

## ***TROPICAL CLIMATE AND IMPLICATION ON PASTURE PRODUCTION***

**The extremes of wet and dry, hot and cold, daily downpours and extended drought, fertile flood plains and eroded overgrazed hills, steaming lowlands and permanent snowclad peaks, along with other inconsistencies of nature make up the tropical environment.**

**These elements- climate, vegetation and soils- are its most essential components. Climate is the dominating factor and shapes the vegetation, modifies the soil and ultimately affects all forms of life.**

**The type and distribution of tropical grasslands are largely determined by climate and its interaction with the soil. Total annual rainfall and its distribution regulate the adaptation, growth and production of grasses, legumes and browse plants, even though other factors such as temperature, humidity, sunlight, elevation, slope and expose of terrain exert a strong influence, man's activities can have great influence on the environment.**

# **CLIMATE**

**Climate is made up of a composite of day to day weather conditions. It is an average of weather overtime while weather is a state of the atmosphere with respect to heat or cold, wet or dry, calm or stormy, clear or cloudy.**

**It changes from day to day and variation is influenced by geographical location, topography, distribution of land and water, mountain barriers, altitude, wind, ocean currents and vegetation.**

**The major atmospheric elements making up climates in the tropics are moisture, temperature, light and air movement.**

**Moisture: Precipitation is the most important climatic element since temperature and light are less likely to be limiting for the growth of plants in the tropics.**

**Average rainfall and distribution: The total amount of rainfall fluctuates widely from one region or location to another. Average rainfall data are usually of limited value and distribution throughout the year is more meaningful for the agriculturist and the grassland husband man.**

- Grass and legume adaptation and production are largely determined by the amount and distribution of rainfall.**
- Under all conditions, the distribution of rain determines the pattern of plant growth.**

**Rainfall intensity: In many parts of the tropics, a high proportion of the rainfall descends in heavy storms of short duration e.g. 50-100mm/h in 5-40mins and generally exceeds that of temperate**

**Rainfall reliability:** Total rainfall fluctuates widely at a given locality. Frequently, the beginning of the rainy season and the onset of the dry season are changeable and vary several weeks or even months.

The reliability of annual rainfall can be calculated however by knowing the average annual rainfall and the range over a given number of years.

**Effectiveness of precipitation:** Percentage of rainfall made available for plant utilization is influenced by the following variables.

- 1. Evapotranspiration**
- 2. Surface run-off**
- 3. Drainage of rainwater**
- 4. Amount of stored water**

- **Humidity** : Moisture in the atmosphere is usually expressed as relative humidity i.e. the percentage of water vapour present given as a percentage of the amount which could be held at saturation. \*fungi problem that hinder seed production increased with high humidity. It also affects seed production.
- **Temperature**: The tropics and subtropics have percentage that permits plant growth throughout the year except at higher elevations. Seasonal differences occur with greater ranges in the wet-dry and arid climates than in the equatorial humid regions e.g. *Panicum maximum* and *Pennisetum purpureum* thrive well in the hot, lowland tropics but lower herbage yields in more northern latitudes and higher altitudes.

- **Chloris gayana, *Setaria anceps*, *Desmodium uncinatum* and *Desmodium intortum* Flourish at elevations where nights are cooler.**
- **Lights: light is of basic important as the source of energy for the the photosynthetic process. The intensity and quality of light varies with the angle of the sun's rays, duration of the light period and atmospheric conditions.**
- **Air movement : movement of air are determined by differences in pressures which are linked with temperature phenomena. The air flow patters are also modified by friction produced by the earth's surfaces, especially mountain ranges.**



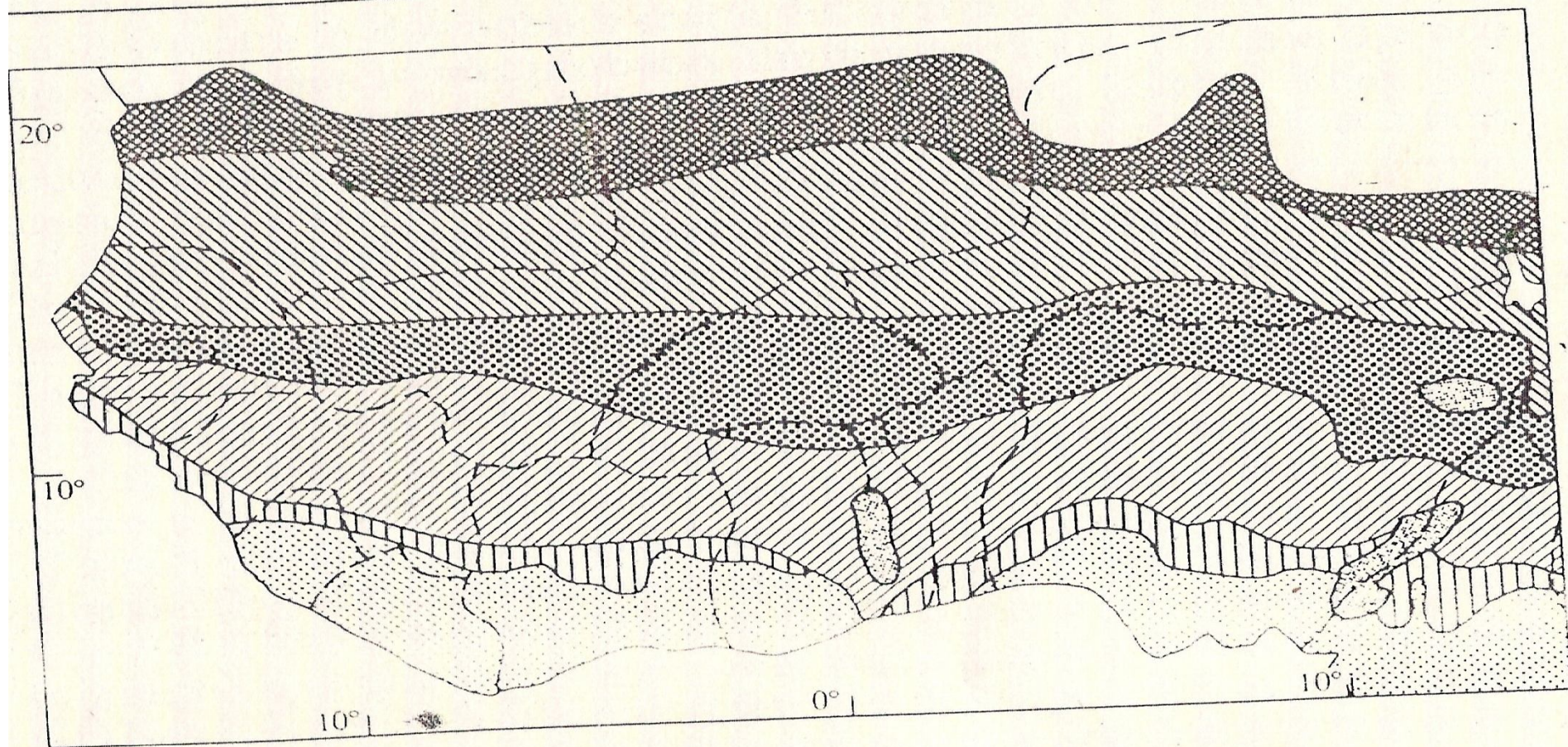
# **Climate and Vegetation**

**A close relationship exists between vegetation and climate as a consequence of plant evolution and adaptation over ages of time.**

**A climax plant formation exist and is also called an association and consists of several spp.**

**Classification of climates: begins with vegetation rather than climate itself. (Critchfield, 1966; Trewartha, 1954-1968).**

**Wladimar Koeppen, 1900- German biologist- world climates. Vegetation maps**










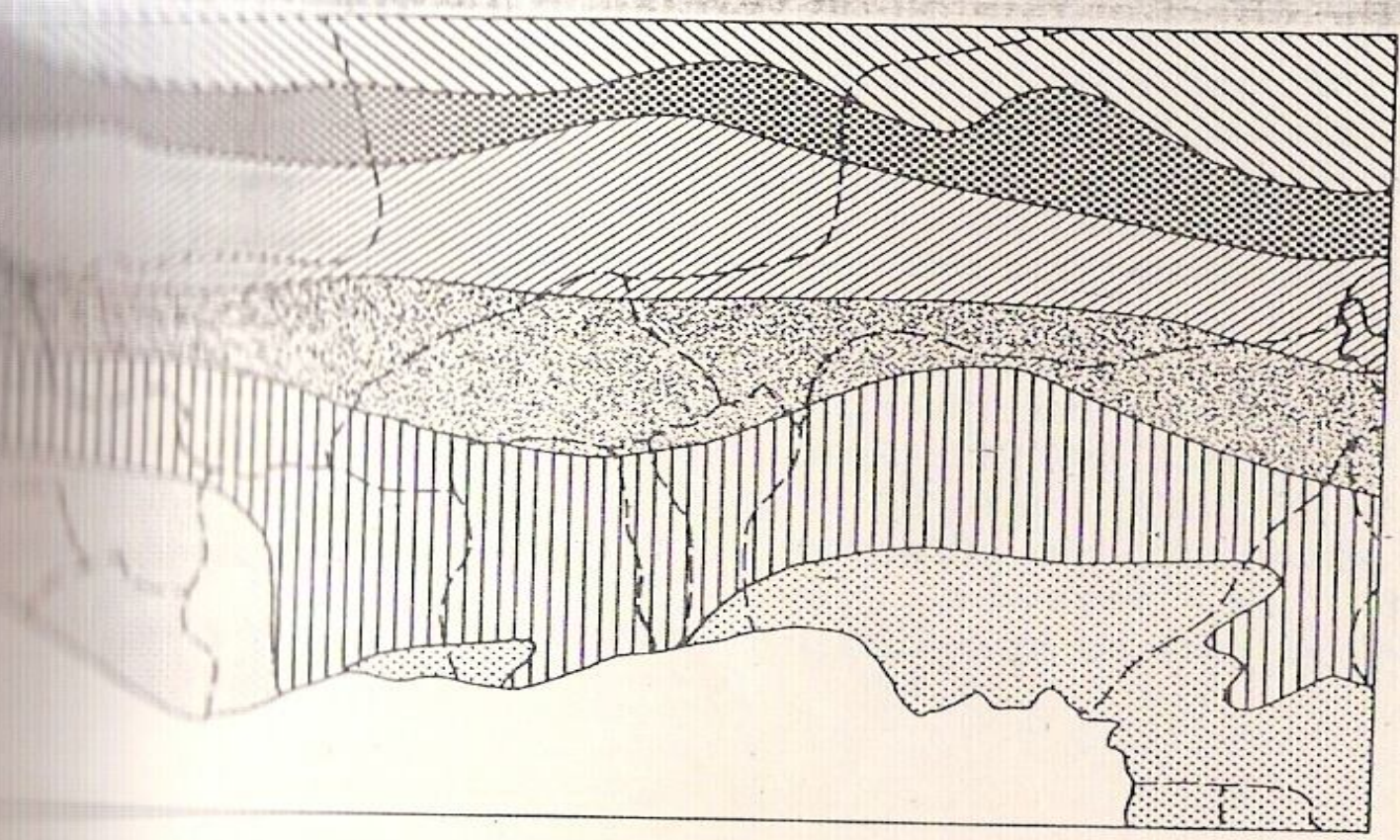



- |   |                                    |   |                              |
|---|------------------------------------|---|------------------------------|
|  | Moist forest, mangroves and swamps |  | Woodland dry savanna (Sudan) |
|  | Derived forest-savanna             |  | Wooded steppe (Sahel)        |
|  | Montane forest                     |  | Subdesert steppe             |
|  | Woodland humid savanna (Guinea)    |   |                              |

Fig. 1.2 - Vegetational zones of West Africa (Keay, 1959): (1)

... (Fig. 1.2) and the rainfall map (Fig. 1.3) o

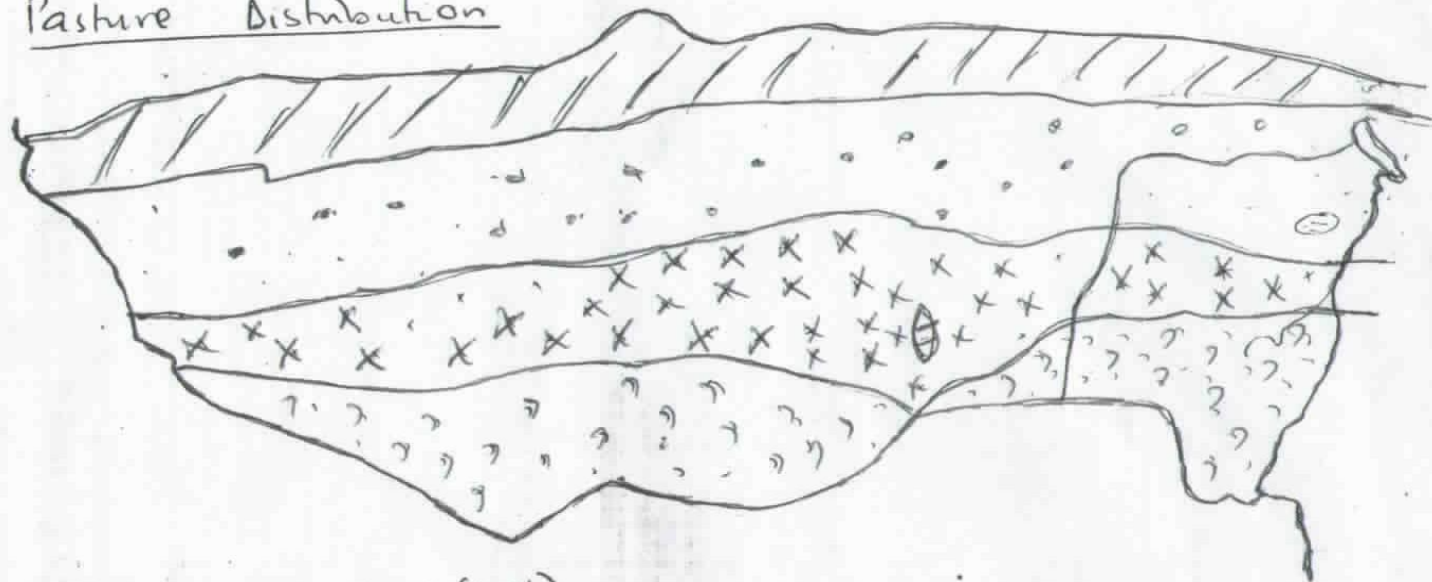
Precipitation



-  200-400
-  100-200
-  Below 100

Precipitation distribution (mm/year) in West Africa (Thompson, 1965).

Pasture Distribution



- Pennisetum type (belt)
- Hyparrhenia type
- Andropogon type
- Aristida type

**Rainfall distribution (mm/year) in West Africa (Thompson, 1965), four of the main vegetational zones are commonly called savannas and are recognized as climatic regions representing different agricultural interest. Their boundaries are in part related to those delineated by the type of genera of the grass distribution, namely**

- 1. *Pennisetum* type- lowland forest and derived savanna**
- 2. *Hyparrhenia* type- Southern Guinea savanna**
- 3. *Andropogon* type- Sahel and part of Sudan savanna**
- 4. *Aristidia* type- Sub-Saharan**

**Near the coast there is no distinguishable dry period and the region is classified tropical rainforest and swamps. Over much of the zone, two peaks of rainfall alternate with two dry seasons. A longer drought period prevails from October or November to March or April and a shorter one occurs in July or August.**

**The forests are broken vertically with 2 or 3 layers of trees, the tallest storey emerging at more than 30m. Tall coarse grasses appear in the more open lands of the forests. A semi deciduous forest exists where the trees have been cleared for cultivation and where the dry season ranges from 3-5 months.**

**The derived savanna merges into two woodland savannas' which are separated on the basis of moisture and vegetational core. The 'humid savanna' (Guinea savanna) is characterized by 5-7 months of dry season, usually continuous.**

**Rainfall varies from about 1,000 to just less than 1,500mm the area is largely woodland with fire-resistant, broadleaved deciduous trees. The canopy may be full or open at 15-20m. Tall perennial tufted grasses grow up to 3m beneath the scattered trees and up to 5m open places.**

**Since, the cattle population is relatively sparse, a heavy growth of grass accumulates by the end of the rainy season. Always widespread fires rage beyond control.**

**The 'dry woodland savanna' (Sudan) receives from 500-800mm annual rainfall with 7-9 months having 100mm total. The region is wooded but many single trees occur and display wide, spreading crowns and small leaves. The trees grow from 10-15m height and shorter than in the humid savanna, there are many leaves growing shrubs and bushes in the southern areas.**



**Thorn bushes are prevalent in the northern part of the dry savanna. Grass cover is shorter than in the humid savanna, from 1.5m to just over 3.0m in height when matured, less tufted, more feathering with finer leaves and stems, and fewer perennials. Much of the area is burned annually, but fire is less severe than in the derived savanna.**

**In the ‘wooded steppe’ (sahel savanna) a water deficit exists for most of the year and many areas receive less than 200mm of rainfall. The rain occurs in down pours scattered over a 2-3 month period.**

**The original climax was probably thorn woodland. This has opened up with scattered dwarfed trees and of 5-10m height. Thorn shrubs of 2-3m height with short conical bases and divided stems are common.**

**Grasses are short, discontinuous, wiry and tufted. Less serious fires than further south.**

**The southern Sahara is fringed with a 'sub' desert steppe. In some places dispersed, permanent vegetation prevails, being composed of small shrubby plants and bushes, with acacias, other trees and shrubs. This area receives about 150mm/year and are extremely unreliable.**

**After rains, annual grasses and herbs appear and soon mature. Altitude modifies the vegetation due to increased humidity and cloudiness, lower temperature and less evaporation.**

**Relative humidity has a marked effect on the vegetation association in the different regions. The coastal areas have a mean monthly relative humid of 95% at 06.00 may drop to 60% at noon in the driest months. In the north, the moving relative humidity climbs up to 90% during the rainy season. In the dry season it seldom reaches 30% but drops to less than 10% before noon.**

- **A temperature gradient extends from the coastal forest zones to the Sahara. Temperature lines run east and west, as do the vegetational zones.**
- **The gradient effects on vegetational associations are less visible than those of the rainfall. A gentle rise in elevation occurs from south to north. This also causes a change in temperature and has some influence on vegetation type.**

# Soil-plant-animal interrelationship

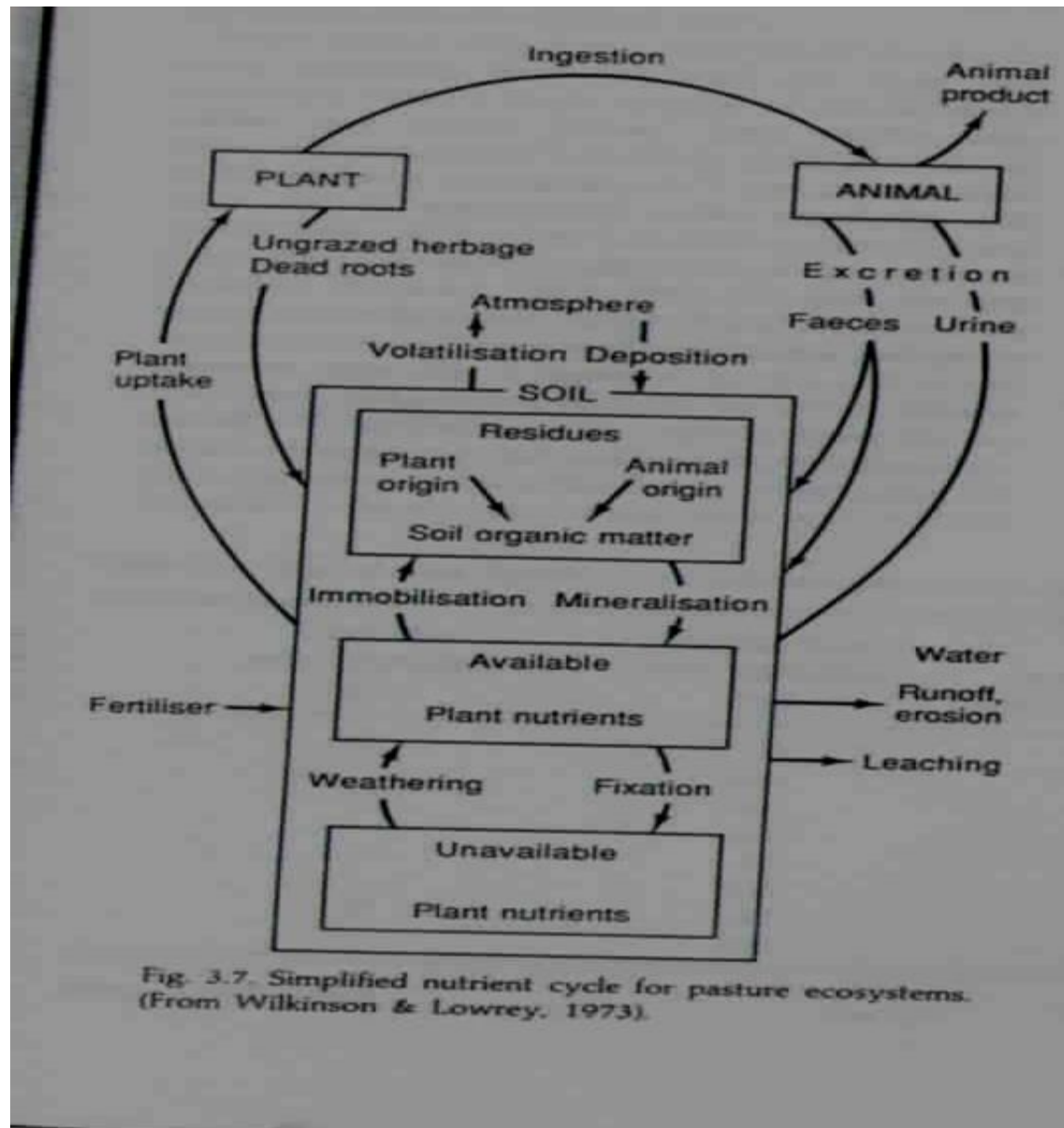


Fig. 3.7. Simplified nutrient cycle for pasture ecosystems. (From Wilkinson & Lowrey, 1973).

Fig. 1.3. Environmental and plant factors that dominate grassland pattern and species cycling in a grassland comprised of Townsville stylo and annual grasses in the wet-and-dry tropics. The factors exert quantitative effects on yield and species composition; the plant factors germination, establishment, competition and seed production may be seen as a series of filters through which individual plants attempt to pass. (From Torrsell, 1973.)

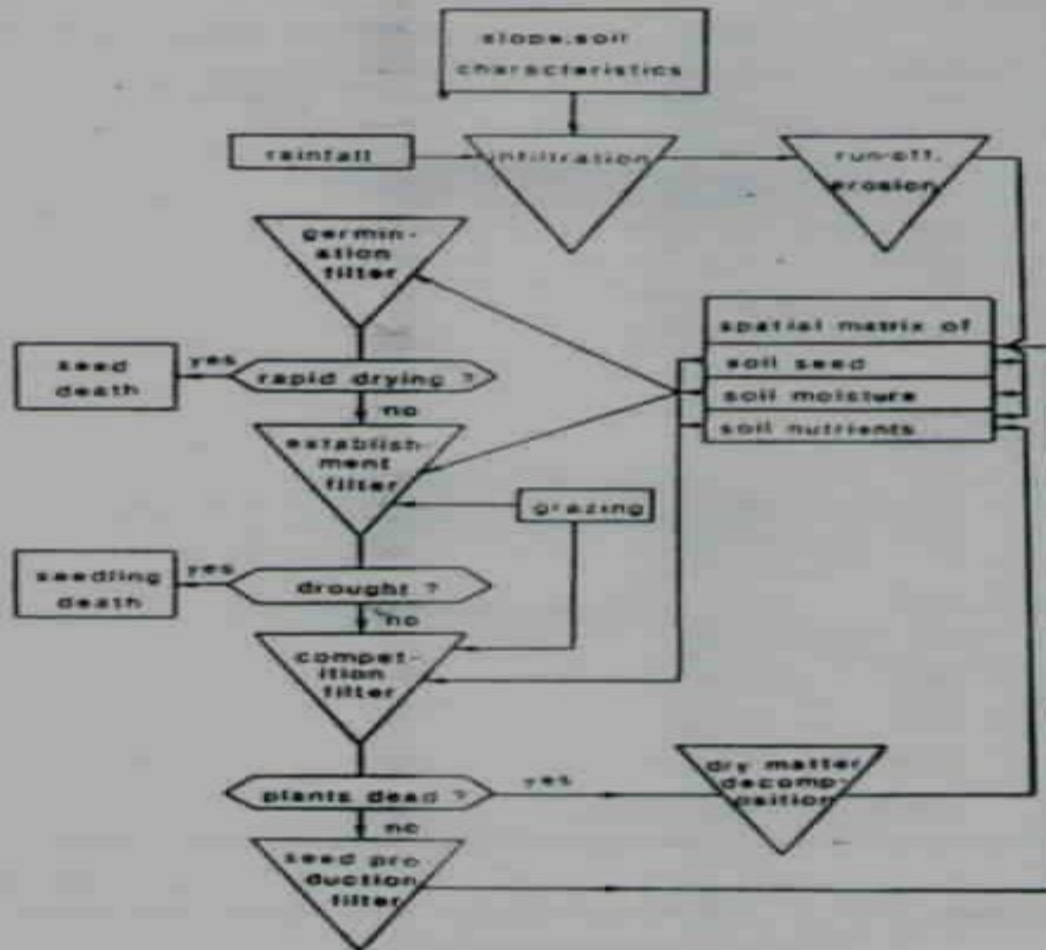
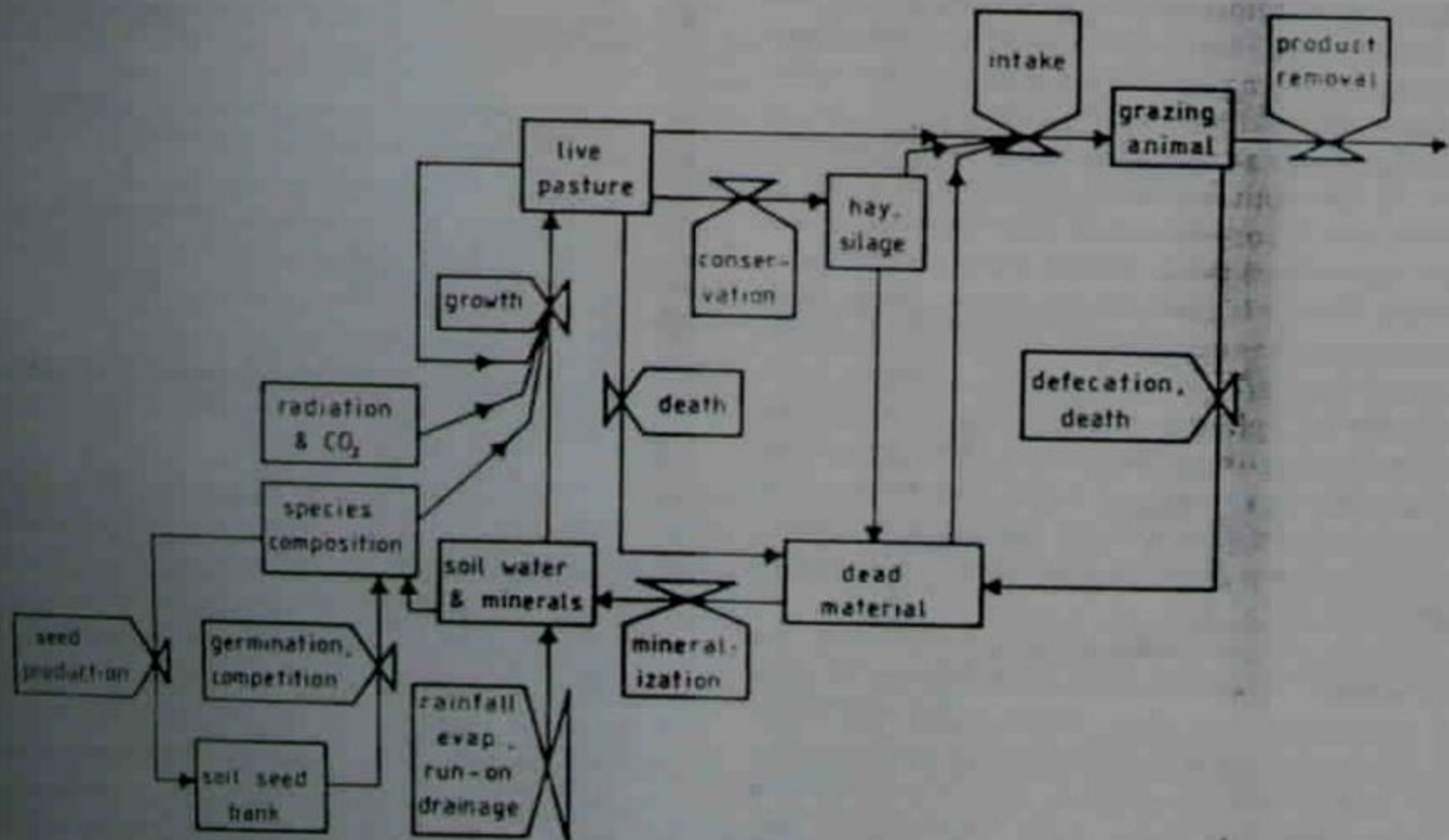


Fig. 1.2 The main biological components in the function and management of grassland systems: A grassland system is dynamic: various pools or state variables (□) are linked by flows of material, e.g. seed, leaf (arrows) and governed by rate variables (◇).



## **Herbage quality:**

**The suitability of a particular pasture plants depends on the production objectives, considering the environment for pasture establishments, the aims of pasture (e.g the type of animal production, the importance of pasture-crop integration or the necessity for watershed stability) will decide the importance of various pasture qualities (e.g nutritive value, ease of eradication, or ground cover.) Pasture qualities are usually judged in terms of their nutritive value, ease of establishment, and persistence. The value of a pasture must be determined by the output of animal products.**



**Nutritive value:** Is the chemical composition, digestibility and the content of proteins, minerals and vitamins, and the absence of toxins. Nutritive value is being affected by acceptability, presence of undesirables substances, rate of passage and availabilities of forage because they influence the amount of forage consumed.

**Chemical composition:** This indicates the constituents in the forage and attempt had been made by early nutritionist to determine the chemical composition of a given feed stuff.

**The weende's proximate analytical scheme resolves a given feed stuff into five fractions: Crude protein (CP) through determination of kjeldhal nitrogen and multiplying N value by 6.25; fat or ether extract (EE) through extraction with anhydrous ether; Crude fibre (CF) determined by extractions with ether, sulphuric acid and sodium hydroxide; ash content using muffle furnace and nitrogen-free extract (NFE) determined by subtraction of CP, EE, CF and ash contents from sample weight.**

**The above is with the belief that CF is totally indigestible while NFE is totally digestible but this is not true.**

**Crampton and Maynard (1938) resolved carbohydrate into lignin, cellulose and other carbohydrates to predict the feeding value.**

**Van Soest (1966) proposed that forages are made up of two basic dietary fractions namely: Cell content (CC) and cell wall content (CWC).**

		<b>Nutritional availability</b>	
<b>Class</b>	<b>Fraction</b>	<b>Ruminant</b>	<b>Non-ruminant</b>
<b>Category A</b>			
<b>(Cellular contents)</b>	<b>Sugars, soluble carbohydrates,</b>		
	<b>Starch</b>	<b>Complete</b>	<b>Complete</b>
	<b>Pectin</b>	<b>Complete</b>	<b>High</b>
	<b>Non-protein N</b>	<b>High</b>	<b>High</b>
	<b>Protein</b>	<b>High</b>	<b>High</b>
	<b>Lipids</b>	<b>High</b>	<b>High</b>
	<b>Other soluble</b>	<b>High</b>	<b>High</b>
<b>Category B</b>			
<b>(Cell wall contents)</b>	<b>Hemicellulose</b>	<b>Partial</b>	<b>Low</b>
	<b>Cellulose</b>	<b>Partial</b>	<b>Low</b>
	<b>Heat-damaged</b>		
	<b>Protein</b>	<b>Indigestible</b>	<b>Indigestible</b>
	<b>Lignin</b>	<b>Indigestible</b>	<b>Indigestible</b>
	<b>Keratin</b>	<b>Indigestible</b>	<b>Indigestible</b>
	<b>Silica</b>	<b>Indigestible</b>	<b>Indigestible</b>

**Fig. 1 above: Classification of forage fractions according to nutritive characteristics (from Van Soest, 1966 and 1967)**

**Fig. 2 below: Various systems of partitioning the dry matter of forage (Harris, 1970) taken from Crowder and Chedda, 1982)**

<b>DRY MATTER</b>						
<b>ORGANIC MATTER</b>				<b>A S H</b>	<b>ORGANIC MATTER SYSTEM</b>	
<b>CRUDE FIBRE</b>	<b>NITROGEN EXTRACT</b>	<b>FREE</b>	<b>ETHER EXTRACT</b>	<b>CRUDE PROTEIN</b>		<b>A S H</b>
<b>CELL WALLS (NEUTRAL DETERGENT FIBRE)</b>			<b>CELL CONTENTS (NEUTRAL DETERGENT SOLUBLES)</b>		<b>VAN SOEST SYSTEM</b>	
<b>CELL WALLS (FONNESBECK &amp; HARRIS)</b>			<b>CELL CONTENTS</b>			
<b>NON- NUTRITIVE MATTER</b>	<b>PARTIALLY NUTRITIVE MATTER</b>		<b>NUTRITIVE MATTER</b>			
<b>LIGNIN &amp; ACID INSOLUBLE ASH</b>	<b>CELLULOSE</b>	<b>HEMICELL ULOSE</b>	<b>SOLUBLE CARBOHYDRATE, PROTEIN, ETHER EXTRACT, SOLUBLE ASH</b>			

# Factors affecting chemical composition

## A. Soil and climatic factors:

1. high moisture stress

hamper nutrient absorption

2. High heat intensity induces rapid physiological Maturation hence formation of highly lignified tissues

3. Yields of green & dry matter, %CP, silica, free ash and NFE are directly related to amount of precipitation

4. The physical, chemical and biological properties of soil, Fertilizer practices, nutrients supplied & renewed affects Forage chemical composition.

- B. Stage of growth:
1. There increase in cell wall Contents, decrease in cell contents hence increase in dry matter with advancing maturity.
  2. Dilution of mineral contents in proportion to increase in bulk and lower %CP, P and K
  3. Rate of dry matter accumulation through photosynthetic activity is greater than the rate of mineral absorption.
  4. Chemical composition varies vertically in a sward due to endogenous variations in maturity along this axis.

The cell wall contents increase at a faster rate in stems as compared to leaf



C. Genotype: 1. Legumes have higher feeding values than grasses especially in the tropics.

2. There are also differences between species, between genotypes within a species in the same Environment and under the same management

3. Chemical composition is indirectly affected by differences in genotypic factors such as maturity dates, leaf:stem ratio, growth habit, responsiveness to fertilizer and management practices and acceptability.

D. Sampling and processing: 1. methods of sampling e.g. handpicking simulate animal selectivity than Mowing.

2. Pretreatments like drying – oven/freeze – dried, temperature of drying, cleaning, washing etc.

3. There is need to standardize laboratory techniques to allow for valid comparisons of herbage analytical Results originating from different experiments, locations and seasons.

E. Toxic substances: Some forages that rated high in their dietary components also contain substances such as cyanogenetic glucosides, organic acids such as oxalic acid, amino acids, alkaloids, oestrogenic isoflavones and saponin which cause deleterious effects in livestock that feeds on them.

Legumes generally contain a wider range of deleterious substances than grasses.

In localized areas, forages tend to accumulate excessive amounts of minerals such as Mo that causes scouring, Se – alkali disease; fluorides – mottling and wearing of teeth.

Some grasses during rapid growth are high in nitrates.

Sorghum spp. – cyanogenetic glucosides

Pennisetum glaucum – prussic acid

Lablab purpureus causes bloat at a young and rapid growing stage.

Desmodium spp. – tannin, reduction in palatability and digestibility of the herbage.

Leucaena leucocephala – mimosine cause wool shedding and abortion in sheep, loss of hair on the rump and tail and loss of weight in cattle, due to incomplete metabolization of the substance in the rumen.

# Digestibility

is an important measure of the nutritive of forage and can be defined as the difference in value between the feeds eaten and materials voided by the animals, expressed in percentage of feed eaten. Thus, the overall digestibility of forage will be the summation of the content, digestibility of the chemical components of the forage (Harden 1975)

# *Factors affecting digestibility*

- 1. Stage of growth and genotype – Digestibility declines with advancing age and (maturity) rate vary considerably between genera, species and varieties.

- a. Plants high initial digestibility (70-85%) followed by high decline – *Andropogon gayanus*, *Cynodon dactylon*, *Pennisetum purpureum*, *Sorghum sudanense*.

- Intermediate initial digestibility (60-70%) followed by varying decline – *Andropogon gayanus*, *Cynodon dactylon*, *Dactylis glomerata* & *Digitaria pruriens*.

- **Low initial digestibility (50-60%) generally Low rate of decline – Paspalum, Cymbopogon, Hyparrhenia and Themeda spp.**
- **2. Plant fractions: Stem and leaf fractions of a plant are equally digestible at young age, but at maturity, stem becomes less digestible.**
- **3. Climate: reduced digestibility and poor nutritive value is due to high heat intensity that causes rapid growth, enhanced maturity with decreasing leaf : stem ratio and increased crude fibre content, particularly higher lignification, as well as increased levels of acid detergent fibre and cell wall contents.**

**•4. Protein and mineral content: Under natural fertility conditions, up to 2 months of growth after the onset of rains, the crude protein content in forage grasses is well above 7%, the growth is rapid with high heat intensity and crude protein content drops drastically to 4-6% with 3 – 5 months and 1-2% in the dry season. The crude protein content has a significant effects on digestibility, because below 7%, microbial activity in the rumen is depressed for lack of nitrogen which causes an incomplete utilization of structural carbohydrates in ingested forages and therefore, slow rate of digestibility and voluntary intake. Grass-legume mixtures, high protein feed supplementation or feeding of urea are some of the ways to improve the digestibility of low-protein forages.**



- Likewise, intake and digestibility are adversely affected when mineral contents of plants drops. Life weight gain is linearly related to P and Ca levels. Silica is absorbed by forages with water and reduces digestibility like lignin. Tropical grasses contain more Si than legumes.

- 5. Digested products: Quantitative determinations of these acids and their relative proportions, as well as the efficiency of their utilization by the animals are also used to estimate the nutrient value of forages.

- Animals in the tropics and subtropics derive their energy from the herbage they consume.

- Microbial activity in the rumen produces volatile fatty acids that are major sources of energy.

# *Forage Intake*

The feeding value of a feed is related to the amount which the animal will consume voluntarily. Assessment of forage quality depends not only on the nutritive value of the forages, but also on the total quantity of digestible nutrients consumed by the animal. In Ruminates, unlike monogastrics intake depends on the capacity of the digestive system, particularly the rumen.

*Factors affecting intake*

1. Season of the year
2. Stage of growth
3. Digestibility & genotype
4. The animal factor – size of animal, potential productions

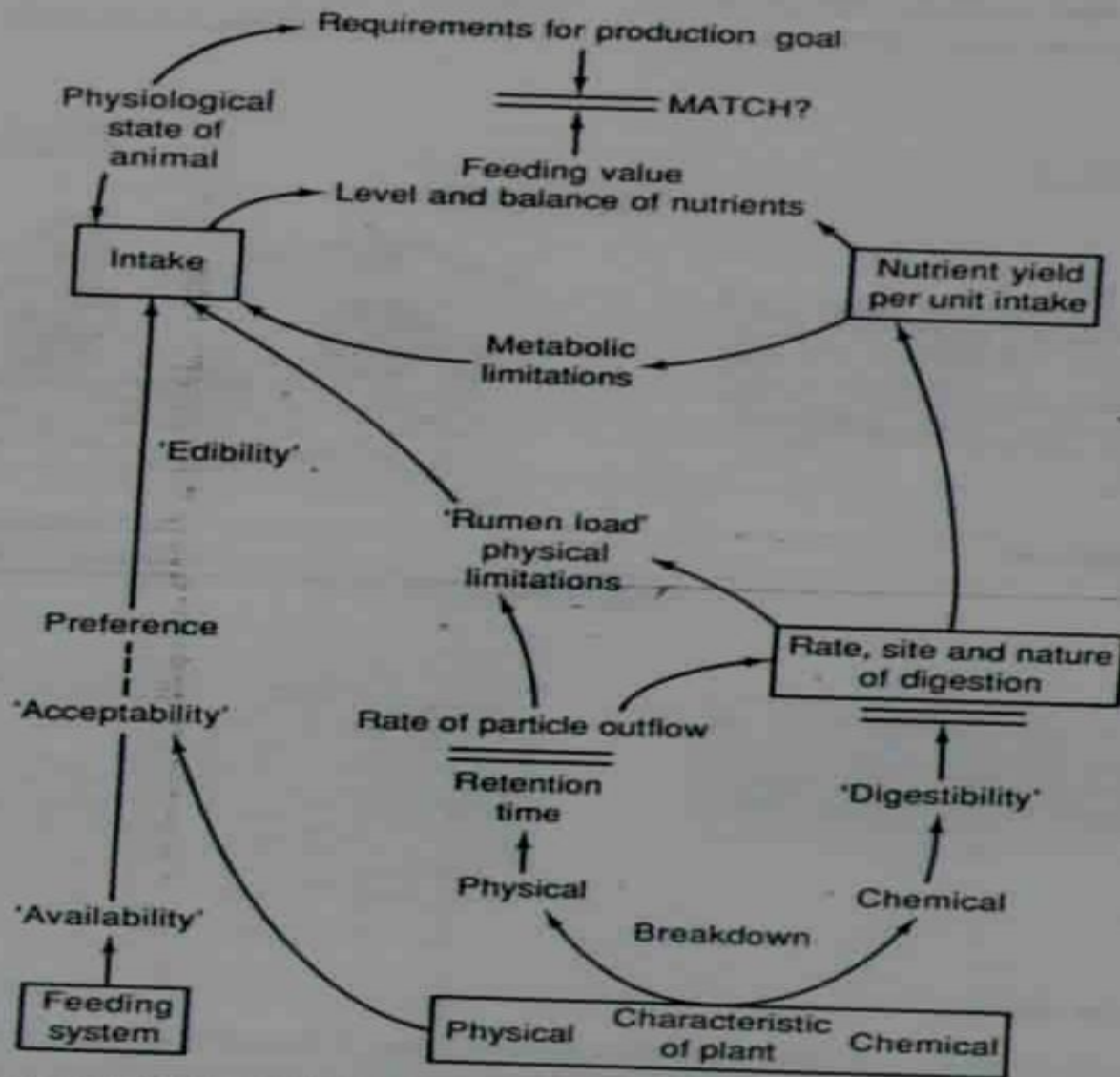


Fig. 6.1. Relationships between digestibility, intake and retention time. (From Egan *et al.*, 1986.)

# Pasture Terminologies

- Acceptability: Readiness with which animals select and ingest a forage; sometimes used interchangeably to mean either palatability or voluntary intake.
- Ad libitum: the voluntary intake achieved when feed is available to the animal at all times.
- Acid detergent fiber (ADF): Insoluble residue following extraction with acid detergent (Van Soest); cell wall constituents minus hemicellulose.

- Acid detergent lignin (ADL): Lignin in the residue determined following extraction with acid detergent.
- Adventitious roots: The second root system which develops from the lower nodes of each grass tiller.
- Browse: A class of range forage including twigs with their shoots and leaves which are selectively cropped by livestock or other wild herbivores from shrubs, small trees and woody vines.
- Carbohydrate: Complex polyhydroxy, aliphatic aldehydes and their anhydric polymers which the proportion of hydrogen and oxygen generally the same as in water e.g. glucose, sucrose, starch, cellulose

- Please photocopy others

THANK YOU

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