Energy

AG 240

"I can loan you money for a boat or a snowmobile, but not for cattle feed."

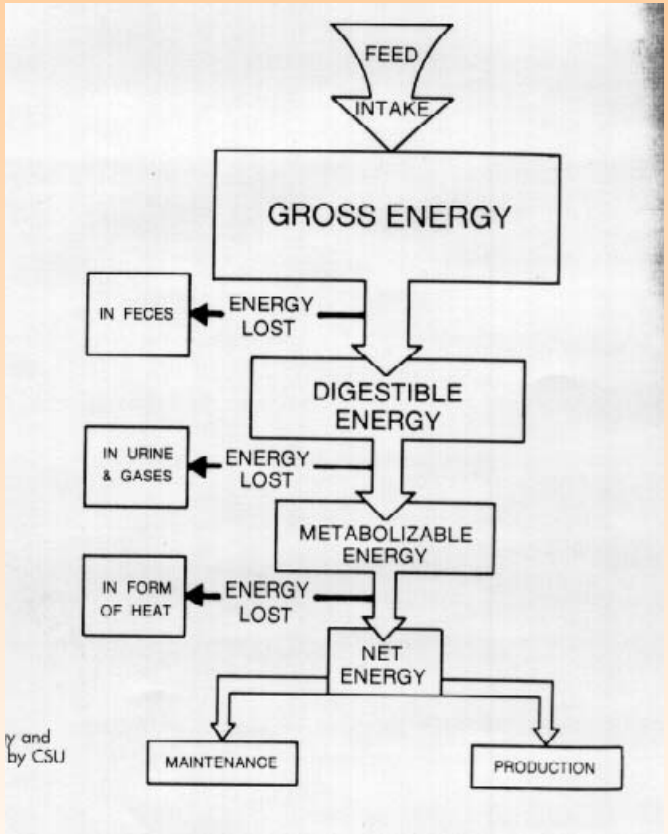
Characteristics of Energy

- Definition of Energy
  - Capacity to do work
  - Amount of heat that is produced when feedstuff is completely oxidized in the body

Characteristics of Energy Con't

- Units
  - In US we use calories, kcal or mcal
    - 1 kcal = 1000 calories
    - 1 mcal = 1000 kcal or 1,000,000 calories
  - In Britain, use BTUs or joules
- Important for ration balancing

Energy Diagram



Gross Energy (GE)

- DEF: Amount of heat produced when a feed is completely oxidized (burnt)
- Use bomb calorimeter to measure GE
  - Measured in calories
  - Total amount of energy potentially available (may or may not be available to animal)

Fecal Energy (FE)

- Def: Energy lost in feces
- Varies with feed and animal
- Collect fecal samples from digestion trial

Digestible Energy (DE)

- GE - FE
  - Gross energy - Fecal energy (lost in feces)
- What animal has available to use
- Can use to balance ration
  - Doesn't take into account gas and urine loss
  - We'll use TDN or DE to balance rations for most species

Metabolizable Energy (ME)

- Def: Usable portion available for animal to metabolize (use)
- GE-FE-Gas-Urine
  - Aka DE-energy lost in gas and urine
- Used to calculate poultry rations and in Europe

Metabolizable Energy (ME)

- Obtained by placing animal in metabolic chamber

Expensive to determine!

Net Energy (NE)

- Portion of ME used in metabolism related to maintenance and production
- Def: ME- energy lost in form of heat (rumen fermentation and tissue metabolism)
  - Measured in kcal

Problems with Net Energy

- Has not been determined on very many feedstuffs
  - Most values seen in tables are computations
  - These values assume ideal conditions

Three types of NE

- NEm - Maintenance
- NEg - Gain
- NE_l - Lactation

NEm - Maintenance

- Def: Condition in which animal is neither gaining or losing body energy
  - BUT, how often is an animal truly in"maintenance"

NEg - Gain

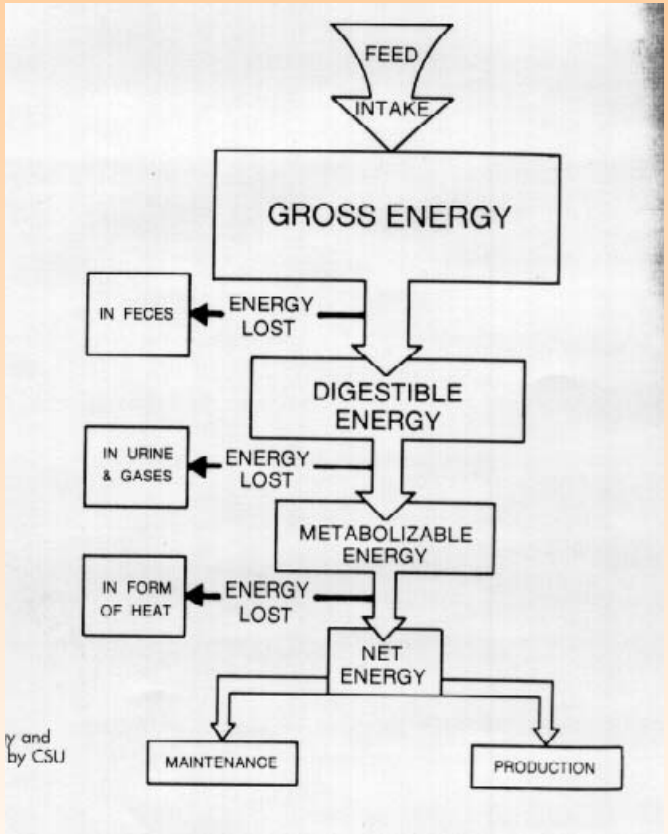
- Takes more energy for gain than for maintenance
- NEm is usually higher than NEg because animal maintains itself first

NE_l - Lactation

NE_l - Lactation

- Def: Energy needed for synthesis of milk
- Related to NEp (production) Note: Often referred to as NEp (production) to cover synthesis of fetus, milk, eggs, wool, fur, feathers, etc.

Energy Diagram



Total Digestible Nutrients (TDN)

- Alternative Method for estimating Energy
- Can be used to balance rations for energy
- Similar to DE but expressed differently

Determining TDN

- Know that fat, protein, fiber, starches, sugars are excreted in feces
- Amount of each in feed is determined
- Amount of each in feces is determined
- TDN equals:
  - Amount of each in feed - Amount of each in feces

Final notes on TDN

- Criticism of TDN
  - Tends of over value roughages
- Adv of TDN
  - More accurate estimate for animals not in "ideal" environment

Notes on Energy Loss

- Greatest energy loss is associated with fecal losses
- Digestibility of diet is closely related to fecal losses
- Losses are also related to metabolism

Metabolic losses

- Urine and microbial methane account for 10% of GE (less in monogastric)
- Heat losses/gains

Metabolic losses con't

- Heat losses/gains
  - Heat is produced during fermentation
  - Heat is produced when nutrients are oxidized
    - Protein has largest heat increment
    - CHO is second
    - Fat is third
  - This heat can also be used to maintain body temperature but can't be stored

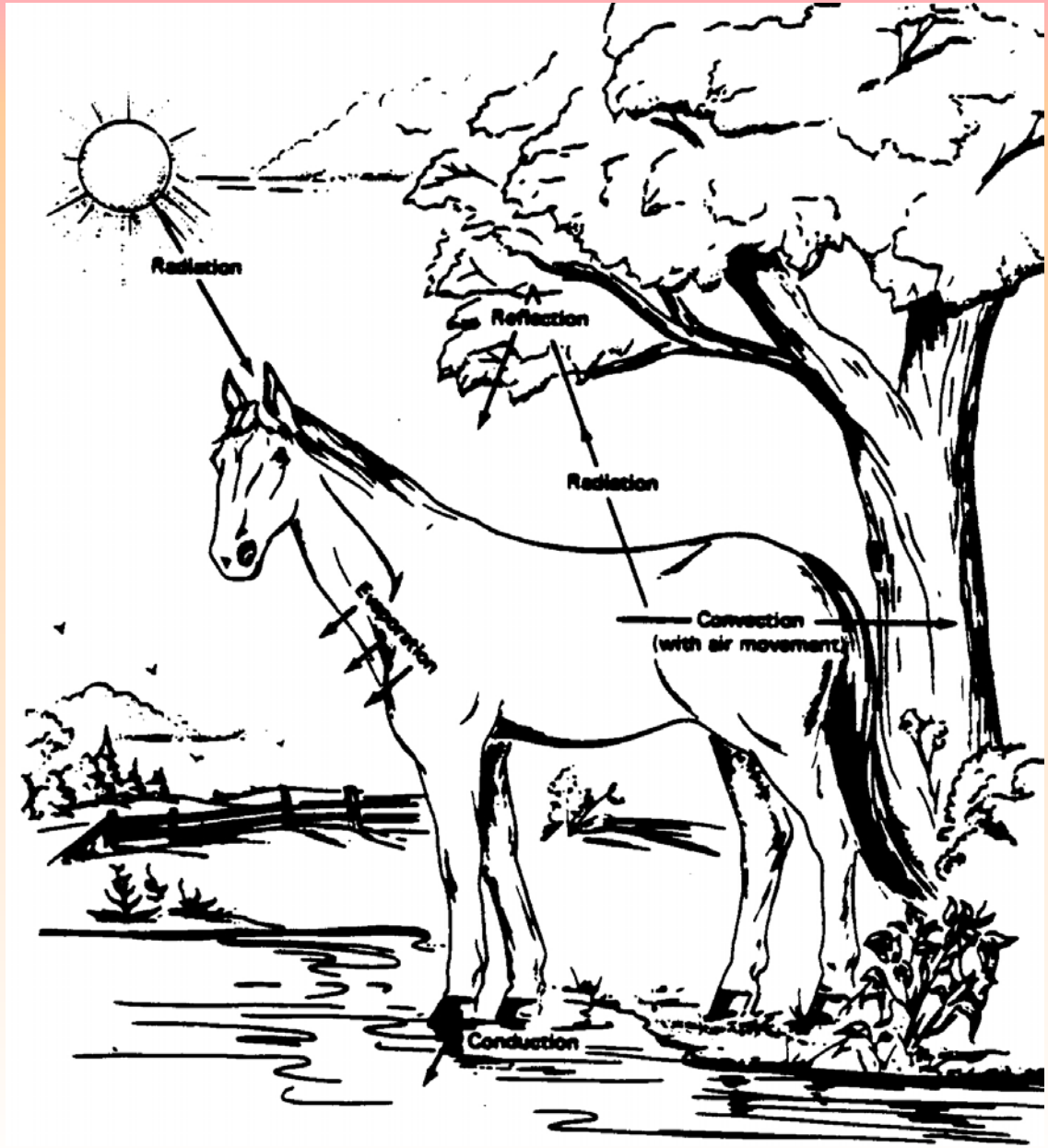
Energy requirements affected by:

- Age
- Species
- Activity level
- Production level

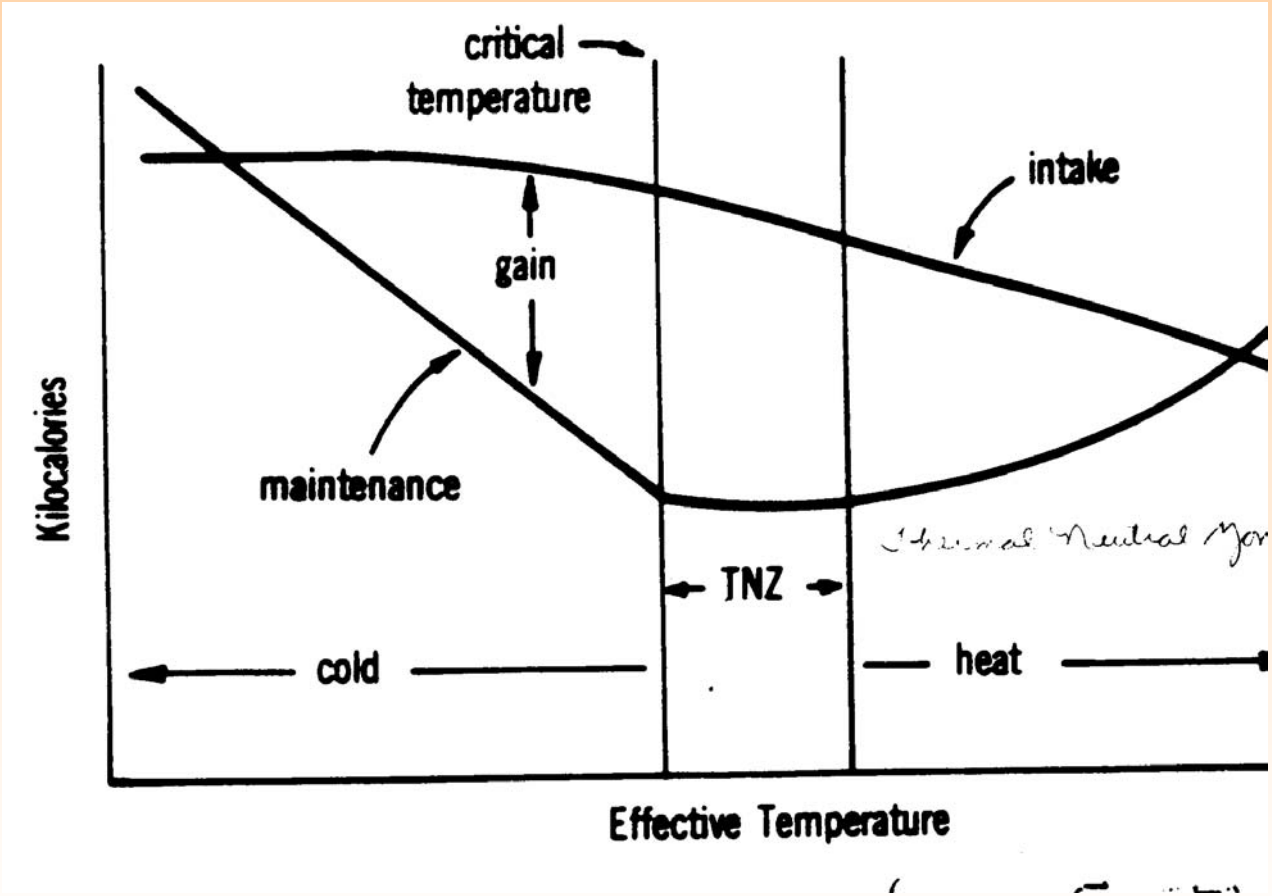
Energy requirements affected by:

- Environmental conditions/Comfort zone
  - Humidity
  - Wind
  - Activity
  - Immersion/Wetness
  - Hair coat

Heat Gain and Loss



Thermal Neutral Zone (TNZ)



Energy requirements affected by:

- Nutrient deficiencies
- Body surface area
  - Metabolic Wt
    - body wt $^{.75}$

Determining Energy Requirements

- National Research Council (NRC) Tables
  - Minimum requirements for an average population of animals of a given species, age, weight and productive status

Reading NRC Tables

- Expressed in quantities of nutrients required per day OR as a percentage of a diet
  - Quantities are for animals fed an exact quantity
  - Percentages are used for rations being fed ad libitum (free choice)
  - Values can be lbs, %, ppm, IUs

Expressing Energy Requirements

Specie	Energy
Poultry	ME
Swine	DE, ME, TDN
Sheep	DE, ME, TDN
Cattle	ME, TDN, NEm, Neg
Dairy Cattle	DE, ME, TDN, NEm, NEg, Nel
Horse	DE, TDN

Reading NRC Tables to Determine Energy Requirements

Proximate Analysis

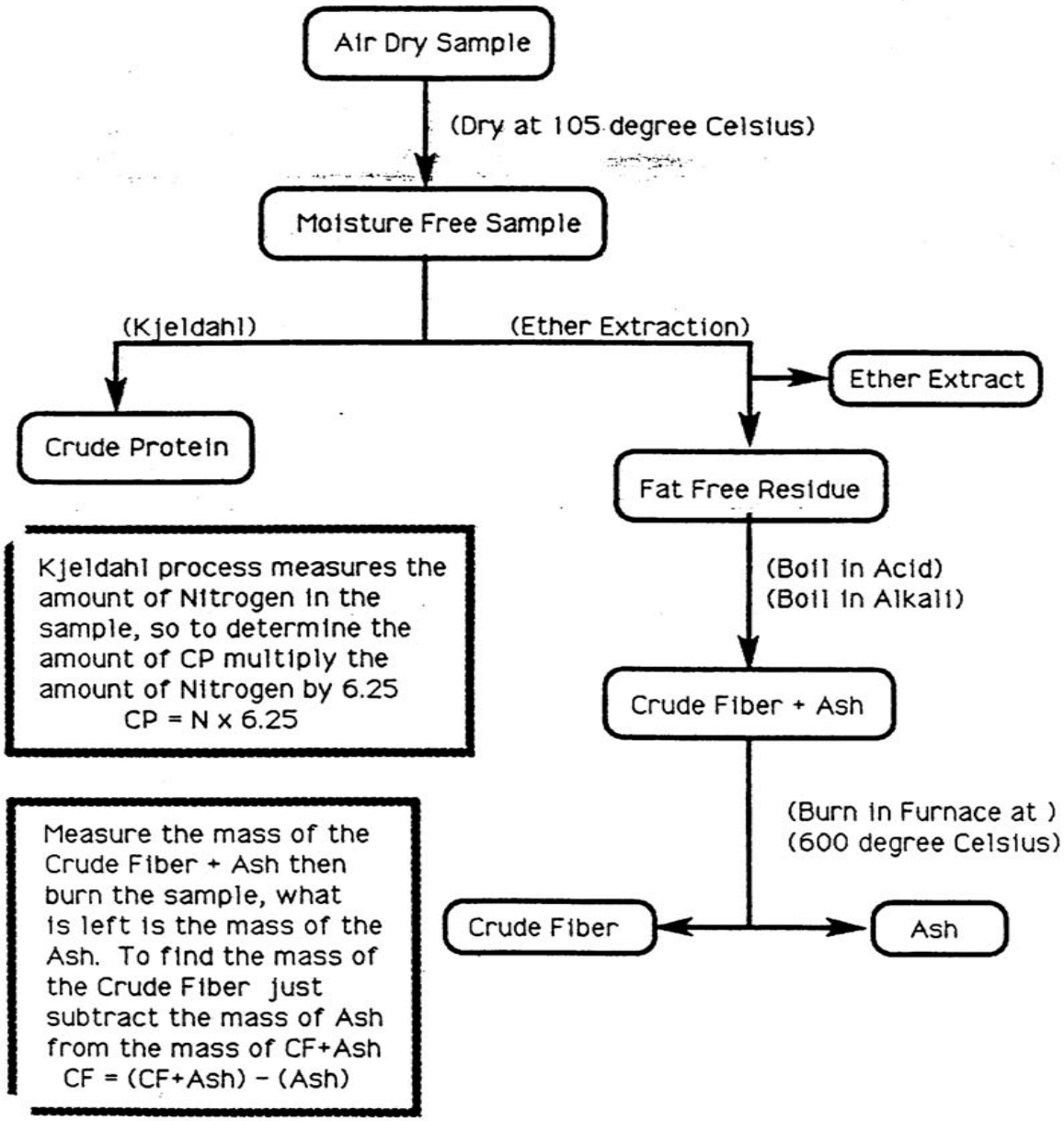
Proximate Analysis

- Methods for evaluating feedstuffs
- Set of chemical/analytical procedures
  - Developed in Germany over 100 years ago

Estimates nutrient composition

- Water
- Crude Protein (CP)
- Ether Extract (EE) (fat)
- Crude Fiber (CF)
- Nitrogen Free Extract (NFE)
- Ash

PROXIMATE ANALYSIS



Determining Water Content

- Methodology
  - Heat sample above boiling point
  - Electrical probes
- Expressed as % dry matter
  - % moisture + % dry matter = 100%

Why compute DM?

- Must know DM to equally compare feeds

Crude Protein

- Kjeldahl process used to determine CP
  - Add concentrated sulfuric acid to sample until all organic matter is destroyed
- Estimate based on amount of N in sample
  - Total N X 6.25 = % CP
- > 20% CP is considered high

Ether Extract (EE)

- Determines fat in sample
  - Extract dry sample with ether to remove fat

Crude Fiber

- Used to determine portion of CHO content
  - CHO = CF + NFE
- Done after water and fat have been removed
  - Boil in acid, boil in alkali
  - Difference before and after in weight is CF portion and Ash

Crude Fiber con't

- Also known as % ADF
  - Acid Detergent Fiber
- Primarily hemicellulose, cellulose and some lignin in Crude Fiber

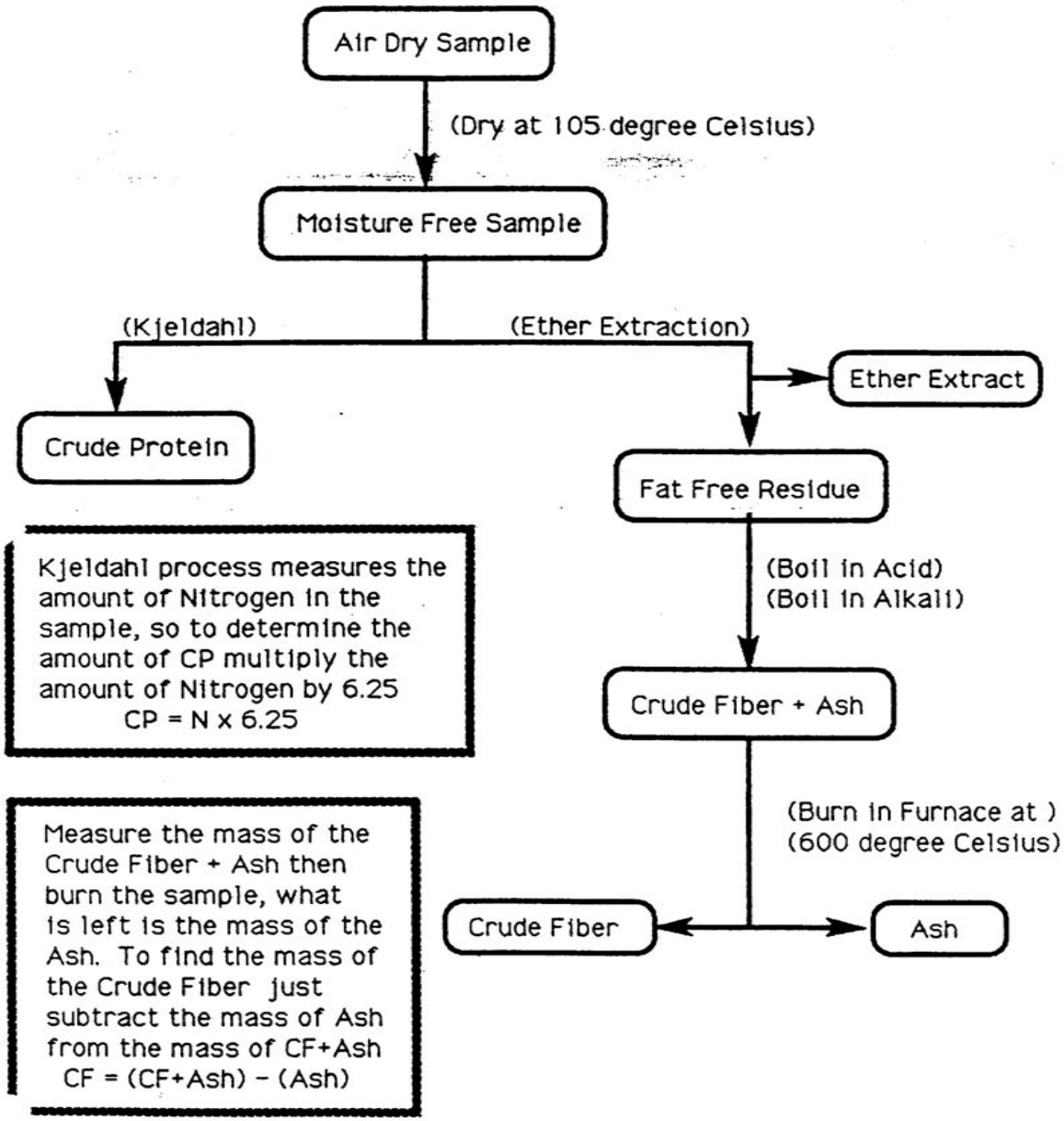
Ash (Minerals)

- Place feed sample in muffle furnace for 2 hours at 600 degrees C to burn off crude fiber

Nitrogen free extract (NFE)

- Also used to determine CHO content
  - CHO = CF + NFE
- Found by difference not actual analysis
  - 100- % water - % ash - % CP - % CF - % EE
- Primarily determines available CHO like sugars and starches but may contain some hemicellulose and lignin

PROXIMATE ANALYSIS



Relationship between Proximate Analysis and TDN

- Proximate analysis is performed on feed
- Feed is fed in a feed trial
- Proximate analysis is run on the feces
  - The difference between the two analysis is what was absorbed

How TDN is calculated?

- TDN = /g protein + /g NFE + /g Fiber + (/g Fat*2.25)

- TDN is expressed as a percent

Conversion of feed nutrients from an as fed to a dry matter basis

Formula needed:

$$\frac{\%\text{ nutrient (as fed basis)}}{\%\text{ feed dry matter}} = \frac{\%\text{ nutrient (dry matter basis)}}{100\%\text{ dry matter}}$$

Example 1

- Assume alfalfa silage analyzed 7% CP on an as fed basis and contained 40% dry matter. What percent CP would the alfalfa silage contain when expressed on a dry matter basis?

Example 2

- Two samples of shelled corn were sent to a laboratory for analysis of crude protein. One sample was “dry” corn and the other “high moisture” corn. The lab sent back the following analysis:

Analysis	Dry corn	High moisture corn
% DM	89	75
% CP (as-fed)	8.8	7.4

- Which sample is “really” higher in protein?

The End

Losses due to Digestibility

- Monogastric diets versus Ruminant diets
  - Grain versus straw hay
  - High quality versus low quality
  - 85% digestible versus 35% digestible