REVIEW: PHYSIOLOGICAL CHARACTERISTICS, NUTRITION REQUIREMENTS AND SOME CONSIDERATIONS WHEN FEEDING BEEF COWS

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TÓM TẮT

Ngành chăn nuôi bò thịt của Việt Nam hiện nay không đáp ứng được đủ nhu cầu tiêu dùng nội địa. Chính vì vậy, trong những năm qua Việt Nam đã phải nhập khẩu một lượng lớn bò thịt sống và thịt bò đông lạnh từ các nước như Úc hay Thai Lan. Để giảm lượng bò hơi và thịt bò nhập khẩu, Việt Nam cần phát triển mạnh hơn nữa ngành chăn nuôi bò thịt trong nước. Trong ngành công nghiệp chăn nuôi bò thịt, việc xác định chính xác nhu cầu dinh dưỡng của đàn bò là vấn đề rất quan trọng vì thức ăn chiếm hơn 65% tổng chi phí sản xuất, và thức ăn là một trong những yếu tố chính ảnh hưởng tới năng suất và sức khỏe vật nuôi. Khẩu phần ăn cung cấp đầy đủ chất dinh dưỡng vừa giúp con vật phát huy tối đa tiềm năng sinh trưởng, sinh sản, đảm bảo phúc lợi của động vật vừa giúp tăng lợi nhuận của người chăn nuôi. Bài viết này thảo luận và cung cấp thông tin một cách có hệ thống về các đặc điểm sinh lý, các công thức tính toán nhu cầu dinh dưỡng, và một số điểm nên được chú ý khi nuôi dưỡng bò sinh sản hướng thịt ở các giai đoạn hậu bị, mang thai và tiết sữa. Bài tổng quan này cung cấp thông tin một cách có hệ thống cho các nghiên cứu sâu hơn. Đồng thời những thông tin này sẽ có ý nghĩa trong việc xây dựng khẩu phần cho bò sinh sản hướng thịt ở các giai đoạn sinh lý khác nhau.

Từ khóa: Bò cái sinh sản hướng thịt, nhu cầu dinh dưỡng, nuôi dưỡng.

Bài tổng quan: Đặc điểm sinh lý, nhu cầu dinh dưỡng và một số điểm lưu ý khi nuôi bò sinh sản hướng thịt

ABSTRACT

The beef production industry of Viet Nam currently cannot meet the domestic demands and Viet Nam had to import increasing large quantities of both live cattle and frozen beef from foreign countries. Therefore, it is necessary to advance the domestic beef production. In beef industry, the determination of cattle requirements might be the main critical issues because feed is a major cost item which represents over 65% of total cost, and feed is one of the main factors effecting animal performance. Adequate supply of feed for nutrient requirements of a beef herd can maximize their productivities and reproductive performance, ensure animal welfare, and maximize profit of producers. This paper discussed the main physiological characteristics, the formulations to calculate the nutrition requirements, and some critical points needed to be considered when feeding heifers, pregnant beef cows, and lactating beef cows. This information will be useful for further researches and applications in beef production of Viet Nam.

Keywords: Beef cows, feeding, nutrition requirements.

1. INTRODUCTION

Currently, the beef production industry of Viet Nam cannot meet the domestic demands. As a result, year by year Viet Nam imported increasing large quantities of live cattle and frozen beef from markets such as Australia, New Zealand, US, Thailand and Cambodia. For example, although Viet Nam just started importing 3000 beef cattle from Australia in

2012, the number of imported cattle from this country has increased up to about 18000 cattle in 2014. According to statistics from the General Department of Viet Nam Customs (2015), in the first 3 months of 2015, the value of live cattle imported to the domestic market reached $ 124 million, with 115 242 live cattle, increased by 74.6% in quantity and increased by 107% in value when compared with the respective numbers of the same period in 2014. Thus, in order to reduce the importation of beef cattle, it is of importance to advance the domestic beef cattle production industry and reduce production cost of beef. In beef industry, the determination of cattle requirements might be the main critical issues. This is because feed is a major cost item which represents over 65% of total cost, and feed is a main factor effecting animal performance (Ferrell, 2005). Only adequate supply of feed for nutrient requirements of a beef herd can maximize their productive and reproductive performance, ensure animal welfare, and maximize profit of producers (NRC, 2000). However, the knowledge of how nutrition requirements of cattle can be calculated and adjusted remains so many limitations in Viet Nam. Therefore, this paper aims to revise the knowledge including physiological characteristics, nutrition requirements of beef cattle and how to feed them properly. Calculating nutrient requirements of beef cattle as accurately as possible and feeding them properly are the best ways for producers to minimize overfeeding of nutrients, increase efficiency of nutrient utilization, maximized animal performance, and avoid excess nutrient excretion (NRC, 2000). Nutrition of beef cattle is a very large topic including nutrition of calves, heifers, pregnant beef cows, lactating beef cows and bulls, but this paper only discusses the nutrition aspects of replacement heifers, pregnant cows, and lactating cows.

2. NUTRITION REQUIREMENTS OF HEIFERS

2.1. Physiological characteristics of heifers

Feed and management program of replacement heifers will have a lifelong influence on their productivity (Ensminger and Perry, 1997). How young heifer will be bred, whether they calve early or late, whether they will be good or poor milker, how weigh their weaning calves will be, and how long they should be remained on the herds are determined by heifers' nutritional status (Ensminger and Perry, 1997). A typical growth curve of a beef cattle is shown in figure 1 (Tisch, 2006). The figure 1 shows that the heifers grow rapidly in the first three years. This means that their nutrient requirements for growth in the first three years are very high (NRC, 2000). The diet must supply enough nutrients for this requirement.

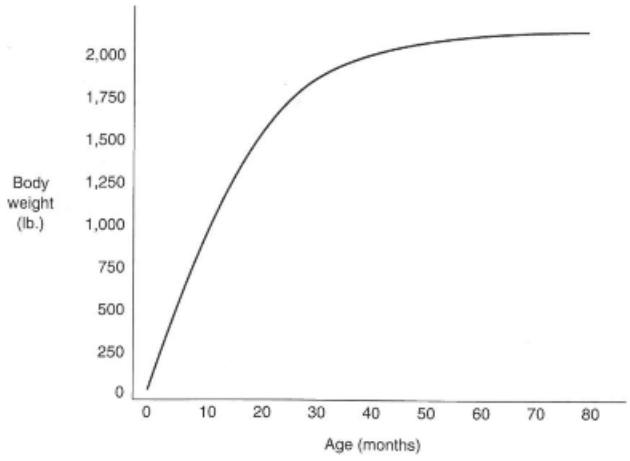

Figure 1. A typical growth curve of beef cattle adapted from Tisch (2006)

The most important requirement when feeding replacement heifers is that they must get a preselected or target weight at a given age (Dziuk and Bellows, 1983). The threshold age and weight at which heifers attain puberty are determined by gen, but they also depend on nutrition (Ferrell, 1991, Dunn and Moss, 1992). The growth rate that heifers first calve at 2 year of age is most economical (Gill and Allaire, 1976). Some equations to predict target weights and rates of gain have been given by NRC (2000).

2.2. Nutrition requirements of heifers

Many protein and energy systems have been developed for calculating the nutrition requirements and formulating the diets of cattle like the metabolisable energy and protein system of Agricultural and Food Research Council (Afrc, 1993), net energy and metabolisable protein of National Research Council (NRC, 1989, 2001, 2000, 1996), Feed into Milk (FiM) system of United Kingdom (Thomas, 2004), or Cornell Net Carbohydrate and Protein System of Cornell Univesity (Tylutki et al., 2008). However, these systems are mainly developed for calculation of dairy cattle nutrition requirements. Untill now, it seems that only the system of equations published by NRC (1996, 2000) is fully developed for calculation of beef cattle nutrition requirements, and this system is applied most widely.

2.2.1. Energy requirement of beef heifers

* Total net energy requirement for maintenance (NE_mtotal)

The total net energy requirement for maintenance (NE_mtotal, Kcal/day) of beef heifers adjusted for effects of breed, sex, pasture condition, acclimatization, and stress can be calculated using the following equations of NRC (2000).

If a cow is cold stressed: NE_mtotal (Mcal/d) = $NE_m + NE_{mact} + NE_{mcs}$

If a cow is heat stressed: NE_mtotal (Mcal/d) = $(NE_m \times NE_{mhs}) + NE_{mact}$

Where: NE_m(Mcal/d): net energy requirement for maintenance adjusted for acclimatization

NE_{mact}(Mcal/d): adjustment of energy maintenance requirement for activity

NE_{mcs} (Mcal/d): net energy require due to cold stress

NE_{mhs}(Mcal/d): net energy require due to heat stress NE_{mhs} = 1.07 (Mcal/d) for rapid shallow panting, and NE_{mhs} = 1.18 (Mcal/d) for open mouth panting if temperature is equal or higher than 30°C.

Calculation of NE_m:

NE_m (Mcal/d) = $SBW^{0.75}$ x ((0.077 x BE x L x COMP) + 0.0007 x (20-T_p)

COMP = 0.8 + ((CS - 1) x 0.05)

Where: SBW is shrunk body weight (kg)

BE is effect of breed on NE_m requirement. For example, BE is 1 for Angus, Charolaise,

Limousin, but BE = 0.9 for Brahman and Sahiwal, and BE = 1.2 for Simental.

L is effect of lactation on NE_m requirement (1 if dry or heifer, 1.2 if lactating).

COMP is effect of previous plane of nutrition on NE_m requirement.

T_p (°C) is average temperature of previous month.

CS is body condition score (CS = 1-9).

Calculation of NE_{mact}. NE_{mact} can be calculated using equation of CSIRO (1990):

If the cow is on pasture NE_{mact} is calculated by following equation; otherwise, NE_{mact} = 0

NE_{mact} (Mcal/day) = (0.006 x DIM x (0.9 x (TDN_p/100))) + (0.05 x Terrain/(GF + 3)) x BW/4.18

Where: DIM (kg/d): dry matter intake from pasture.

TDN_p (%): total digestible nutrient content of the pasture.

Terrain is terrain factor. When land is level, undulating, and hilly, terrain is 1, 1.5, and 2 respectively.

GF (ton/ha) : availability of green forage of pasture.

BW (kg): body weight of cow.

Calculation of NE_{mcs}:

NE_{mcs} (Mcal/d) = k_m x ME_{cs}

Where: ME_{cs} (Mcal/d): metabolisable energy requirement due to cold stress.

k_m (assumed 0.576) is efficiency of using ME for maintenance.

ME_{cs} = SA x (LCT - T_c)/IN

T_c (°C) is current temperature

SA (m^2) is surface area: SA = 0.09 x $BW^{0.67}$

LCT (°C) is animal's lower critical temperature: LCT = 39- (IN x HE x 0.85)

IN (°C/Mcal/m^2/day) is insulation value: IN = TI + EI

TI (°C/Mcal/m^2/day) is tissue (internal) insulation value; TI depends on days of pregnancy (t). This section calculates requirement for non-pregnant heifers, so TI = 0.

EI (°C/Mcal/m^2/day) is external insulation value: EI = (7.36 - 0.296 x Wind + 2.55 x Hair) x Mud x Hide

Where: Wind (kph) is wind speed; Hair (cm) is effective hair depth; Mud is mud adjustment factor for external insulation (Mud is 1 when cow is dry and clean; Mud is 0.8 when cow has some mud on lower body; Mud is 0.5 when cow is wet and matted; and Mud is 0.2 when cow is covered with wet snow or mud); Hide is hide adjustment factor for external insulation (Hide is 0.8 if it is thin; Hide is 1 if it is average; and Hide is 1.2 if it is thick).

HE (Mcal/day) is heat production: HE = (MEI - RE)/SA

RE (Mcal/day) is net energy available for production: RE = (DIM - I_m) x NE_{ga}

DIM (kg/d) is dry matter intake.

NE_{ga} (Mcal/kg) is net energy content of diet for gain.

I_m (kg DM/d) is dry matter intake for maintenance: I_m = (NE_m + NE_{mact})/(NE_{ma} x ADTV)

ADTV is feed additive adjustment factor, ADTV = 1.12 if diets contain ionophores; otherwise, ADTV = 1.

NE_{ma} (Mcal/kg) is net energy content of diet for maintenance.

* Net energy requirement for growth (NE_g)

According to NRC (2000), net energy requirement for growth of beef cows (NE_g, Kcal/d) can be calculated by the following equations:

NE_g = 0.0635 x $EQEBW^{0.75}$ x $EBG^{0.1097}$

EBG (kg) is empty body gain

EBG = 0.956 x SWG (SWG, kg, is shrunk body weight gain)

EQEBW (kg) is equivalent empty body weight

QEBW = 0.891 * EQSBW

EQSBW (kg) is equivalent shrunk body weight:

EQSBW = SBW * (SRW/FSBW) (Tylutky et al., 1994)

SBW (kg) is shrunk body weight: SBW = 0.96 x BW

SRW (kg) is standard reference weight for expected final body fat, SRW of heifers = 478 kg.

FSBW (kg) is final shrunk body weight at maturity of breeding heifers.

* Total net energy requirement (NE)

NE = NE_m total + NE_g

2.2.2. Protein requirement

* Metabolisable protein requirement for maintenance of beef heifers (MP_m)

According to NRC (2000):

MP_m = 3.8 x $SBW^{0.75}$

Where: MP_m (g/d): metabolizable protein requirement for maintenance

SBW (kg): shrunk body weight.

* Metabolisable protein requirement for growth (MP_g)

According to NRC (2000), if heifers have EQSBW ≤ 300 kg:

MP_g = NP_g/(0.834 - (EQSBW x 0.00114)

Where: MP_g (g/day) is metabolizable protein requirement for growth

NP_g (g/day) is net protein requirement for growth

If EQSBW > 300 kg:

$MP_g = NP_g/0.492$

Calculation of NP_g:

NP_g = SWG x (268-(29.4 (RE/SWG)))

Where: SWG has been mentioned previously

RE can be calculated from equations in previous section.

* Total metabolisable protein requirement (MP)

$MP = MP_m + MP_g$

2.2.3. Mineral and vitamins requirements of beef heifers

* Calcium and phosphorus requirements for maintenance

Ca (g/d) = 0.10154 x SBW/0.5

P (g/d) = 0.016 x SBW/0.68

* Calcium and phosphorus requirements for growth

Ca (g/d) = NP_g x 0.071/0.5

P (g/d) = NP_g x 0.045/0.68

* Maximum level of calcium and phosphorus for beef cows

According to NRC (2000) the maximum amounts of Ca and P per day for beef heifers, pregnant beef cows, and lactating beef cows are calculated as followed:

Maximum amount of Ca (g/d) = 0.2 x DMI

Maximum amount of P (g/d) = 0.1 x DMI

DIM is kg dry matter intake.

According to CSIRO (1990), the level of Ca should be supplied for beef cows is 1.9-4.0 g/kg dry matter (DM) of the diet, and the level of P should be 1.8-3.2 g/kg DM diet.

** Other mineral and some vitamin requirements*

Besides the requirements of calcium and phosphorus, the beef cows' requirements of some other minerals and vitamins for growth, pregnancy, and lactation suggested by NRC (2000) and CSIRO (1990) are shown in table 1. The suggestions of CSIRO (1990) and NRC (2000) are quite similar to each other.

Table 1. Mineral and vitamin requirements of beef cows

Minerals and vitamins	Unit	Requirements of cows according to NRC (2000)				Requirements of cows according to CSIRO (1990)
		Growing and finishing	Gestation	Early lactation	Maximum tolerable levels	
Magnesium	%	0.10	0.12	0.20	0.40	0.19
Potassium	%	0.60	0.60	0.70	3.00	0.5
Sodium	%	0.06–0.08	0.06–0.08	0.10	-	0.08- 0.12
Sulfur	%	0.15	0.15	0.15	0.40	0.15
Chlorine	%	-	-	-	-	0.2
Cobalt	mg/kg	0.10	0.10	0.10	10.00	0.11
Copper	mg/kg	10.00	10.00	10.00	100.00	7-10
Iodine	mg/kg	0.50	0.50	0.50	50.00	0.5
Iron	mg/kg	50.00	50.00	50.00	1000.00	40
Manganese	mg/kg	20.00	40.00	40.00	1000.00	15-25
Selenium	mg/kg	0.10	0.10	0.10	2.00	0.05
Zinc	mg/kg	30.00	30.00	30.00	500.00	20-30
Vitamin A	IU/kg	2200	2800	3900	-	-
Vitamin D	IU/kg	275	275	275	-	-

Note: Adapted from CSIRO (1990) and NRC (2000).

2.3. Some noticeable points when feeding heifers

According to Church (2010), replacement heifers, which will be breed cows in the future, are not recommended to be creep fed. This is because although creep feeding increase growth of heifers, it will mask the effect of cow milk production which is a criterion used when selecting female (Church, 2010).

Heifers should be fed to puberty in time and breed at 13 to 14.5 months of ages and first calve at two years of age (Church, 2010, Ensminger and Perry, 1997). Feeding heifers with inophores can reduce their puberty age and enhance their reproductive performance (Church, 2010).

In summer season, good pasture plus mineral supplements fed free-choice normally can meet the nutrient requirements for proper growth and development of heifers (Ensminger and Perry, 1997). However, in the winter, the quality of dry forage is very low, and not too abundant, the heifers should be supplied with 1 to 2 lb of protein in form of cubes, blocks, meal-salt, or liquid (Ensminger and Perry, 1997). In addition, the vitamin A should be supplied and minerals also need to be provided for heifers, preferably free choice (Ensminger and Perry, 1997). Occasionally, the replacement heifers are suffered from overfeeding, but the thousands of undersized, poorly developed heifers are resulted from grossly underfed (Ensminger and Perry, 1997). In case that winter grazing is not available, heifers should be dry lotted and fed a complete ration (Ensminger and Perry, 1997).

3. NUTRITION REQUIREMENTS OF LACTATING COWS

3.1. Physiological characteristics of lactating cows

The lactating cows are the cow in postpartum, first trimester, and second trimester periods (Tisch, 2006). The cows in postpartum period only require nutrients for maintenance, growth, and lactation (Ferrell, 2005). However, the requirements of cows in first and second trimesters include pregnant requirements, although pregnant requirements are relatively low (Ferrell, 2005, Tisch, 2006). The growth requirements of first and second calf heifers are still very high because they continue growing (Ferrell, 2005, NRC, 2000, Marston et al., 1998). All these requirements of lactating cows must be met from dietary nutrients.

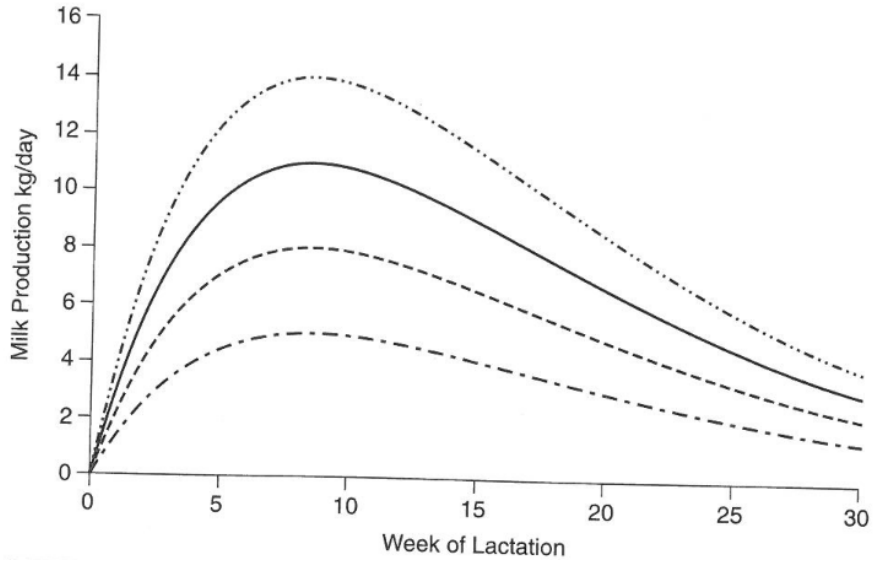

Figure 2. The lactation curves of beef cow during 30 weeks of lactation adapted from Ferrell (2005)

The lactation curves of lactating cows during 30 weeks are shown in figure 2 (Ferrell, 2005). Figure 2 shows that the milk yield of cows increases rapidly and reach the peak in postpartum period (150 days postpartum) (Tisch, 2006). Then the milk yield will decrease during first and second trimesters. This also means that the nutrient requirements of cows in postpartum period is much higher than requirements in first and second trimesters (Tisch, 2006).

3.2. Nutrition requirements of lactating cow

3.2.1. Energy requirements of lactating cow

* Maintenance and growth requirements (NE_m total and NE_g)

According to NRC (2000), the energy requirements for maintenance and growth of lactating beef cows are calculated similarly to these requirements of beef heifers which have been discussed in section 2.2.1. There are only some noticeable points.

Firstly, when calculating NE_{mcs}, the tissue (internal) insulation value (TI, °C/Mcal/m^2/day) is calculated based on the days of pregnancy (t, days):

If t is 30 days, TI = 2.5 and if t is from 30 to 183 days, TI = 6.5.

If t is from183 to 363, TI = 5.1875 + (0.3125 x CS).

If t is more than 363, TI = 5.25 + (0.75 x CS).

CS (1-9) is body condition score of beef cows

Secondly, when calculating heat production energy (HE, Mcal/d), we have to consider the net energy value of milk (YE_n, Mcal/kg), and net energy retained in uterus (NEpreg, Mcal/kg):

$HE = (MEI - (RE + YE_n + NE_{preg}))/SA$

MEI and RE have been mentioned in previous section.

HE also can be calculated by: $HE = (MEI - ((DIM – I_m) \times NE_{ma})/SA$

DIM, I_m, and NE_{ma} have been mentioned in previous section.

* Gestation requirement (NE_p)

According to NRC (2000), calf birth weight and day of gestation are used to calculate gestation requirement. However with lactating beef cow, this requirement is not high (NRC, 2000, Tisch, 2006):

NE_p (Kcal/d) = CBW x (k_m/0.03) x (0.05855 – 0.0000966 x t) x $e^{((0.3233 - 0.0000275 \times t) \times t)}$

Where: CBW (kg) is expected birth weight of calf

e is the base of the natural logarithms

* Lactation requirement (NE_l)

According to NRC (2000), the information of cow age, duration of lactation, day of lactation, time of lactation peak, peak milk yield, milk fat content, milk solids not fat, and protein is used to calculate the lactation requirement of beef cows using the following equations:

$NE_l = E \times Yn$

Yn (kg/day) is daily milk yield at week n postpartum:

$Yn = n/(a \times e^{(kn)})$ (Jenkins and Ferrell, 1984)

In cases that ages of cows are 2 or 3 Yn must be adjusted by multiplying with 0.74 or 0.88 respectively.

e is base of natural logarithms.

k and a are intermediate rate constants which can be calculated by equation:

k = 1/T

T is week of peaks of lactation, normally, T = 8.5 so k = 0.1176 (Sacco et al., 1987, Jenkins and Ferrell, 1984, Chenette and Frahm, 1981).

a is estimated of 0.6257, 0.3911, 0.2844, and 0.2235 for cows which have maximum yields of 5, 8, 11, 14 kg/day at 8.5 weeks postpartum (NRC, 2000).

E (Mcal/kg) is energy value of milk

E = 0.092 x MF + 0.049 x SNF - 0.0569 (Terrell and Reid, 1965)

MF (%) is milk fat content.

SNF (%) is milk solids non-fat composition

* Total net energy requirement (MP)

$NE = NE_m$ total + NE_g + NE_p + NE_l

3.2.2. Protein requirement

* Maintenance and growth requirements (MP_m and MP_g)

According to NRC (2000), the metabolisable protein requirements for maintenance and growth (MP_m and MP_g) of lactating beef cows are calculated similarly to the requirements of beef heifers which have been discussed in section 2.2.2.

* Gestation requirement (ME_p)

According to NRC (2000), metablisable protein requirement for pregnancy of beef cows can be calculated by following equations:

ME_p (g/d) = Ypn/0.65

Ypn (g/d) is net energy requirement for pregnancy:

Ypn = (CBW x (0.001669 - (0.001669 - (0.00000211 x t) x $e^{((0.0278 - 0.0000176 \times t) \times t)}$)x 6.25

CBW (kg) is expected calf birth weight

T (days) is days of pregnancy

* Lactation requirement (MP_l)

According to NRC (2000), metablisable protein requirement for lactation (MP_l, g/d) of beef cows can be calculated by following equations:

MP_l = (YProtn/0.65) x 1000

YProtn (kg/d) is daily milk protein yield at current stage of lactation.

YPront = Prot/100 x Yn

Prot (%) is milk protein composition.

Yn is daily milk yield calculated like section 2.2.1

* Total metabolisable protein requirement (MP)

$MP = MP_m + MP_g + MP_p + MP_l$

3.2.3. Mineral and protein requirements of lactating cows

Calcium and phosphorus requirements for maintenance and growth of lactating cows are calculated as for heifers in section 2.2.3 (NRC, 2000).

Calcium and phosphorus requirements for pregnancy of lactating cows might be not necessary because foetus is very small in this period (NRC, 2000). These requirement are only needed at last 90 days of pregnancy (NRC, 2000).

Calcium and phosphorus requirements for lactation of lactating cows can be calculated using following equations.

Ca (g/d) = Yn x 1.23/0.5

P (g/d) = Yn x 0.95/0.68

Yn is daily milk yield calculated like section 2.2.1

Requirements of other minerals and vitamins can be derived from Table 1.

3.3. Some noticeable points when feeding lactating cows

In the postpartum period: to ensure the cow will be bred within 80-day goal, cows after calving must be fed so that they have body condition score no less than 4 (Tisch, 2006). Beside forage, cows should be supplied with good quality feeds because they will peak their milk production in this period (Tisch, 2006). For the first calf heifers, nutritional management during the postpartum period is critical because they require nutrition for lactation, rebreeding and growth (Church, 2010).

In the first trimester: body condition score of cows can be adjusted effectively in this period by changing level of feeding because their requirements in this period is relatively low (Tisch, 2006). Calves should be considered to be creep fed in this period (Tisch, 2006). For pregnant heifers, they should be fed to maintain their adequate body condition, and they should not lose more than 5-10% of their fall weight during winter (Church, 2010).

In the second trimester: This is a good time for producers to maximize the use of low-cost roughages and other crop residues (Marston et al., 1998). If cow body condition scores are low, this is also an excellent time to increase the cows' weight (Marston et al., 1998). The cows should be fed to have body condition score between 4 and 7 when calving (Tisch, 2006). For spring-calving cows, it is suggested that the

breeding season should be timed so that cows are in the mid-gestation period when the crop residues are most available (Marston et al., 1998). By this way, the annual cow cost cab can be reduced (Marston et al., 1998)

4. NUTRITION REQUIREMENTS OF DRY PREGNANT COWS

4.1. Physiological characteristics of dry pregnant cows

In production cycle of a beef cow, the dry pregnant cow corresponds to the third trimester which is about 80 days before parturition (Tisch, 2006). As discussed in previous section, this is a very crucial reproductive period which decide the reproductive performance of beef cows, and the cows in this periods should be taken special interest in terms of nutrition (Marston et al., 1998). In order to have a suitable nutrition programme for dry pregnant cows, some physiological characteristics of them need understanding.

Firstly, it is necessary to understand that the development of foetus mainly occurs in last three months of gestations (NRC, 2000). Many researchers have shown the same development curves of foetal weights versus days of gestation (figure 3) (Ferrell et al., 1976, Ferrell et al., 1982, Prior and Laster, 1979, Winters et al., 1942, Jackobsen, 1956, Jackobsen et al., 1957). Beside the increase of foetus weight, the uterine and placental tissues also develop rapidly in this period to support foetal growth (Ferrell, 1991, Prior and Laster, 1979). Although the development of the foetus is determined by its genetic potential for growth, the foetus can only grow best when the supply of nutrients from the cow via placental system meet its requirements (Ferrell, 1989). Therefore, the nutrition requirements for the developments of placental system and foetus in this period are very high and must be supplied adequately (NRC, 2000). According to John et al. (2009), energy and protein needs increase by 20% or more compared to the beginning of gestation period. Research by Tudor (1972) shown that under-feeding energy and protein for cows has resulted in considerable decrease of calf birth weight.

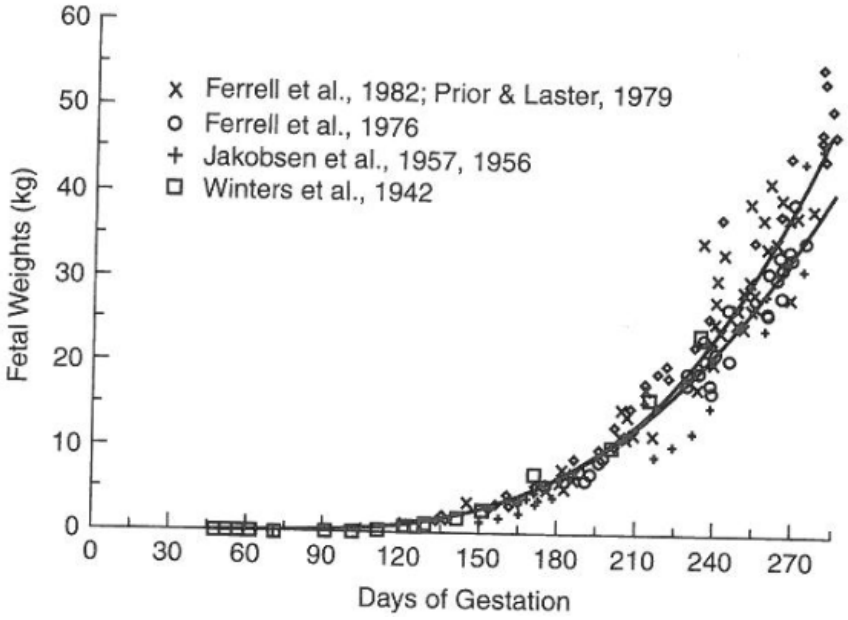

Figure 3. Representation of relationship between days of gestation and foetal weights

Note: Ferrell et al., 1976, Ferrell et al., 1982, Prior and Laster, 1979, Winters et al., 1942, Jackobsen, 1956, Jackobsen et al., 1957.

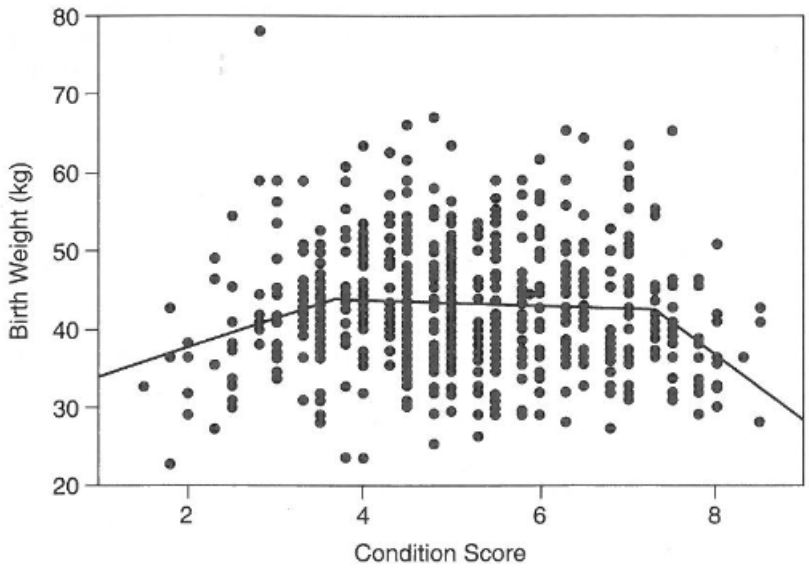

Figure 4. Effect of cow condition scores on calf birth weight adapted from Ferrell (2005)

Secondly, it should be noticed that the calf birth weight depends on the body condition score (BCS) of the cows (figure 4) (NRC, 2000, Ferrell, 2005). The calf birth weight seems to remain stable when the BCS of the cow ranges from 3.5 to 7, but either BCS less than 3.5 or more than 7 results in the reduction of calf birth weight (NRC, 2000). This suggest that the calf birth weight will be reduced when the cow is extreme under- or over-fed (NRC, 2000, Church, 2010). The under- or over-feeding not only affect calf birth weight, it also affect rebreeding ability and dystocia of the cows (NRC, 2000). Therefore, it is suggested that cows must reach or preferably maintain BCS 5 or 6 during this period (John et al. 2009). Cows must calve in BCS 5 or greater to have healthy calves and breed back quickly (John et al. 2009).

It is easy to find out that nutrient requirements of dry pregnant cows are very high although they are not milking. However, it is not easy to meet these requirements because the feed intake of the cows in this period is restricted by impeding of increasing foetus and placental system (Cheeke, 2005). So, feeds should be chosen to supply for cows in this period.

4.1.1. Nutrition requirements of dry pregnant cows

According to NRC (2000), almost nutrient requirements of dry pregnant cows are calculated by the equations used to calculate nutrient requirements of lactating beef cow in section 3.2. There are only some different points:

Firstly, the total net energy requirement and metabolisable protein requirement of dry pregnant cows do not include requirements for lactation:

$$NE = NE_m \text{ total} + NE_g + NE_p$$

$$MP = MP_m + MP_g + MP_p$$

Secondly, the Ca and P requirements for pregnant must be calculated and added to total Ca and P requirement because the Ca and P requirements for pregnant of dry pregnant cows are considerable. The Ca and P requirements for pregnant can be calculated using following equation:

Ca (g/d) = CBW x (13.7/90)/0.5

P (g/d) = CBW x (7.6/90)/0.68

CBW (kg) is expected weight gain

The table 1 is also used to calculate the other mineral and vitamin requirements of dry pregnant cows.

4.1.2. Some noticeable points when feeding dry pregnant cows

In a spring calving program, this period usually coincides with the winter which is lack of feeds (Tisch, 2006). If dry cows are based on dry grass pastures, they should be fed 1.5-2 lb of 40 to 44% CP protein supplement, and 1 to 2 lb of grain along with a protein supplement (Chiba, 2009).

If dry cows are fed based on harvested feed, they must be fed with high quality hays (Tisch, 2006). Research shown that cow herd fed hay with less than 10% crude protein had no problem in calf, but cows fed hay containing less than 10% crude protein gave serious week calves (Church, 2010). In addition, they should be supplied with 1.5 – 2 lb of 40 to 44% CP protein supplement (Chiba, 2009).

5. SITUATION OF FEEDING BEEF COWS IN VIET NAM

In Viet Nam, the beef industry are relatively backward in terms of breeds and nutrition. So far, Viet Nam has not really had cow-calf operations who produce massively calves for the beef production. For the household farms, their knowledge and skills to raise beef cows are still very limited. Husbandry practices in these households are mostly extensive with small scale of about 1 to 5 cattle. Also, for these household farms, the issues of animal nutrition has not been considered much and they have very lack knowledge about animal nutrition for self-mixing the diets for their beef cows. Therefore, their profit is very low. For the beef production enterprises, the husbandry practices recently have been positively changed. In the first few years when some Vietnamese beef production enterprises started importing and nurturing beef cattle, they mainly imported beef, fattened beef cattle for slaughtering or imported skinny beef cattle for fattening before slaughtering. Recently, after realizing the importance of beef cows in sustainable development of beef production, they are turning to import heifers or beef cows rather than import skinny or fattened beef cattle as before. For example, some local businesses in Dong Nai, Tay Ninh, Dong Thap..., turned to imports of pure beef heifers from Australia to establish cow-calf operations. Similarly, Hoang Anh Gia Lai Group, Yen Phu Company (Ninh Binh) and several businesses in Vinh Phuc, Phu Tho have also started importing and nurturing pure beef cow breeds from Australia. In Hanoi, the businesses and farmers have concentrated on renovating their current beef cow herds by inseminated them imported Blanc Blue Belge (BBB) semen. However, the current difficulties of these cattle businesses are still the nutritional issues. These businesses have cows but still face many difficulties in formulating feeds for their beef cows. Even if they want to buy the animal feed from other enterprises they have very few choices because the number of enterprises producing beef cattle feeds is very limited compared to the number of enterprises producing pig and poultry feeds. Currently, only a small number of enterprises such as Guyomarc'h Ltd., De Heus Group, CJ VINA AGRI Ltd., Vina feed Company or Anova Feed Company produce cattle feeds. A reasons for these can be because the beef commodity chain especially beef production in Viet Nam is still very young and new industry. Therefore, it is hoped that this article systematized the knowledge of beef cow nutrition for the cattle feed enterprises and for the cow-calf operations.

6. CONCLUSIONS

In conclusion, this paper has given an overview of beef cows' nutrition requirements in different periods of their production cycle. The cows at different stages of production cycle have different physiological characteristics. As results, their nutrient requirements also vary widely. Therefore, when feeding or formulating diet for cows, these changes in their nutrient requirements and their physiological characteristics must be taken into account. The combination of these strategies will give best results.

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REFERENCES

AFRC (1993). Energy and protein requirements of ruminants, Wallingford, England, CAB International.

Cheeke, P. R. (2005). Applied animal nutrition: feeds and feeding, Upper Saddle River, NJ, Pearson Prentice Hall.

Chenette, C. G. and Frahm, R. R. (1981), Yield and compositions of milk from various two-breed cross cows, Journal of Animal Science, 52: 483-492.

Chiba, L. I. (2009). Animal nutrition handbook [Online]. Available: http://www.ag.auburn.edu /~chibale/animalnutrition.html [Accessed 30 November 2012].

Church, D. C. (2010). Livestock feeds and feeding, Boston, NJ, Prentice Hall.

CSIRO (1990). Feeding standards for Australian livestock: ruminants, East Melbourne, Australia, CSIRO Publishing.

Dunn, T. G. and Moss, G. E. (1992). Effect of nutrient deficiencies and excesses on reproductive efficiency of livestock, Journal of Animal Science, 70: 1580-1593.

Dziuk, P. J. and Bellows, R. A. (1983). Management of reproduction in beef cattle, sheep, and pig, Journal of Animal Science, 57: 355-366.

Ensminger, M. E. and Perry, R. C. (1997). Beef cattle science, Danville, Illinois, Interstate Publishers.

Ferrell, C. L., Grrett, W. N. and Hinman, N. (1976). Growth, development and composition of the under and gravit uterus of beef heifers during pregnancy, Journal of Animal Science, 42: 1477-1489.

Ferrell, C. L., Laster, D. B. and Prior, R. L. (1982). Mineral excretion during prenatal growth of cattle, Journal of Animal Science, 54 (3): 618-624.

Ferrell, C. L. (1989). Placental regulation of fetal growth. In: Campion, D. R., Hausman, G. J. and Martin, R. J. (eds.) Animal growth regulation New York: Plenum Press.

Ferrell, C. L. (1991). Nutrient requirements and various factors effecting fetal growth and deverlopment, Minnesota Nutrition Conference, 52: 76-92.

Ferrell, C. L. (2005). Beef cattle. In: Pond, W. G., Church, D. C., Pond, K. R. and Schoknecht, P. A. (eds.) Basic animal nutrition and feeding. Hoboken, NJ: Wiley.

Gill, C. S. and Allaire, F. R. (1976). Relationship of age at first calving days open, days dry, and herd life with a profile function for dairy cattle, Journal of Dairy Science, 59: 1131-1139.

Jackobsen, P. E. (1956). Protein requirement for fetus formation in cattle International Congress of Animal Husbandry, 6: 115-126.

Jackobsen, P. E., Sorensen, P. H. and Larsen, H. (1957). Energy investigation as related to fetus formation in cattle, Acta Agric. Scand., 7: 103-112.

Jenkins, T. G. and Ferrell, C. L. (1984). A note on lactation curve s of crossbred cows, Animal Prodcution, 39: 479-482.

John, B. H., William, W. S., Scott, M. B. (2009). Nutrition and feeding of the cow-calf herd: production cycle nutrition and nutrient requirements of cows, pregnant heifers and bulls, Publications and Educational Resources, Verginia state university. Available: https://pubs.ext.vt.edu/400/400-012/400-012.html [Accessed 5 November 2015].

Marston, T. T., Blasi, D. A., Brazle, F. K. and Kuhl, G. L. (1998). Beef cow nutrition guide, US, Kansas State University.

NRC (1989). Nutrient requirements of dairy cattle. Washington, D.C: National Academy Press.

NRC (2000). Nutrient requirements of beef cattle: seventh revised edition: update 2000, US, The National Academies Press.

NRC (2001). Nutrient requirements of dairy cattle, Washington, DC, The National Academies Press.

NRC (1996). Nutrient requirements of beef cattle, Washington, DC, National Academy Press.

Prior, R. L. and Laster, D. B. (1979), Development of bovin fetus, Journal of Animal Science, 48: 1546-1553.

Sacco, R. E., Baker, J. F. and Cartwright, T. C. (1987). Production characteristics of primiparous females of a five-breed dialled, Journal of Animal Science, 64: 1612-1618.

Terrell, H. F. and Reid, J. T. (1965). Prediction of energy value of cow's milk, Journal of Dairy Science, 48: 1215-1223.

Thomas, C. (2004). Feed into milk : a new applied feeding system for dairy cows: an advisory manual, Nottingham, UK., Nottingham University Press.

Thomas, H. S. (2009). Storey's guide to raising beef cattle, North Adams, Mass, Storey Pub.

Tisch, D. (2006). Animal feeds, feeding and nutrition, and ration evaluation, Clifton Park, NY, Thomson Delmar Learning.

Tudor, G. D. (1972). The effect of pre- and post-natal nutrition on growth of beef cattle. I. The effect of nutrition and parity of the dam on calf birth weight, Australian Journal of Agricultural Research, 23: 389-385.

Tylutky, T. P., Fox, D. G. and Anrique, R. G. (1994). Predicting net energy and protein requirements for growth of implanted an nonimplanted heifers and steers and nonimplanted bulls varying in body size, Journal of Animal Science, 72: 1806-1813.

TylutkY, T. P., Fox, D. G., Durbal, V. M., Tedeschi, L. O., Russell, J. B., Van Amburgh, M. E., Overton, T. R., Chase, L. E. and Pell, A. N. (2008). Cornell net carbohydrate and protein system: a model for precision feeding of dairy cattle, Animal Feed Science and Technology, 143: 174-202.

Winters, L. M., Green, W. W. and Comstock, R. E. (1942). Prenatal development of the bovin, Minnesota Agricultural Experiment Station Technical Bulletin, 151: 3-47.