) and Kang (1979) who observed that increased dietary energy level significantly increased daily feed intake.

Daily feed intake per metabolic body size(MBS) over the weight range of 200-250 kg varied from 117.2 to 125.0 g and was highest in bulls fed 2.4 Mcal ME diet but was not different in bulls fed the 2.6 and 2.8 Mcal ME diets. Daily feed intake per MBS during the weight range of 250-350 kg varied from 108.4 to 117.2 g and that of during the final fattening period(350-450 kg) varied from 96.2 to 101.7 g. Increased energy level of ration decreased daily feed intake per MBS.

Over the entire experiment(200-450 kg), daily feed intake per MBS ranged from 100.9 to 110.8 g and was slightly higher in bulls fed 2.4 Mcal ME diet than for bulls fed the 2.6 and 2.8 Mcal ME diets. These results are in agreement with those of Preston (1972) who reported that daily feed intake of beef cattle per MBS was 95 g and of Fox and Black(1984) who observed that daily feed intake per MBS ranged from 90 to 100 g.

Feed efficiency of bulls receiving the 2.6 and 2.8 Mcal ME diets during the category 1 was

significantly improved ($P < .01$) compared with 2.4 Mcal ME diet but was similar between bulls fed 2.6 and 2.8 Mcal ME diets. The following equation was developed to predict feed efficiency (Y) from energy level(X) of ration.

$$Y = -55.331X + 10.161X^2 + 81.357$$

During the category 2, feed efficiency had a similar tendency observed in the category 1. The following equation was developed to predict feed efficiency(Y) from energy levels(X) of ration.

$$Y = -89.728X + 17.008X^2 + 124.15$$

However, feed efficiency during the final fattening period was best in bulls fed 2.6 Mcal ME diet among energy levels but was not significantly different between energy levels of ration. Over the entire experiment(200-450 kg), feed efficiency of bulls receiving the 2.6 and 2.8 Mcal ME diets was significantly better ($P < .05$) than for bulls receiving 2.4 Mcal ME diet and the following equation was developed to predict feed efficiency(Y) from energy levels(X) of ration.

$$Y = -118.34X + 22.448X^2 + 162.85$$

The regression line of energy level(X) of ration against feed efficiency(Y) is presented in figure 3.

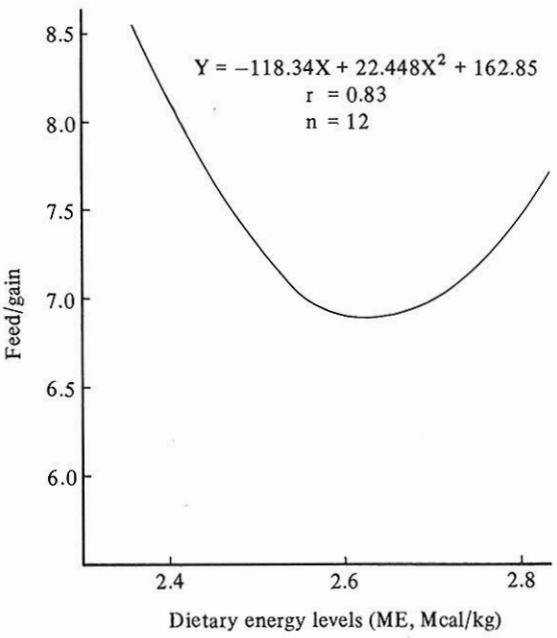

Figure 3. Relationship between energy levels and feed/gain during the entire feeding period.

These results are similar with those of Paladines et al.(1964), Hatch et al.(1972), Craddock et al. (1974) and Prior et al.(1977) who reported that increasing energy level of ration improved feed efficiency. However, these results are different from that of Ferrell et al.(1978) who observed that feed efficiency was not affected by energy levels of ration.

Energy effects on energy intake

Daily metabolizable energy intake(MEI) during the category 1 as shown in table 4 was slightly higher in bulls fed 2.8 Mcal ME diet compared with bulls fed 2.4 and 2.6 Mcal ME diets but was not influenced by energy level of ration. During the category 2, daily MEI was significantly higher ($P < .01$) in bulls fed 2.8 Mcal ME diet than for bulls receiving 2.4 Mcal ME diet. The following equation was developed to predict daily MEI(Y) from energy level(X) of ration.

$$Y = -17.672X + 4.1267X^2 + 37.292$$

During the category 3, daily MEI of bulls fed 2.6 and 2.8 Mcal ME diets was significantly higher ($P < .01$) than for bulls fed 2.4 Mcal ME diet. The following equation was developed to predict daily MEI(Y) from energy level(X) of ration.

$$Y = 32.513X - 5.2524X^2 - 27.625$$

Over the entire experiment(200-450 kg), daily MEI was 18.90, 19.16 and 19.99 Mcal for the 2.4, 2.6 and 2.8 Mcal ME diets, respectively and was slightly increased with increasing energy level of ration but was not significantly affected by energy level of ration. These results are in agreement with that of Meyer et al. (1965) who reported that steer given a fattening ration following a low, medium or liberal energy intake did not differ in daily DE intake. However, these results are different from those of Jones and Hogue (1960, Song et al. (1974), Kim (1976), Kim (1978) and Kang (1979) who reported that energy intake was increased with increasing energy level of ration.

Daily MEI per metabolic body size(MBS) ranged from 277.0 to 298.4 Kcal during the category 1, from 262.2 to 281.1 Kcal during the category 2, from 229.2 to 249.9 Kcal during the category 3 and from 248.6 to 260.8 Kcal over the entire feeding period. Daily MEI per MBS was

TABLE 4. INFLUENCE OF DIFFERENT ENERGY LEVELS ON ME INTAKE OF GROWING AND FINISHING BULLS (MCAL)

Items	Energy levels (ME, Mcal/kg)			SE[1]
	2.40	2.60	2.80	
		Category 1(200-250 kg)		
Total ME intake	710.30	709.60	767.40	14.09
Daily ME intake	16.14	16.14	17.43	0.31
ME intake (kcal/$W^{0.75}$/day)	277.03	282.71	298.36	
		Category 2(250-350 kg)		
Total ME intake	1,399.10	1,443.60	1,512.40	16.49
Daily ME intake	18.65^{B}	19.24^{A,B}	20.17^{A}	0.31
ME intake (kcal/$W^{0.75}$/day)	262.16	270.64	281.08	
		Category 3(350-450 kg)		
Total ME intake	2,228.50	2,156.00	2,460.20	54.47
Daily ME intake	20.15^{B}	21.40^{A}	22.23^{A}	0.28
ME intake (kcal/$W^{0.75}$/day)	229.16	239.64	249.92	
		Entire experiment (200-450 kg)		
Overall ME intake	4,338.00	4,309.00	4,740.00	68.18
Daily ME intake	18.90	19.16	19.99	0.26
ME intake (kcal/$W^{0.75}$/day)	248.59	250.59	260.83	

[1]Standard error of mean

^{A,B}correspond to significant difference ($P < .01$).

slightly higher in bulls fed 2.8 Mcal ME diet than for bulls receiving 2.4 and 2.6 Mcal ME diets.

According to fattening period, daily MEI per MBS was progressively decreased as the fattening period advanced. These results were slightly lower than those of Fox et al.(1972) who reported that daily MEI per MBS was 277 Kcal and of Ahn and Garrett(1988) who reported that MEI per MBS ranged from 296 to 327 Kcal.

Energy required for kg body gain

ME required for kg body gain over the entire period as shown in table 5 was 18.24, 17.25 and 19.11 Mcal for the 2.4, 2.6 and 2.8 Mcal ME diets, respectively. Bulls receiving the 2.6 Mcal ME diet required less ME per kg of body gain than for bulls receiving the 2.4 and 2.8 Mcal ME diets. The decrease in ME per kg of body gain for bulls fed 2.6 Mcal ME diet may be accounted by an increase in body gain although daily MEI was not high compared with bulls fed 2.8 Mcal ME diet. These results are consistent with that of Song et al. (1974) who reported that bulls receiving the

TABLE 5. INFLUENCE OF ENERGY LEVELS ON ME REQUIREMENT PER KG BODY GAIN OF BULLS DURING THE ENTIRE FEEDING PERIOD

Items	Energy level (ME, Mcal/kg)		
	2.40	2.60	2.80
Avg. initial body wt. (kg)	203.20	196.00	201.80
Avg. final body wt. (kg)	441.00	453.00	446.80
Avg. total body gain (kg)	237.80	257.00	245.00
Avg. daily body gain (kg)	1.04	1.14	1.03
Avg. daily feed intake (kg)	8.42	7.86	7.78
Avg. daily ME intake (Mcal)	18.90	19.16	19.99
Feed per kg gain (kg/day)	8.13	7.08	7.39
ME per kg gain (Mcal/day)	18.24	17.25	19.11

medium energy diet are lower in ME per kg body gain than for bulls fed the low and high energy diets. Also, these results are similar with that of Kang (1979) who reported that energy required for kg of body gain was lower in bulls receiving the high energy diet than for bulls fed the low energy diet but differ from that of Kim (1978) who reported that energy required for kg of body gain increased as the energy level of ration increased.

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