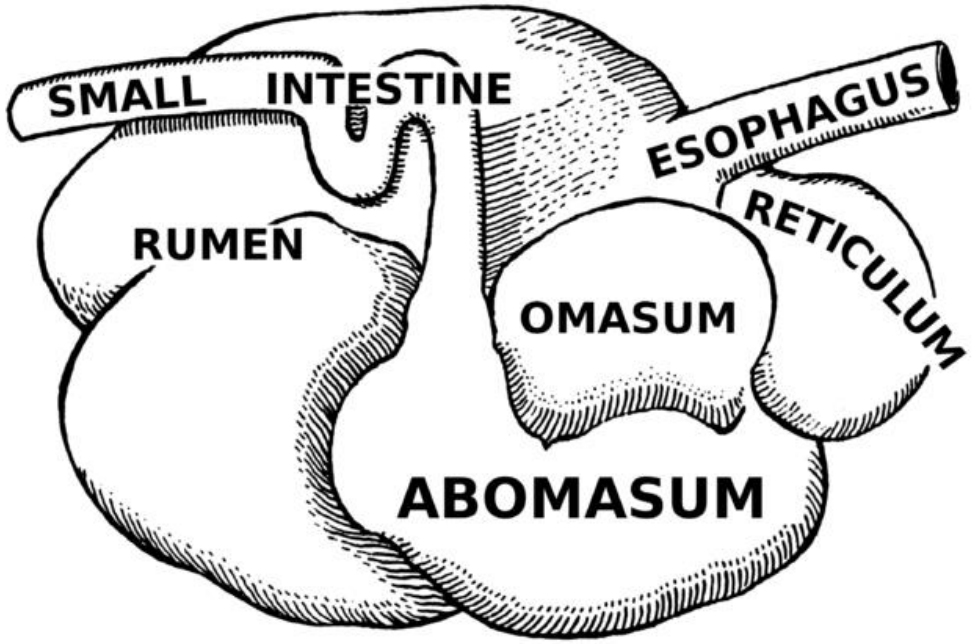
Beef Cattle Nutrition

UTAH STATE UNIVERSITY EXTENSION

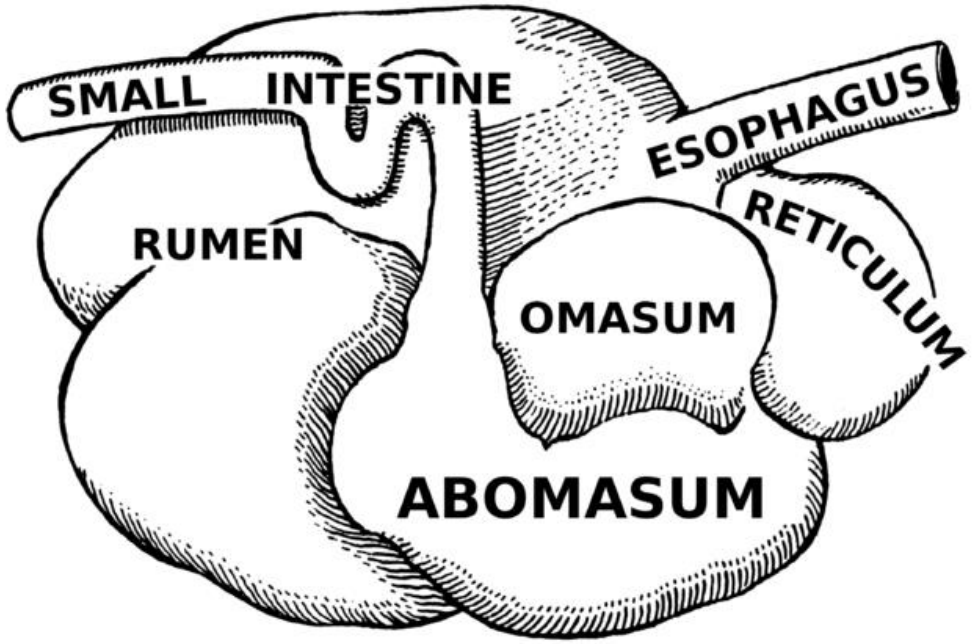
Basic Ruminant Physiology

- Rumen – fermentation vat
  - Mature cow capacity ~ 50 gallons
  - Microbial fermentation produces volatile fatty acids (VFA's)
    - Very wet environment
    - Break down fiber component
    - Majority of VFA's absorbed in rumen
    - No enzymatic digestion
  - Microbial protein
    - Microbes flow to small intestine and provide protein (amino acids) to the animal



Basic Ruminant Physiology

- Reticulum
  - Rumination – reducing particle size
  - Controls flow to Omasum
- Omasum
  - Firm, oval shaped
  - Absorbs water and VFA's
  - Reticular groove
    - Allows for milk flow directly to Omasum
  - Abomasum – "True Stomach"
    - Acidic and enzymatic digestion of feed



Basic Ruminant Physiology

- Small Intestine
  - Enzymatic digestion
    - Protein
    - Carbohydrates (if not digested in the rumen)
    - Major site of nutrient absorption
- Large Intestine
  - Nutrient absorption

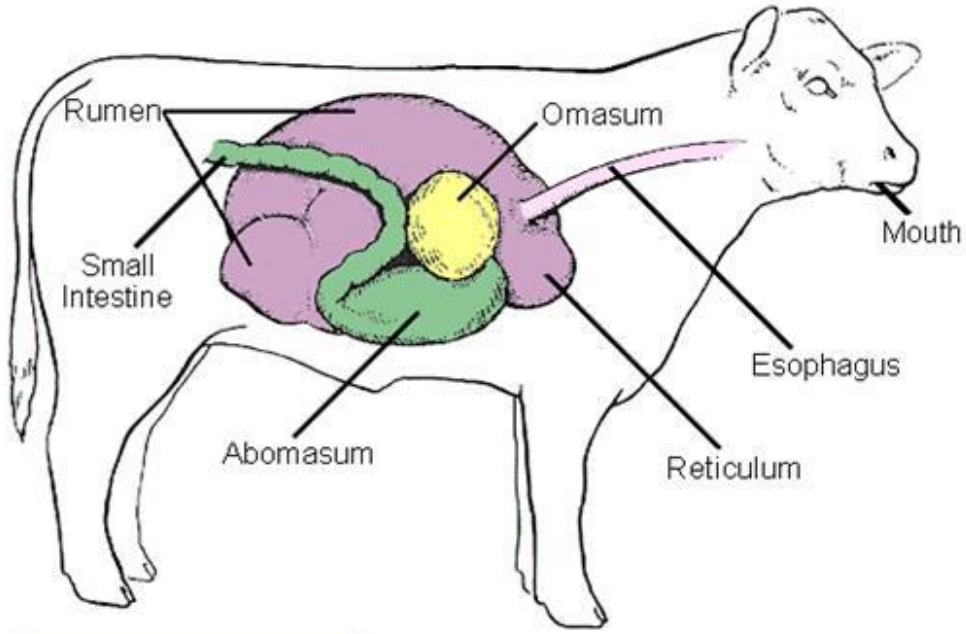


Fig: Showing Rumen

Basic Nutritional Needs

- Water
- Carbohydrates (energy)
- Protein
- Roughage
- Fats
- Minerals
- Vitamins

Water

- Most critical nutrient for performance
  - Easily taken for granted
  - 70% of animal's body weight
- Requirements
  - Unrestricted access
    - Feed intake drops with dropping water intake – No water…No feed
  - ~ 12 gallons per day for a mature animal (70° F)
  - Can double with higher temperatures (90° F)
- Quality
  - "Clean" – improves intake
  - Salinity, pH, sulfates, nitrates – decrease water intake hurt performance

Carbohydrates

- Structural – Plant cell walls
  - Fiber component - makes up plant cell wall structure
    - Lignin – largely indigestible
      - Warm season plants accumulate ligin more rapidly
    - Cellulose – limited breakdown by microbial enzymes in the rumen
      - Not digested by monogastrics
    - Hemicellulose – more easily broken down by ruminants
  - Fiber increases with increasing plant maturity
- Non-structural – plant cell contents
  - Starch
  - Sugars

Carbohydrates

- Digestion
  - 70-90% takes place in the rumen – Microbial digestion
    - Starch digesting microbes
    - Fiber digesting microbes
  - Products of carbohydrate digestion
    - Microbial flow – cells flow through the system and are digested enzymatically in the small intestine
      - Mainly protein – amino acids
    - Volatile fatty acids (VFA's)
      - Principle energy source for ruminants
      - Absorbed primarily in the rumen
    - Gas – methane, carbon dioxide
    - Heat

Protein

- Proteins are made up of amino acid (AA) chains
  - Essential AA's – animal cannot produce for themselves
    - Sources of AA's
      - Diet
      - Microbial protein
        - AA's not sufficient for high production
  - AA's primarily absorbed in the small intestine
    - All AA's contain nitrogen
- Rumen microbes can utilize nitrogen to make AA's (microbial protein)
  - Non-Protein Nitrogen (NPN)
    - Often fed in the form of urea
    - Can be used in ruminant diets **on a limited basis** to supplement protein needs

Protein

- Microbial activity breaks down protein in the rumen
  - Nitrogen and AA's are utilized by rumen microbes for growth and proliferation
  - AA composition at the small intestine tends to be the same regardless of diet composition
- Sources of essential AA's
  - Microbial protein (insufficient by itself)
  - Dietary protein that escapes digestion in the rumen
    - Bypass protein
    - Protected AA's – mostly dairy diets

Fats

- Forages and grains contain small amounts of fat
- Added fats
  - Vegetable oils
    - Corn, soy, canola, palm, cottonseed
      - By-product feeds contain relatively high levels of fat
  - Animal fats
    - Beef or pork tallow
  - High levels of added fat (<5%) can reduce fiber digestion
- Primarily absorbed in the small intestine
- Increase diet energy
  - Reduced heat and gas loss

Macro-Minerals (% of diet)

- Salt (sodium chloride) – only mineral cattle will seek out
- Calcium – high in forages, need to be supplemented in high concentrate (feedlot, dairy diets)
- Phosphorous – high in grains, need to be supplemented with dormant forage or grazing diets, critical for optimal production
- Magnesium – adequate in most forages, but can be lacking in lush, early spring growth (grass tetany)
- Potassium – may need to be supplemented with low quality forages
- Sulfur – rarely need to supplement, excess sulfur can negatively affect ruminal digestion, absorption of copper and zinc
  - Excess sulfur can be found in water sources and some feeds (distillers grains)

Trace Minerals (ppm)

- Usually deficient and require supplementation for optimal production
- Sulfate forms usually better absorbed than oxides
- Organic or chelated sources can be beneficial
  - Copper
    - Copper antagonists – molybdenum, iron, sulfur
    - Essential for health, growth and reproduction
  - Cobalt
    - Integral part of Vitamin B12
    - Improve energy metabolism
  - Iodine
    - Thyroid function, hoof health
    - Toxic at high levels
  - Manganese
    - Cofactor in many metabolic processes/enzyme function
  - Selenium
    - Muscle growth, fertility
  - Zinc
    - Immune system, hoof health

Vitamins

- Supplementation required
- Vitamin A – bone and skin tissue growth, eyesight
  - ~30,000 IU/hd/d
- Vitamin D – can be synthesized in the skin by sunshine,
  - Important in bone formation, calcium mobilization from bone
  - ~10,000 IU/hd/d
- Vitamin E – general health and immune function
  - ~100 to 400 IU/hd/d – health stressed animals need higher levels
- Thiamine – central nervous system development and function
  - Cattle with normally functioning rumen can synthesize but feedlot cattle can become deficient if digestive issues occur

Dry Matter Intake (DMI)

- Feed intake is measured on a dry matter basis
  - Water content of feed does not carry nutritive value
  - Example
    - Cow eats 50 lbs of corn silage as fed
      - Corn silage is 35% dry matter – 50 X .35 = 17.5 lbs dry matter
    - Cow eats 20 lbs of grass hay
      - Grass is 88% dry matter – 20 X .88 = 17.6 lbs of dry matter
    - DMI is nearly identical in spite of the cow eating significantly more corn silage (as fed weight)
- Predicted as a % of body weight
  - Example
    - 1,200 lb eats 2.5% of body weight = 30 lbs of dry matter

Factor Affecting Dry Matter Intake

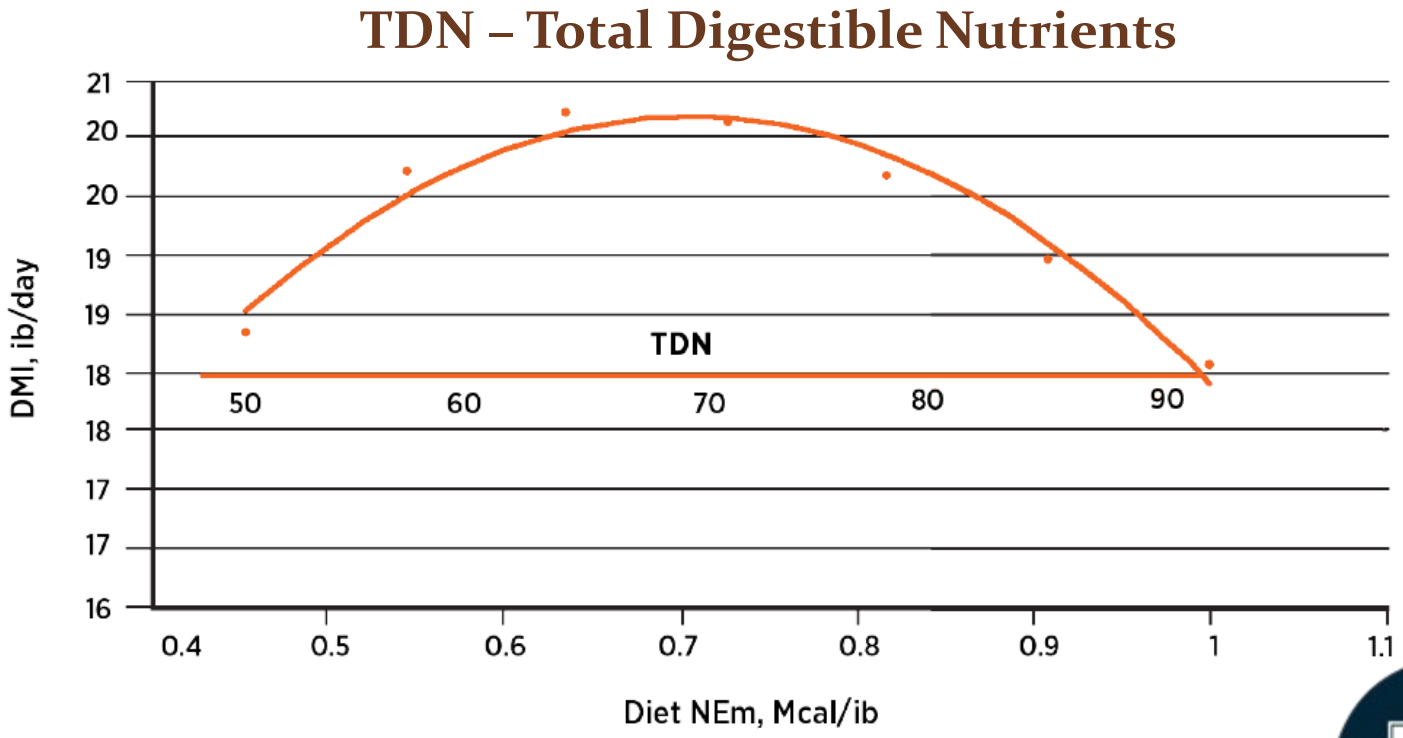
- Body weight – larger animals eat more
- Body condition – thinner cattle eat more
- Stage and level of production – higher energy demands increase DMI
  - Pregnancy
    - Late stages of pregnancy can reduce DMI
  - Lactation
- Forage quality – low quality (low digestibility) reduces feed intake
  - Retention time (rate of passage) in rumen reduced with diets high in indigestible fiber components (cellulose, lignin)
- Supplementation
  - Protein supplementation can improve intake of low-quality forage
  - Energy supplementation (in some cases) can reduce intake of forages

Other Factors Affecting DMI

- Environment
  - Heat – reduce DMI
  - Cold – increase DMI to a point
    - Cold with wind can cause cattle to bunch and not eat
- Physical and Metabolic Factors
  - Rumen fill – cattle can become full even if energy requirements are not being met
    - Low-quality forage – low rate of passage cause rumen filling
  - High-energy diets will reduce DMI
    - DMI controlled by metabolic feedback – limit to the number of calories cattle will consume even if the rumen is not full

Dry Matter Intake

- Low energy diets – Left
  - Low quality forage
  - Rumen fill Controls back DMI
- High energy diets – Right
  - High concentrate (grain)
  - Total caloric intake controls DMI
- DMI max at 65% to 75% TDN



Nutrient Requirements

SUPPLEMENT CONSIDERATIONS

Priority of Nutrient Use

1. Maintenance
2. Activity
3. Pregnancy maintenance
4. Lactation
5. Growth
6. Energy reserves
7. Estrous cycle
8. External fat

Mature Cow Considerations

- Stage of Production – 4 stages
  - Period 1 – calving to bull turn out (80 days)
  - Period 2 – breeding and lactating (125 days)
  - Period 3- Pregnant and not lactating or post-weaning (100 days)
  - Period 4 – Just prior to calving (60 days)
- Questions to answer for each stage
  - What is the forage quality? TDN? CP?
    - Need estimates or forage tests (best)
  - Expected DMI?
    - Cow size
    - Forage quality

Forage Quality Effect on Dry Matter Intake

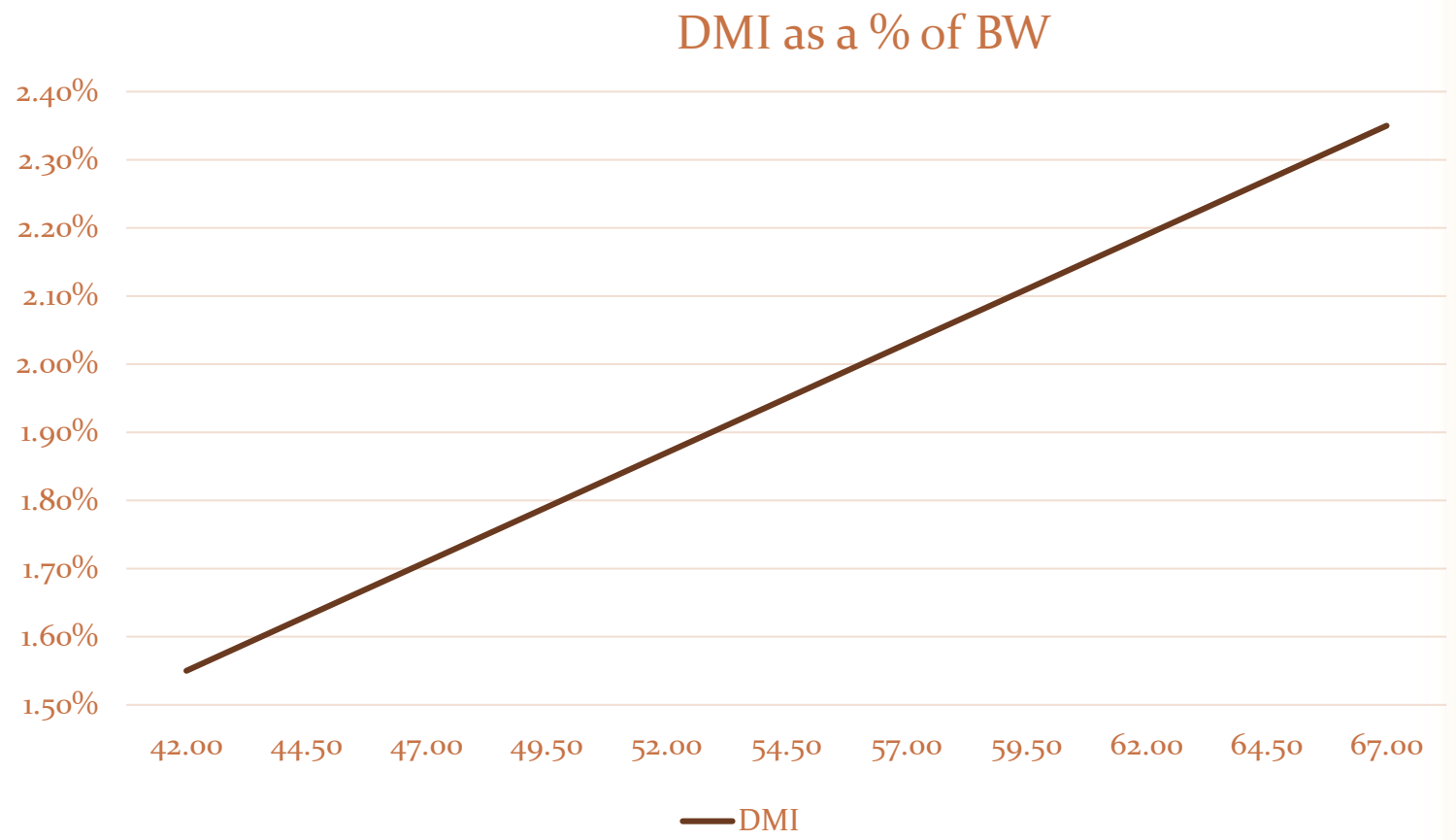
TDN, %	DMI, % of BW
42.00	1.55%
44.50	1.63%
47.00	1.71%
49.50	1.79%
52.00	1.87%
54.50	1.95%
57.00	2.03%
59.50	2.11%
62.00	2.19%
64.50	2.27%
67.00	2.35%

- Barley Straw – 41% TDN
- Crested wheat grass (early spring) – 75% TDN

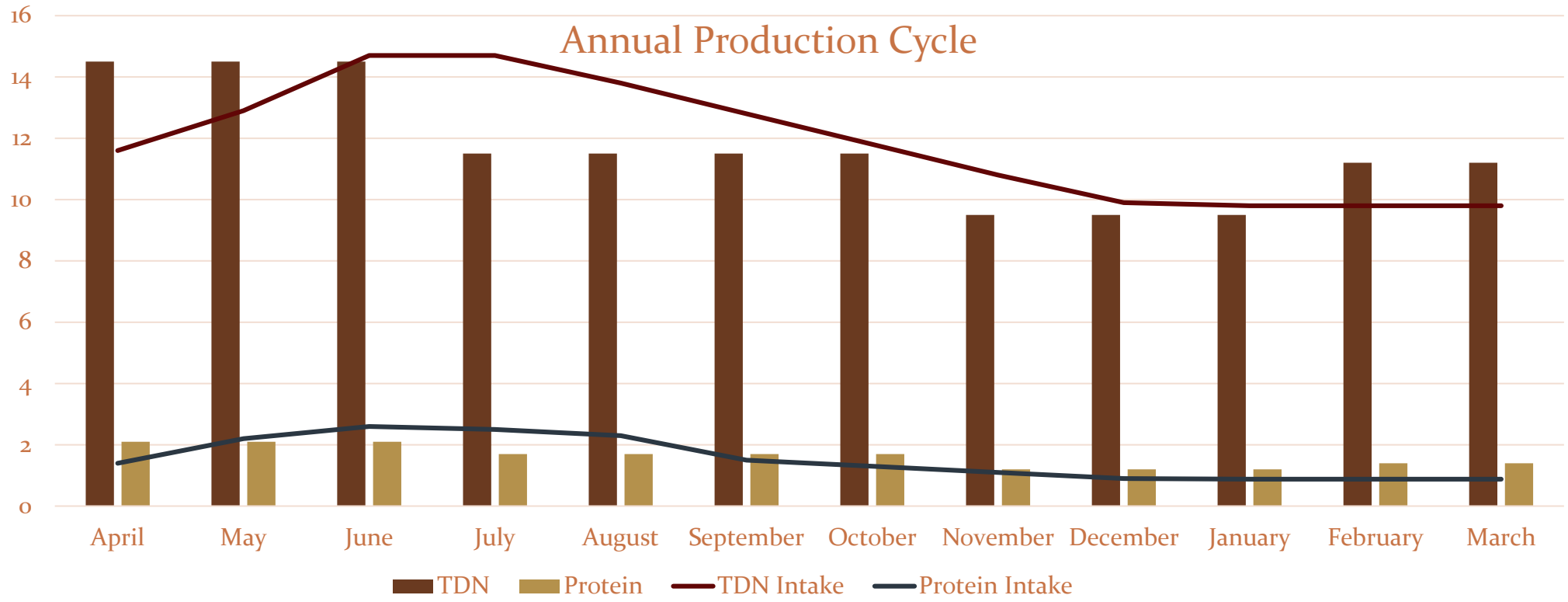
Example:

1,100 lb cow eating hay with 52% TDN

1,100 X 1.87% = 20.6 lbs DMI



Spring Calving Cow Energy and Protein Balance



Assume 1,100 lb cow, calving on April 1 grazing native range year-round

Supplementation Considerations

- When protein is deficient…
  - Protein supplement will improve fiber digestion and improve DMI (TDN intake)
    - Solve two problems at once
      - Energy and protein
- Period 1 – calving to bull turn-out
  - Difficult to maintain body condition
    - Supplementation early can reduce impact of condition loss
    - Positive energy balance going into breeding can help
- Period 2 – breeding and lactating
  - Excess energy and protein can compensate for weight loss during period 1 IF not excessive
  - Protein supplementation toward the end of period can improve body condition going into winter by increasing intake
- Period 3 – pregnant, not lactating
  - Lowest maintenance requirements
  - Great time to add weight, especially early in the period
  - Protein supplementation to improve DMI
- Period 4 – 60 days before calving
  - Nutritional demands going up
  - Maintain body condition – very difficult to add condition
  - Likely need protein and energy

Protein Supplementation

- Non-Protein Nitrogen (NPN)
  - 287% crude protein
  - Urea – contains two nitrogen molecules
    - Utilized by rumen microbes
    - Biuret –two urea molecules, slower release
  - Can be used on a limited basis with low-quality forages (period 3)
  - Best used in conjunction with natural proteins
- Natural protein sources
  - Soybean meal, cottonseed meal, canola meal – high-level 40%+ CP
  - Dry distillers grains (DDG) – mid-level ~ 30% CP
  - Millrun (wheat by-product) – low-level ~ 20% CP
  - Alfalfa hay – low level ~ 20% CP
  - Look at cost per unit of CP

Form of Protein Supplementation

- Molasses based lick tubs
  - Usually contain NPN and some natural protein
  - Controlled intakes – cooked molasses will slow down consumption
  - Serve mainly as protein source – intake not high enough to provide substantial energy
  - Can include vitamin and minerals
  - Enhance grazing behavior
  - Feed with a pick-up
  - Expensive
  - Low labor

- Protein blocks
  - Normally higher levels of natural protein but also can contain NPN
  - Intakes can be difficult to control – soft
  - Mainly protein source but high intakes will supplement energy
  - Can include vitamin and minerals
  - Enhance grazing behavior
  - Feed with a pick-up
  - Fairly expensive
  - Relatively low labor

Forms of Protein Supplementation

- Loose meals
  - "Roughage Buster"
    - Similar in nutritional composition to lick tubs
    - Intake control
    - Contains vitamins and mineral
    - Enhances grazing behavior
    - Feed with a pick-up
    - Low labor
    - Expensive

  - Commodity mix – mix of several commodities listed above
    - Usually all-natural protein
    - Could be in small pellets or meal form
    - Fed on the ground – some waste
    - Need to be fed on regular basis – 3 times per week
    - May need equipment to feed unless bagged
    - May disrupt grazing behavior
    - Higher labor
    - Less expensive than tubs on or blocks

Forms of Protein Supplementation

- Range cubes – cake
  - Mix of natural protein sources – can contain some NPN
  - Flexible – wide range in protein and energy content depending on need
  - Large cube or pellet – reduce waste
  - Need to be fed on regular basis – 3 times per week
  - May need equipment to feed unless bagged
  - May disrupt grazing behavior
  - Higher labor
  - Less expensive than tubs on or blocks

Forms of Protein Supplementation

- Alfalfa hay - protein and energy supplement
  - Need to be fed on regular basis
    - 3 times per week if fed as protein supplement
    - Daily if supplementing energy
  - May disrupt grazing behavior
  - Labor intensive
  - May be less expensive - $/unit of protein

Energy Supplementation

- Supplement or replace grazing
- Test forage for nutritional value
- Disruptive to grazing behavior
- Labor intensive
- Hay
  - Alfalfa
  - Grass
  - Small grains (Triticale, wheat, barley)
  - Straw
- Silage
  - Corn
  - Small grains

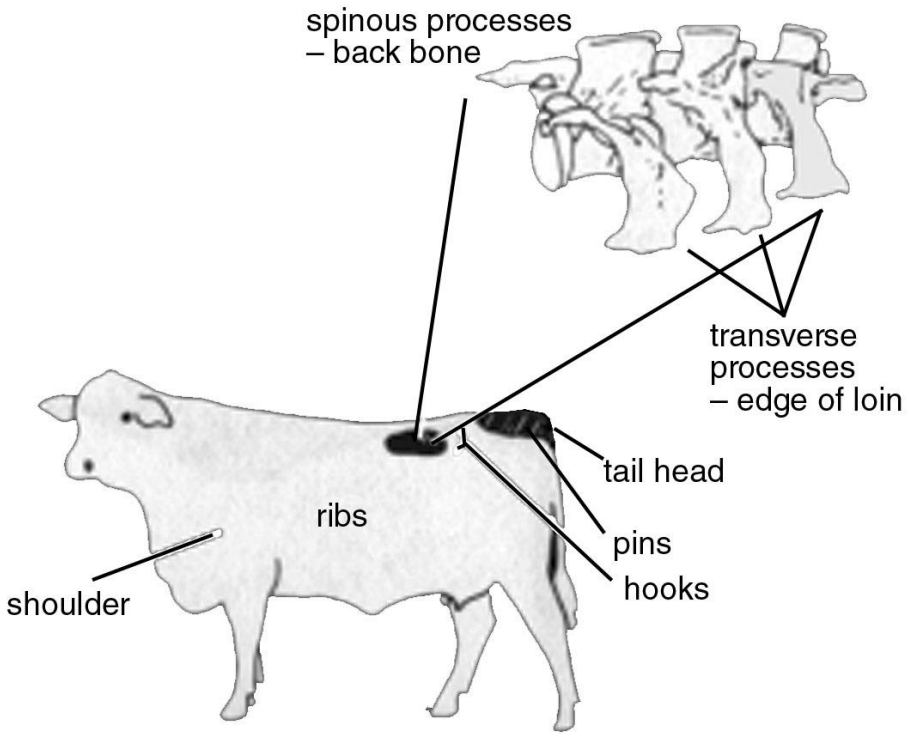
Mineral Supplementation

- Salt blocks
  - Unfortified – salt only
  - Fortified
    - Can contain some trace minerals and vitamins
    - Usually lacking in macro-minerals
      - Calcium, phosphorus, magnesium
  - Low labor
  - Cheaper
  - May be adequate when forage quality is high
- Loose mineral supplements
  - More complete mineral and trace mineral supplement
  - Flexible formulation to fit needs
  - Need to monitor intake
  - Higher labor
  - More expensive

Body Condition Scoring

What is Body Condition Score (BCS)

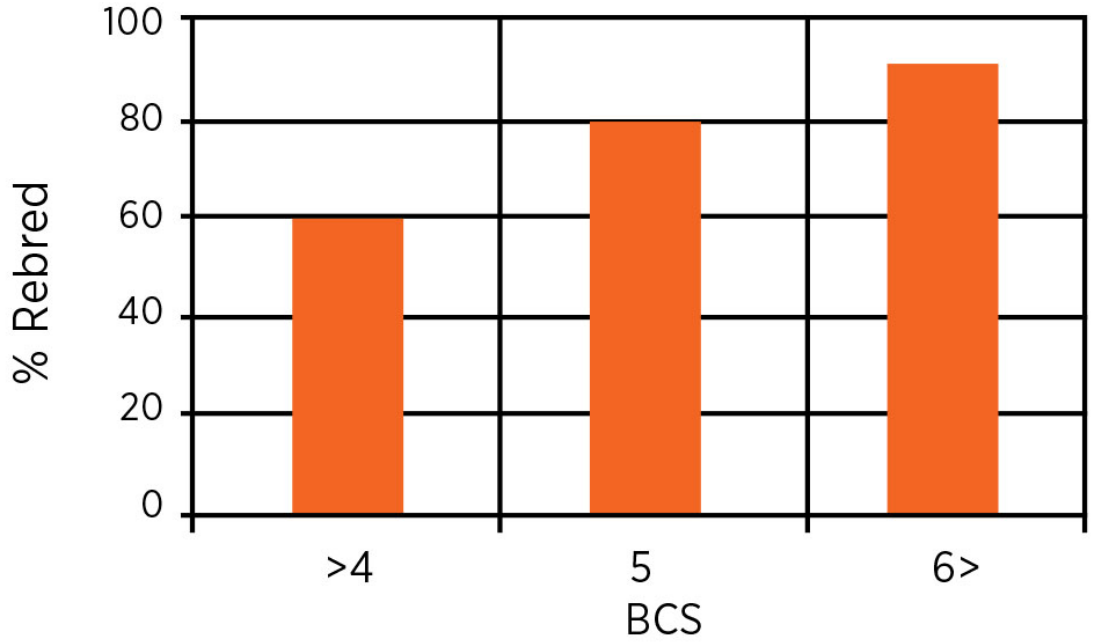
- Measure of body energy (fat) stores available as an energy source
- Scoring ranges from 1 (very thin, emaciated) to a 9 (obese)



Body Condition Scoring

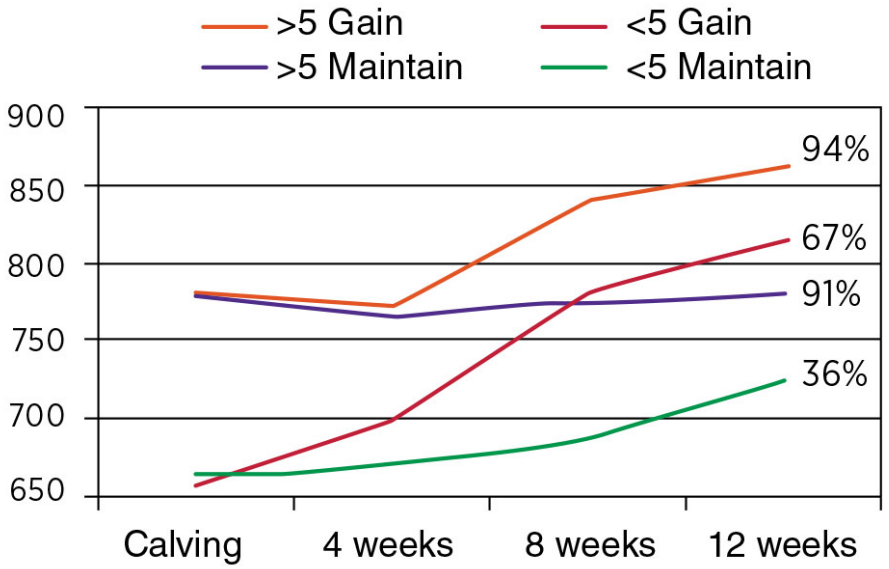
Effects of BCS at Calving

- Strong relationship between BCS at calving and reproductive success
- Cows must conceive at 80 to 85 days post-calving maintain post-partum interval



Effects of BCS at Calving

- BCS > 5 at calving results in high reproductive efficiency
  - Small improvement with weight gain
  - Cost/benefit?
- BCS <5 at calving results in poor reproduction
  - Big improvement with weight gain but still compromised
- Much cheaper to keep cattle in good condition



Heifer postpartum body weight and BCS gaining or maintaining weight

Potential Feed Strategy

- Assumptions
  - April 1 calving
  - Grazing permit – May 15 to October 15
  - Graze crop aftermath in fall
- 4 stages of Production
  - Period 1 – calving to bull turn out (80 days)
  - Period 2 – breeding and lactating (125 days)
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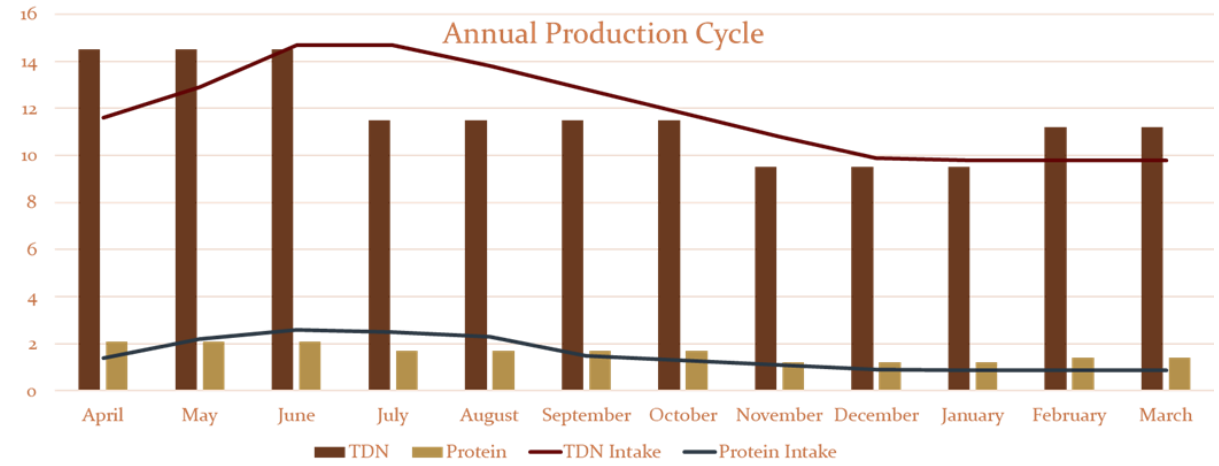

Assume 1,100 lb cow, calving on April 1 grazing native range year-round

Period 3 – November - January

- Excellent time to put condition on cows
- Added protein will increase DMI
- Graze dormant (low quality forage) November and December
  - Supplement with tubs or blocks if accessibility is an issue
  - OR feed 4.5 lbs of 20% CP alfalfa hay, 3X per week
    - Provide ~ .40 lbs of added protein per day
  - Free choice 8% phosphorus loose mineral

Period 4 – February-March

- 60 days before calving
- Assume cows are BCS >5
- Maintain BCS
- Feed lower quality grass hay or straw
- Supplement with 3 lbs alfalfa hay daily
  - May be able to feed alfalfa 3-5X/week
  - Be prepared to feed more in extreme weather
- Free choice 8% phosphorus loose mineral

Periods 1 and 2

- April – June - 0 to 90 days post-calving
  - April 1 to May 15
    - Feed higher quality grass or small grains hay (oat, triticale)
    - 4 to 5 lbs alfalfa fed daily
    - Free choice 8% phosphorus loose mineral
  - May 15 through June
    - Grazing on permit
    - Consider free choice 4% phosphorus loose mineral
- July–October 15 (Bulls out)
  - Assume adequate forage quantity and quality
  - Free choice fortified salt block

Weaning Calves

Suckling Calves

- Take care of the cow and she will take care of the calf
- Calves will consume mineral and supplemental feed
- Vitamin and mineral nutrition critical for optimal **health** and growth
  - May have good health on the cow but fall apart at weaning
  - Usually a result of antagonisms
    - High iron and sulfur interferes with coppern and zinc absorption
    - High molybdenum can interfere with selenium absorption
  - Chelated trace minerals can help with severe deficiencies or antagonisms
- Energy/Protein deficiency
  - May be more efficient to feed calf directly
    - Creep feeders
    - Early weaning

Weaning

- Vaccination program
  - Prefer to vaccinate at branding and 2-3 weeks before weaning (if possible)
  - Avoid additional processing – dehorning, castration
  - Deworming?
- Helpful to feed calves with cows prior to weaning if possible
  - Acclimate to new feed – let cows teach calves how to eat
- Weaning methods
  - Avoid dust – wean on a pasture if possible
  - Abrupt removal – better to leave the calves and remove the cows out of sight and ear-shot
  - Fenceline weaning – cows and calves can stand together but not suckle
    - Fences must be good enough to allow contact but not nursing
      - May use hot wire
    - 5 to 7 days

Weaning

- Water – clean and easy to get to
  - May consider letting the water run if calves have not used a trough
- Feed
  - Quality matters
    - Low intakes – make every bite count
  - Familiar hay type - palatable
    - Clean, high-quality grass may be preferred to alfalfa if that is more familiar
    - Avoid silage
  - Free choice palatable mineral
    - Extra vitamin and trace mineral (chelates) fortification
  - Introduce new feeds with hay within the 2-3 days
    - Mixed ration or pelleted feed

Weaning Health Concerns

- Coccidiosis – bloody scours
  - All rations or supplement should contain a coccidiostat
    - Deccox, Bovatec, Rumensin
    - Amprolium can be used in the water for prevention or treatment

- Respiratory disease
  - Good preweaning nutrition and vaccination program is best preventative
  - Other prevention options
    - Prophylactic antibiotic treatment
      - Injectable antibiotics given at weaning
      - Feed grade antibiotics – require veterinary prescription