NRC Changes Affecting Cow-Calf Nutrition

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Major Differences Between 7th and 8th Revised Editions

- No change
  - E requirements for maintenance and growth
- Updated
  - Estimation of microbial protein
  - Nitrogen recycling
  - Change in BE and protein reserves in cows
    - Weight/BCS change
    - Body energy required/BCS
  - Major update and expansion of feedstuffs

All Chapters Updated

- Rearrangement of previous chapters
- Added chapters
  - Production Systems, Beef Quality and Safety
  - Physiology, Digestion and Metabolism
  - Carbohydrates and Lipids
  - Compounds that Modify Ruminant Digestion
  - Nutrition and the Environment
  - Nutritional Value of Byproducts
- Software update (more intuitive/user friendly)

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"The Model" (Empirical and Mechanistic)

- Both use the same cattle requirements
- Empirical (similar to previous Level 1)
  - Uses table values of TDN to compute MP
    - Bacterial crude protein (BCP) synthesis
    - Ruminal bacteria requirement for RDP
    - Dietary energy supply
    - Tabular values of RDP

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"The Model" (Empirical and Mechanistic)

- Mechanistic (similar to previous Level 2)
  - Rumen degradation kinetics (CHO and protein) used to compute
    - TDN
    - Microbial crude protein (MCP)
    - RUP
  - Small intestine digestibilities are assigned to compute dietary energy and MP supplies
    - Escaped CHO and lipids
    - BCP
    - RUP

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"The Model" *(Empirical and Mechanistic)*

- ***Mechanistic calculations***
  - ***Same as previous Level 2 (1996, 2000)***
  - ***Except***
    - ***It uses 3 instead of 5 protein fractions***

Nutrient Partitioning *(Short et al. 1990)*

1. Basal metabolism
2. Activity to gather food
3. Growth
4. Basic energy reserves
5. Maintenance of pregnancy
6. Lactation to support an existing offspring
7. Accumulation of additional energy reserves
8. Estrous cycles and initiation of pregnancy
9. Accumulation of excess energy reserves.

NRC (1996, 2000)

"The *weakest link in this model is the prediction of body weight change associated with each CS change*. This is a critical step because it is used to compute total energy reserves available and energy required to replenish reserves….The weights and weight changes appear to agree well with other data at CS 5 and below, but appear to be high above CS 7."

Wt and BCS Cycling

- Synthesis vs. Catabolism
  - Maintenance is more biologically efficient?
  - No difference in efficiency of E retention
    - Freetly and Nienabar (1998)
      - Non-pregnant, non-lactating cows
      - Restricted followed by realimentation
    - Freetly (2008)
      - Pregnant cows
      - Equal Wt gain, but different patterns
- Offers flexibility (forage quality, supplement strategy)
- Developmental programming

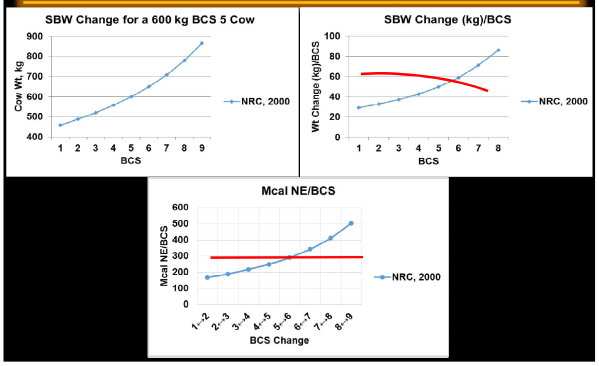
More Complete BCS Table

Moderate. There is slight evidence of fat deposition in the brisket. Muscle expression in the shoulder, loin, rump, and hindquarters are normal. A thin layer of fat covers the muscles in the shoulder, and when the animal is in motion; the muscle and scapula movement under the hide are not prominent. The last two ribs (12th and 13th) can only be seen if the cow has less than normal gut fill. Individual spinous processes along the topline and transverse processes along the loin edge between the hooks and last rib appear smooth and are not visible, but they can be palpated with firm pressure. The hooks and pins are covered with a layer of fat, but still distinguishable. Areas on each side of the tail head are fairly smooth, but not mounded. Cows in this condition would typically produce carcasses that qualify for the USDA market news category of "Boners" (Boning Utility). Empty body fat content would be approximately 18.8%.

BCS Decision Tree

Reference Points	1	2	3	4	5	6	7	8	9
Physically weak	Yes	No	No	No	No	No	No	No	No
Muscle atrophy	Yes	Yes	Som	No	No	No	No	No	No
Fat in brisket	No	No	No	No	Slt	Som	Full	Dist	Extr
Fat over shoulder	No	No	No	No	Slt	Som	Yes	Yes	Yes
Vis. ribs, no.	All	All	3-5	1-2	(1-2)	No	No	No	No
Vis. spinous proc.	Yes	Yes	Yes	Slt	No	No	No	No	No
Vis. transverse proc.	Yes	Yes	Yes	Slt	No	No	No	No	No
Vis. hooks/pins	Yes	Yes	Yes	Yes	Yes	Som	Slt	No	No
Tail head fat pones	No	No	No	No	No	Slt	Som	Yes	Extr
Fat in udder	No	No	No	No	No	No	Slt	Yes	Yes
Mobility	Poor	Mar	Ok	Ok	Ok	Ok	Ok	Mar	Poor

Cow Energy Relationships (600 kg Cow)



Cow Wt Change/BCS

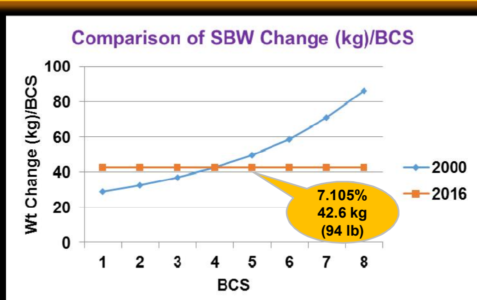
Source	Wt, kg/BCS	% Change/BCS
CSIRO (1990, 2007)	46	--
Houghton et al. (1990)	33.3	
Buskirk et al. (1992)	37.8	
Graffam (1992)	38.6	
Wagner (1984)	38	--
Ferrell and Jenkins (1996)	51	--
USMARC (Ferrell)	44	--
NRC (1996, 2000)	Variable	6.850%
NRC (2016)	Variable	7.105%

9 PP means = 36.57 kg (80 lb)

9 PP means = 514.6 kg (1130 lb)

Wt Change (kg)/BCS

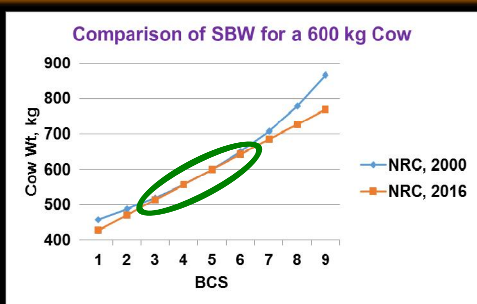
(600 kg/1320 lb BCS 5 Cow)



Estimated Shrunk Body Wt by BCS

BCS	Weight Adjust.	Mature Cow Shrunk Body Weight (BCS, kg) 400	500	600	700	800
1	0.716	286	357	428	500	571
2	0.787	314	393	471	550	628
3	0.858	343	429	514	600	686
4	0.929	371	464	557	650	743
5	1.000	400	500	600	700	800
6	1.071	429	536	643	750	857
7	1.142	457	572	686	800	914
8	1.213	486	607	729	850	972
9	1.284	514	643	772	900	1029

SBW for 600 kg, BCS 5 Cow



Application of Wt Change/BCS

Mature Cow SBW, lb (kg)	Weight Change/BCS, lb (kg)
1000 (454)	**71.5** (32.2)
1100 (500)	**78.2** (35.5)
1200 (545)	**85.3** (38.7)
1300 (590)	**92.4** (41.9)
1400 (636)	**99.5** (45.2)
1500 (680)	**106.6** (48.4)
1600 (726)	**113.7** (51.6)

Consistent with Application

USDA (2010) – Avg. cow size = 520 kg (1150 lb)

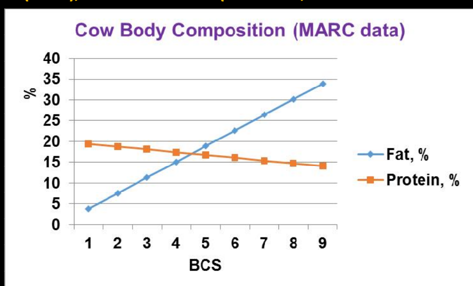
Energy Content of 1 kg Gain

Source	Mcal NE/kg	Breeds
CSIRO (1990, 2007)	6.4	British
CSIRO (1990, 2007)	5.5	Continental
INRA (1989)	6.0	All
NRC (1996, 2000)	5.82	All
Buskirk et al. (1992)[a]	Variable 2.16-7.96	SimAngus
NRC (2016)	Variable 3.69-7.99	All

- Logical that energy content of gain is variable
- Biological limits 1.2 – 8.0 Mcal
  - Reid et al. (1955); Garett and Hinman (1969)

Empty Body Composition

NRC (2000), Ferrell USMARC (105 cows, validated with 65 cows)

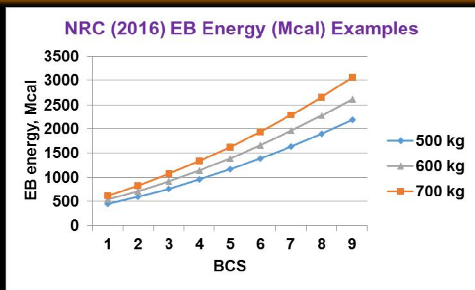


Estimated Body Energy Reserves

BCS	Empty Body Composition[a] Fat, %	Protein, %[c]	Mature Cow Empty Body Energy Reserves, Mcal 400 kg	500 kg	600 kg	700 kg	800 kg	Mcal/kg EBW gain[d]	Mcal/kg EBW loss[e]
1	3.77	19.42	356	445	534	623	712	4.22	3.69
2	7.54	18.75	476	595	714	833	952	4.76	4.22
3	11.30	18.09	611	764	917	1,070	1,223	5.30	4.76
4	15.07	17.42	762	952	1,143	1,333	1,524	5.84	5.30
5	18.84	16.75	928	1,160	1,392	1,624	1,856	6.38	5.84
6	22.61	16.08	1,109	1,386	1,664	1,941	2,218	6.91	6.38
7	26.38	15.42	1,306	1,632	1,958	2,285	2,611	7.45	6.91
8	30.15	14.75	1,517	1,897	2,276	2,655	3,035	7.99	7.45
9	33.91	14.08	1,744	2,181	2,617	3,053	3,489		7.99

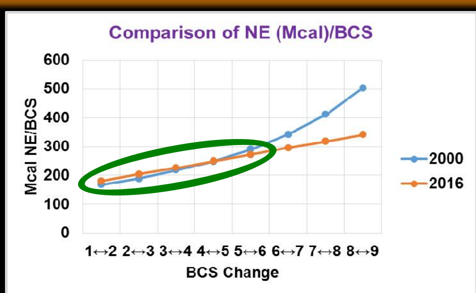
EB Fat, kg x 9.4 Mcal; EP Protein, kg x 5.7 Mcal

Total Empty Body Energy (Mcal) by BCS & Wt.



Mcal NE/BCS Change

(600 kg, BCS 5 Cow)



Energy Reserves (Mcal) for Cows

BCS		Current SBW at BCS 5, kg								
Gain	Lose	400	450	500	550	600	650	700	750	800
1 → 2	2 → 1	120	135	150	165	180	195	210	225	240
2 → 3	3 → 2	135	152	169	186	203	220	237	254	271
3 → 4	4 → 3	151	169	188	207	226	245	264	282	301
4 → 5	5 → 4	166	187	207	228	249	270	290	311	332
5 → 6	6 → 5	181	204	226	249	272	294	317	340	362
6 → 7	7 → 6	196	221	246	270	295	319	344	368	393
7 → 8	8 → 7	212	238	265	291	318	344	371	397	424
8 → 9	9 → 8	227	255	284	312	341	369	397	426	454

1st Calf Heifer Wt Change/BCS

- No adjustments were made to the model, but:
  - 7.105% x SBW is probably not appropriate
- Heifer wt change/1 BCS (vs. cows) should be:
  - Higher (growth + body energy) to increase 1 BCS
  - Lower to lose 1 BCS

Source	Wt, kg (lb)/BCS gain
Lalman et al. (1997)	33 (73)
Graffam (1992)	38 (84)
Ripberger (1997)	70 (150)
Bradford (1998)	62 (136)
MEAN	50.9 (112)

1st Calf Heifer Wt Change/BCS

- Limited data, but propose using:
  - Instead of 7.105%
  - 1.6 x 7.105% = 11.4% adjustment to gain 1 BCS
  - 0.4 x 7.105% = 2.8% adjustment to lose 1 BCS
- Ex. 400 and 500 kg (880-1100 lb) BCS 5
  - To gain 1 BCS = 46 vs. 58 kg (100 vs. 127 lb)
  - To lose 1 BCS = 12 vs. 15 kg (25 vs. 32 lb)

1st Calf Heifer Maintenance Energy

- Model uses 77 kcal/$BW^{0.75}$
  - Default value is 1.0
  - User can modify default value
- Limited data
  - But there is evidence that NE_m is:
    - Ok during gestation
    - But ~25% higher during early lactation

Replacement Heifer Target Wt

- *Same as NRC (1996, 2000)*
  - *55% for dual purpose or dairy breeds*
  - *60% Bos taurus*
  - *65% Bos indicus*
- *Model allows user to change target wt*

Dry Matter Intake

- NE_m intake, Mcal/d = $BW^{0.75}$ × (0.04997 × NE_m^2 + 0.04631);

  Intercept for nonpregnant cows = 0.03840

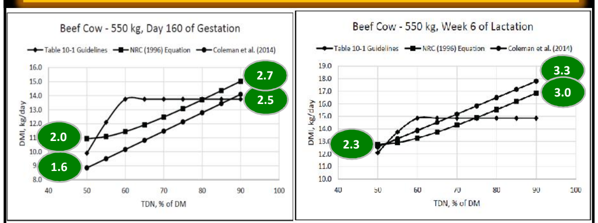
  Recommendations:
  Decrease by 0.95 when $NE_m \leq 0.95$ Mcal/kg (.43 Mcal/lb)
  Increase by 0.2 x daily milk production (kg/d)

Dry Matter Intake, %BW

Forage type	TDN, %	Forage Examples	Dry	Lactating
Low Quality	< 52	Dry winter forage, mature hay, straw	1.8	2.2
Average Quality	52-59	Dry summer/fall pasture, late bloom legume hay, boot- and early bloom grass hay	2.2	2.5
High Quality	> 59	Pre-, early-, mid-bloom legume hay, pre-boot grass hay, lush growing pastures, silages	2.5	2.7

Adapted from Lahlman, 2004

DMI Comparison



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DMI, %BW (DM Basis)

- NDF equation (Mertens, 1987)
  - 1.1 – 1.3% of BW NDF intake
  - 1.1% suggested for low-med quality forages
  - 1.2% suggested for med-high quality forages
  - Example: 110/NDF% = %BW DMI
    - Diet %NDF = 60%
    - 110/60 = 1.83% BW DMI

My interpretation and suggestions:
1.1 when >60% NDF; <53% TDN
1.2 when 45-60% NDF; 53-63% TDN
1.3 when <45% NDF; >63% TDN

Based On BCS 5, Empty Body Weight

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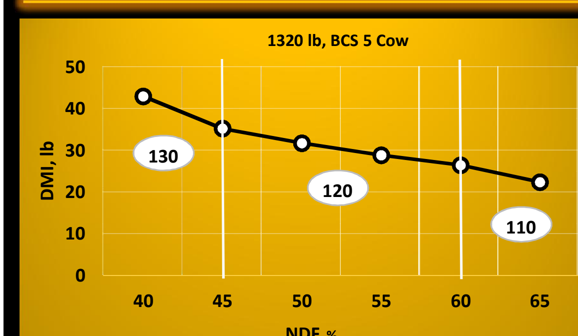
Estimated DMI Using Suggestions



Micro-mineral Requirements

Mineral	Unit	Grow/Finish	Gestation	Lactation	Max.
Chromium	mg/kg	--	--	--	1M
Cobalt	mg/kg	0.15 (0.10)	0.15 (0.10)	0.15 (0.10)	25.0 (10.0)
Copper	mg/kg	10.0	10.00	10.0	40.0 (100.0)
Iodine	mg/kg	0.50	0.50	0.50	50.0
Iron	mg/kg	50.0	50.0	50.0	500.0 (1M)
Manganese	mg/kg	20.0	40.0	40.0	1M
Molybdenum	mg/kg	--	--	--	5.0
Nickel	mg/kg	--	--	--	50.0
Selenium	mg/kg	0.10	0.10	0.10	5.0 (2.0)
Zinc	mg/kg	30.0	30.0	30.0	500.0

Macro-mineral Requirements

Mineral	Unit	Maint.	Grow/Fin	Gestation	Lactation	Max.
Calcium	%	0.0154 x SBW/0.5	NPg x 0.071/0.5	Yn x 1.23/0.5	CBW x (13.7/90)/0.5	0.2 x DMI
Phosphorus	%	0.016 x SBW/0.68	NPg x 0.039/0.68 (0.045)	Yn x 0.95/0.68	CBW x (7.6/90)/0.68	0.007 x DMI
Magnesium	%		0.10	0.12	0.20	0.40
Potassium	%		0.60	0.60	0.70	2.0
Selenium	%		0.10	0.10	0.10	5.0
Sodium	%		0.07	0.07	0.10	--
Sulfur	%		0.15	0.15	.015	0.40

Where: SBW = shrunk body weight, kg; NPg = net protein for gain, g/d; Yn = milk yield, kg/d, CBW = calf birth weight, kg; DMI = dry matter intake, g/d; Ca digestibility = 50%; P digestibility = 68%.

Vitamin Requirements on kg DMI Basis (kg SBW Basis)

Vitamin	Unit	Grow/Finish	Gestation	Lactation	Max.
A	IU/kg	2200 (47)	2800 (60)	3900 (84)	--
D	IU/kg	275 (5.7)	275 (5.7)	275 (5.7)	--
E	IU/kg	35 (0.73)	35 (0.73)	35 (0.73)	--

Example: 600 kg cow (kg SBW Basis)

Vitamin	Unit	Gestation	Lactation
A	IU/d	36,000	50,400
D	IU/d	3420	3420
E	IU/d	438	438

Bulls

- *Limited new data*
- *Same as NRC (1996, 2000)*

Questions/Discussion