Cattle nutrition

MVDr. Macháček Miroslav, Ph.D.

Nature of ruminant stomach

- Four compartments
  - The rumen
  - The reticulum
  - The omasum
  - The abomasum

Nature of ruminant stomach

- Occupy almost 3/4 of the abdominal cavity
- Fills
  - Virtually all of the left side
  - Extending significantly into the right

The rumen

- The largest of the fore stomaches
- Sacculated by muscular pillars
  - Dorsal
  - Ventral
  - Caudo-dorsal
  - Caudo-ventral

The rumen

- Function of the Rumen
  - Fermentation vat filled with microbial populations which
    - Collaborate to digest cellulose and other polysaccharides
    - Produce carbon dioxide, methane and organic acids
  - Ingested food first enters the rumen
    - pH 6.5
    - Temperature of 30°C
    - Microbial digestion for 9 hours

The rumen

- Function of the Rumen
  - The gaseous products of the microbial degradation
    - Expelled from the animal
      - Eructation
    - Cud from the rumen is regurgitated

The rumen

- Function of the Rumen
  - Regurgitated mixture of microorganisms and partially digested materials travels through
    - Abomasum
    - Omasum
      - pH 2
  - Microbes
    - Produce
      - Protein from simple nitrogenous compounds
      - B-complex vitamins
    - Die
    - Are digested and absorbed for nutrients in the small Intestine
    - Useful for the digestion of forages
    - Inefficient in the use of starches and proteins digestion

7

The rumen

- Function of the Rumen
  - The volatile fatty acids
    - Produced by fermentation in the rumen
    - Absorbed across the rumen epithelium

8

The reticulum

- Lies against the diaphragm
- Is joined to the rumen by a fold of tissue
- Is connected to the spherical omasum by a short tunnel

9

The reticulum

- Function of the reticulum
  - Interacts with rumen to mix and stir feed
  - Additional area for fermentation

10

The omasum

- Particle size of digesta is reduced
- Excess water is removed before the digesta enters the abomasum
- Can contain up to 16 litres of digesta
- My function to absorb
  - Residual volatile fatty acids
  - Bicarbonate

11

The abomasum

- True stomach
- Acids and enzymes are secreted to further digest
- First true glandular portion of the gastrointestinal
  - The stomach walls secrete enzymes
- It functions very similarly to the stomach
- Can hold approximately 20 litres
- The time that digesta remains in the abomasum is very short

12

The abomasum

- The presence of food stimulates hydrochloric acid production
- Hydrochloric acid converts pepsinogen to pepsin
  - Breaks down protein to shorter molecular chain compounds
    - Peptides
    - Amino acids
- pH 2 – 4

13

The abomasum

- Need to process large masses of bacteria
- Secrets lysosome
  - Eenzyme that efficiently breaks down bacterial cell walls

14

Small intestines

- Composed of small particles suspended in liquid digesta
- Digestion and absorption peptides and amino acids

15

Nutritional requirements of dairy cattle

- Lactation
  - Dairy cows have very high nutritional requirements
  - Requirements for energy and protein
  - Diets must have sufficient nutrient concentrations
  - Support production and metabolic health

16

Nutritional requirements of dairy cattle

- Feed intake
  - Dairy nutrition is managing feed intake relative to nutrient requirements
  - Feed intake (dry-matter intake) and feed efficiency (milk production per unit of dry-matter intake)

17

Nutritional requirements of dairy cattle

- Feed intake
  - Dry-matter intake is influenced by
    - Feed compositional factors
    - Cow physiologic factors
    - Management factors

18

Nutritional requirements of dairy cattle

- Feed intake
  - Dry-matter intake is influenced by
    - Feed compositional factors
      - Neutral detergent fiber
        - » Quality of ensiled feeds
          - Moisture
          - Fermentation products
        - » Maturity
          - Lignification
        - » Palatability
        - » Nutrient availability

19

Nutritional requirements of dairy cattle

- Feed intake
  - Dry-matter intake is influenced by
    - Cow physiologic factors
      - Age
      - Body size
      - Physiologic state
      - Body condition score
      - Days in lactation
      - Production level

20

Nutritional requirements of dairy cattle

- Feed intake
  - Dry-matter intake is influenced by
    - Management factors
      - Feed bunk management
        - » Feed delivery
        - » Availability
        - » Consistency
      - Grouping strategies
      - Cow comfort
      - Heat abatement strategies

21

Nutritional requirements of dairy cattle

- Feed intake
  - Lactating cows managed to maximize intake rapidly after calving
  - Minimize the severity and duration of negative energy balance
  - Postpartum negative energy balance => Negatively impact body condition => Risk for postpartum disease and reproductive inefficiency

22

Nutritional requirements of dairy cattle

- Carbohydrates
  - Wide range of compounds from simple sugars to complex polysaccharides
  - They account for 60%–80% of dietary dry matter for dairy cows
  - Are segregated based on chemical measures and nutritional impacts
  - Structural carbohydrates
    - Limit intake
    - Stimulate chewing and rumination
    - Helps maintain rumen buffering
    - Increase milk butterfat composition

23

Nutritional requirements of dairy cattle

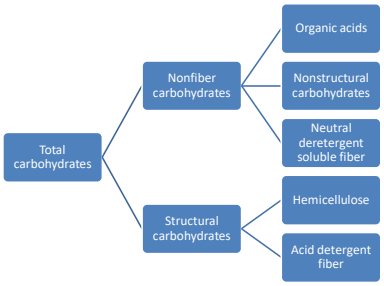
- Carbohydrates
  - Fiber in the diet supports rumen health
  - Fiber from forage sources that have not been finely chopped stimulates
    - Motility
    - Cud chewing
    - Salivary flow
  - These actions stimulating endogenous production
    - Salivary buffers
    - High rate of fluid movement through the rumen

24

Nutritional requirements of dairy cattle

- Carbohydrates
  - Nonfiber carbohydrate
    - Organic acids
    - Sugars
    - Starch
  - Neutral detergent soluble fiber
    - Secondary plant cell wall
    - Highly fermentable and provide good sources of energy
      - Pectins
      - Beta-glucans
      - Galactans

25



26

Nutritional requirements of dairy cattle

- Carbohydrates
  - Balancing fiber and nonfiber carbohydrate optimize energy intake and rumen health
  - Increases the rate and extent of rumen fermentation => Greater energy availability => Increased ruminal fermentation => Increase production of volatile fatty acids => Lower rumen pH
  - Rumen pH
    - <6.2
      - Fiber digestion is reduced
    - ≤5.5
      - Fiber digestion is severely diminished
      - Feed intake may be reduced
      - Rumen health is generally compromised

27

Nutritional requirements of dairy cattle

- Energy
  - Available for metabolic use
    - Metabolizable energy
      - Body maintenance
      - Growth
      - Lactation

28

Nutritional requirements of dairy cattle

- Energy
  - Net energy
    - Differences in efficiency of metabolizable energy utilization for each of these processes and assigns a separate net energy value to individual feedstuffs based on each energy-requiring processes
      - Body maintenance
      - Growth
      - Lactation
    - Energy values of feedstuffs for ruminants
      - Net energy maintenance
      - Net energy for gain
      - Net energy for lactation
    - Major advantage of more equitably comparing the energy values of forages to concentrates when used in ruminant diets

29

Nutritional requirements of dairy cattle

- Energy
  - Metabolizable energy
    - Cannot be measured directly by typical laboratory analyses
    - Based on formulas with acid detergent fiber concentration

30

Nutritional requirements of dairy cattle

- Fats
  - Diets are low in total fat content
  - Microbial fiber fermentation
    - Polyunsaturated fatty acids

31

Nutritional requirements of dairy cattle

- Fats
  - Sources
    - Endogenous
      - Forage lipids
        - » Glycolipids
        - » Pigments
        - » Cutins
        - » Waxes
    - Vegetable
      - Polyunsaturated fats from oilseeds
        - » Soybean
        - » Corn
        - » Canola
        - » Sunflower
      - laxseed
    - Rumen inert fats
      - Saturated animal fats
      - Calcium soaps
      - Prilled fats

32

Nutritional requirements of dairy cattle

- Fats
  - Induce undesirable metabolic effects
  - Ramifications include reduced
    - Fiber digestion
    - Indigestion
    - Poor rumen health
    - Suppression of milk fat concentration

33

Nutritional requirements of dairy cattle

- Fats
  - Can provide additional concentrated energy
  - Adding fat within the first 3 weeks of lactation => negative effect on intake
  - Addition of fat after this period => improve milk fat content, milk production, reproductive efficiency

34

Calcium and phosphorus requirements of dairy cattle

- Most often considered due to their roles in
  - Skeletal structure
  - Metabolism
  - Milk

35

Calcium and phosphorus requirements of dairy cattle

- Calcium requirements of lactating dairy cows
  - High relative to
    - Other species
    - Nonlactating cows
- Phosphorus requirements
  - Approximately half of calcium requirements

36

Calcium and phosphorus requirements of dairy cattle

- Phosphorus
  - Lost to milk
  - Recycled via saliva to the rumen
    - Support microbial growth needs
  - First limiting mineral on a forage-based feeding program
  - Associated with infertility in cattle
    - Only occurs in extremely low forage phosphorus conditions
  - Oversupplementation of phosphorus => Environmental impact

Calcium and phosphorus requirements of dairy cattle

- Dietary calcium and phosphorus supplementation
- Important in young growing animals
  - Support of bone development
- Early lactation
  - Negative calcium and phosphorus balance
    - Bone calcium and phosphorus mobilization

Calcium and phosphorus requirements of dairy cattle

- Legume and grass forages
  - Similar phosphorus content
  - Divergent calcium content
    - Legumes much higher calcium levels

Calcium and phosphorus requirements of dairy cattle

- Parturient hypocalcemia
  - Milk fever
  - Prevention
    - Restricting dietary calcium at or below the available requirement 2–3 weeks prior to calving induces => Homeostatic system => Up-regulate calcium influx to counter subsequent colostrum and milk

Calcium and phosphorus requirements of dairy cattle

- Dietary cation-anion difference
  - Acidifying diet => Diet low or negative
  - Milk fever prevention
  - Higher dietary calcium
    - Compensate for increased urinary loss

Diseases related to dietary characteristics or nutritional deficiencies

- Bloat
  - Consumption of
    - Legume pastures
    - Finely ground, highstarch diets

Diseases related to dietary characteristics or nutritional deficiencies

- Diarrhea
  - Numerous factors
    - Abrupt changes in diet
    - Increases in dietary nonfiber carbohydrates and dietary rumen fermentability

43

Diseases related to dietary characteristics or nutritional deficiencies

- Displaced abomasum
  - Metabolic and nutritional causes
    - Feeding
      - Should be to prevent ketosis
      - Stimulate high dry-matter intakes
    - Pre- and postpartum diets
      - Important in management
  - Predisposing
    - Hypocalcemia
    - Subclinical ketosis

44

Diseases related to dietary characteristics or nutritional deficiencies

- Fatty liver
  - Excess body condition
    - Late lactation
    - Dry period
  - Poor feed intake in
    - Late gestation
    - Early lactation

45

Diseases related to dietary characteristics or nutritional deficiencies

- Hypomagnesemic tetany
  - Functional and absolute magnesium deficiency
  - Increases with consumption of
    - Lush pasture grasses
      - High potassium concentrations

46

Diseases related to dietary characteristics or nutritional deficiencies

- Ketosis
  - Glucose deficiency
    - Insufficient gluconeogenesis
    - Excessive lipid mobilization
  - Primary nutritional influences
    - Excess body condition in late gestation
    - Insufficient feed intake in early lactation

47

Diseases related to dietary characteristics or nutritional deficiencies

- Laminitis
  - Diets with high concentrations of nonstructural carbohydrates
    - Sugar
    - Starches
  - Excessive hindgut fermentation of dietary nonstructural carbohydrates
    - Bypass starch sources

48

Diseases related to dietary characteristics or nutritional deficiencies

- Milk fever (parturient paresis)
  - Failure of calcium homeostasis
  - Control by
    - Feeding low-calcium diets
    - Acidifying diets prepartum

49

Diseases related to dietary characteristics or nutritional deficiencies

- Rumen acidosis - Acute clinical
  - Major errors in feed delivery
  - Inconsistencies in feed delivery
  - High starch intake => Unaccustomed to diets => Formation of lactic acid in the rumen => Drops in rumen pH

50

Diseases related to dietary characteristics or nutritional deficiencies

- Rumen acidosis - Chronic subclinical
  - Lactation diets with
    - High nonfiber carbohydrate concentrations
    - Low fiber concentrations
  - High rumen concentrations of volatile fatty acids => Rumen pH ≤5.6

51

Diseases related to dietary characteristics or nutritional deficiencies

- Urolithiasis
  - Diets with
    - High phosphorus
    - Relatively low calcium
    - High potassium
  - Alkaline urine
    - Struvite
  - Predisposing
    - Vitamin A deficiency
    - Low fiber concentrations => Minimizing saliva flow
    - High intake of oxalates, silicates or calcium

52

Clinical signs related to dietary characteristics or nutritional deficiencies

- Anemia
  - Deficiency in
    - Adult cattle
      - Copper
      - Cobalt
    - Young calves
      - Iron

53

Clinical signs related to dietary characteristics or nutritional deficiencies

- Inappetence
  - Nutritional deficiencies
    - Protein
    - Mineral
    - Vitamin

54

Clinical signs related to dietary characteristics or nutritional deficiencies

- Incoordination
  - Blind staggers
    - Sulfur intoxication
    - Demyelinization
    - Subclinical hypocalcemia

55

Clinical signs related to dietary characteristics or nutritional deficiencies

- Rickets and osteomalacia
  - Insufficient
    - Calcium
    - Phosphorus
    - Vitamin D

56

Clinical signs related to dietary characteristics or nutritional deficiencies

- Skin problems
  - Dull, brittle coats, hypotrichia, easily depilated hair, hyperkeratosis, thin skin, poor healing
    - Deficiencies of
      - Vitamin A
      - Copper
      - Zinc

57

Clinical signs related to dietary characteristics or nutritional deficiencies

- Suppressed immunity
  - Cellular and humoral immunity
    - Malnutrition
      - Nutrient deficiencies
        - » Vitamin A
        - » Vitamin E
        - » Zinc
        - » Copper
        - » Selenium

58

Clinical signs related to dietary characteristics or nutritional deficiencies

- Toxicities
  - Feed borne toxicants
    - Nitrates
    - Cyanide
    - Mycotoxins
    - Toxic plants
    - Urea

59

Water

- Availability of high-quality water
- Ad libitum consumption
- Insufficient water reduced
  - Feed intake
  - Milk production

60

Water

- Water requirements of dairy cows are related to
  - Milk production
  - Dry matter intake
  - Ration dry-matter concentration
  - Salt intake
  - Sodium intake
  - Ambient temperature

61

Water

- Adequate access to water is critical to encourage maximal water intake
- Water should be placed
  - Near feed sources
  - In milking parlor return alleys
- Water troughs
  - Minimum of 5 cm of length per cow
  - Height of 90 cm
- Housed cows
  - One water cup per 10 cows in groups
  - Every cow group should have a minimum of two watering stations
    - Prevent a high social order cow from blocking a single water source

62

Water

- Poor water quality
  - Reduced water consumption
    - Decreases
      - Feed consumption
      - Milk production

63

Water

- Water can be evaluated by
  - Organoleptic properties
    - Color
    - Taste
    - Smell

64

Water

- Factors affecting water quality
  - pH:
    - From 5 to 9
      - Acceptable to cattle
    - Extremes
      - Concern for palatability

65

Water

- Factors affecting water quality
  - Total dissolved solids (total soluble salts)
    - Total amount of inorganic solute in the water

66

Water

- Factors affecting water quality
  - Total dissolved solids (total soluble salts)

Total dissolved solids (total soluble salts)	
Total soluble salts (mg/L)	Comments
< 1,000	Safe
1,000–2,999	Generally safe, cause a mild temporary diarrhea
3,000–4,999	May be refused when first offered to animals or cause temporary diarrhea
5,000–6,999	Pregnant or lactating animals should not drink
≥7,000	Should not be offered to cattle, health problems and/or poor production

Water

- Factors affecting water quality
  - Hardness
    - Calcium and magnesium content in water
    - Not equivalent to total dissolved solids
    - Not shown to affect cow performance
    - Calcium may add to the amount in the diet

Water

- Factors affecting water quality
  - Mineral content
    - Range of mineral elements
      - Essential nutrients as well as toxic elements

Water

- Factors affecting water quality
  - Mineral content

Toxic nutrients and contaminants	
Element	Upper-limit (mg/L)
Aluminum	0.5
Arsenic	0.05
Cadmium	0.005
Copper	1.0
Fluorine	2.0
Lead	0.015
Manganese	0.05
Selenium	0.05
Zinc	5.0

Water

- Factors affecting water quality
  - Inorganic contaminants
    - Nitrates
    - Nitrite
    - Sulfates

Water

- Factors affecting water quality
  - Organic contaminants
    - Wide range of organic compounds
      - Herbicides
      - Insecticides
      - Pharmacological agents

Water

- Factors affecting water quality
  - Microbiological contamination
    - May cause digestive issues
    - If bacteria are present
      - Reasonable to clean watering units more frequently

Feeding and nutritional management of dairy cattle

- Three general types are typically used in dairy production
  - Confinement systems with total mixed rations
  - Confinement systems in which concentrates and forages are fed separately
    - Component feeding
  - Pasture-based systems

Feeding and nutritional management of dairy cattle

- Total mixed rations
  - All dietary components are included in a single uniform mixture
  - Optimize microbial growth in providing fiber and nonfiber ration components
  - Minimizes fluctuations in rumen pH
  - Promotes healthy rumen conditions at relatively high rates of energy intake

Feeding and nutritional management of dairy cattle

- Unmixed or component-fed rations
  - Traditional confinement barns
    - Tie-stall
    - Comfort stall
    - Stanchion barns
  - Concentrates are fed separately from forages

Feeding and nutritional management of dairy cattle

- Unmixed or component-fed rations
  - Disadvantages
    - Potential for large fluctuations in rumen pH
      - Impair fiber digestion => Contribute to poor rumen health
    - Problem in hot weather => Forage consumption may be reduced => Concentrate consumption is less affected => Intended proportions of fiber and nonfiber carbohydrates

Feeding and nutritional management of dairy cattle

- Pasture-based Feeding System for Dairy Cattle
  - Pasture alone with
    - Mineral supplements
    - Grain supplementing in a milking parlor
  - Intensive management of pasture for
    - Optimal dry matter
    - Nutrient yields
    - Feeding
    - Nutrition of high-producing

Feeding and nutritional management of dairy cattle

- Pasture-based Feeding System for Dairy Cattle
  - Pastures are typically divided into paddocks via
    - Easily moved electric fences
    - Cattle are rotated through paddocks
    - Forages reach stages of growth optimal for
      - Dry-matter yields
      - Nutrient composition
    - Paddocks must be rotated frequently => Forages are consumed at an optimal stage of growth => Overgrazing does not occur

79

Feeding and nutritional management of dairy cattle

- Pasture-based Feeding System for Dairy Cattle
  - Nutritional standpoint
    - Favorable rumen fermentation conditions
    - Adequate dry-matter intake
    - Energy requirements
  - Lush pasture
    - High water intake
    - Faster rate of passage
  - Nonsupplemented pasture
    - Cow requirements must be timed with
      - Pasture forage
        - » Growth
        - » Quality
      - Seasonal dairy production system

80

Feeding and nutritional management of dairy cattle

- Pasture-based Feeding System for Dairy Cattle
  - Low neutral detergent fiber
    - Rapidly growing pasture grasses with
    - High energy and protein density
    - Rumen fermentation conditions => Particularly pH => Supplementing the pasture with dry forages

81

Feeding young dairy calves

- Assure adequate passive transfer of antibodies
- Calves should receive
  - At least 3 L of high-quality colostrum
  - Within 6 hours after birth
- Second feeding
  - 8 and 12 hours after birth
- Colostrum feeding
  - Until calves are 3 days old
  - Critical for passive transfer of immunity

82

Traditional system dairy calf feeding

- After colostrum feeding
- Minimize financial input
- Growing the calf to weaning
- Limited quantity of liquid feed => Stimulate solid feed consumption =>Stimulates early rumen development =>Allowing the calf to be weaned
- Weaning
  - Relatively young age
    - 4–8 weeks
  - Growth rates are less than maximal => Feed costs are minimal
  - Risk of enteric disease

83

Traditional system dairy calf feeding

- Liquid feeds for preweaned calves
  - Milk
  - Waste milk
  - Excess colostrum
  - Milk replacers

84

Traditional system dairy calf feeding

- Commercial milk replacers contain
  - Protein
  - Fat
  - Carbohydrate

85

Traditional system dairy calf feeding

- Protein source
  - Affect
    - Quality of the replacer
  - Include
    - Whey protein
    - Delactosed whey
    - Dried skim milk
    - Casein
  - Animal proteins
    - Plasma proteins

86

Traditional system dairy calf feeding

- Protein source
  - Plant protein
    - Less desirable than animal proteins
    - Milk replacers include
      - Soy protein
        - » Isolate
        - » Concentrate
      - Remove antinutritional factors such as trypsin inhibitor.
      - Not all milk replacers containing these protein sources
    - Unacceptable protein sources for milk replacers
      - Unprocessed soy flour
      - Wheat flour are

87

Traditional system dairy calf feeding

- Fat
  - Concentrations
    - Typically 10%–30%
    - Most 15%–20%
  - Sources
    - Coconut oil
    - Tallow
    - White grease
    - Lard
    - Emulsifying agents
      - Lecithin
      - Monoglycerides
    - Cold climates => Energy consumption => Critical for young calves

88

Traditional system dairy calf feeding

- Solid feed
  - Introduced early
    - By 3 days of age
  - Starter feed
    - Stimulates rumen development
      - Volatile fatty acids
        - » Generated by microbial fermentation
      - Butyrate
        - » Rumen papillae development

89

Traditional system dairy calf feeding

- Newborn calves
  - Reticulorumen
    - Underdeveloped
    - Nonfunctional
  - Rapid rumen development
    - Critical for successful early weaning
    - Minimal adverse impacts on calf
      - Health
      - Growth

90

Traditional system dairy calf feeding

- Highquality starters
  - Composed of moderately fermentable carbohydrates
    - Texture
      - Fine particles
      - Powdery particles
  - High fiber concentration

91

Traditional system dairy calf feeding

- Amount and form of starch
  - Induction of ruminal acidosis
  - Crude protein concentration
    - 18%–20% on a dry matter basis
    - More than 20% in accelerated feeding

92

Traditional system dairy calf feeding

- Fresh water
  - Consumption >4 L/day
  - Water in milk or milk replacer is not sufficient to meet the calf's water requirement

93

Feeding calves with enteric disease

- Diarrhea
  - Life threatening dehydration
  - Infectious agents
    - Bacteria
    - Viruses
    - Parasites
    - Nutritional factors
  - Electrolyte solutions administered
    - Orally
    - Parenterally

94

Feeding calves from weaning through maturation

- Feeding replacement heifer from weaning through first calving
  - Targeted growth
  - Age at first calving
    - Generally between 22 and 24 months of age
    - Knowing the mature size of cows in the herd
    - 50%–55% of mature weight at 13–15 months of age

95

Feeding calves from weaning through maturation

- After weaning
  - Calves are not fully functional ruminants
  - Ferment lower quality forage
  - Protein requirements
    - High relative to energy requirements

96

Feeding calves from weaning through maturation

- Gestation
  - Good-quality forages
  - Feeding of corn silage
    - Limited
      - Prevent fattening
    - Increases disease risk at calving
  - Ad libitum intake of lower-quality diet
  - Precision feeding of a higher-quality diet
    - Limited intake

97

Feeding calves from weaning through maturation

- Insufficient growth rates => Older age at first calving => Increases the cost of heifer rearing => Limits milk production and conception rates during the first lactation
- Excessive growth rates => Associated with fattening => Can affect milk production => Increase the risk of metabolic problems at calving
- Target growth rates => Based on mature weight and age at first calving
  - Daily gain
    - Smaller breeds
      - 500 g/d
    - Larger breeds
      - 800 g/d

98

Recommended target body weights (kg) for heifers

Heifer age (mo)	Breeds		
	Small	Medium	Large
Birth	28	34	47
1	41	50	68
2	55	68	92
3	73	89	122
4	90	110	150
5	107	130	178
6	124	151	206
7	140	172	234
8	158	193	263
9	175	214	291
10	191	234	319
11	208	255	347
12	224	274	374

99

Recommended target body weights (kg) for heifers

Heifer age (mo)	Breeds		
	Small	Medium	Large
13	242	295	403
14	258	316	430
15	275	336	458
16	291	356	485
17	308	377	513
18	325	397	541
19	342	418	570
20	358	438	597
21	375	458	625
22	392	479	653
23	409	499	681
24	425	520	708

100

Feeding calves from weaning through maturation

- Environment can impact
  - Performance
  - Outcomes
- Different ages
  - Different dietary requirements
    - Kept in separate pens based on
      - Age
      - Size
  - Calves between weaning and 5 months
    - Groups of 6 or fewer
  - Older calves
    - Kept in larger groups
  - Sufficient bunk space and lying area => Ensure comfort and minimize stress

101