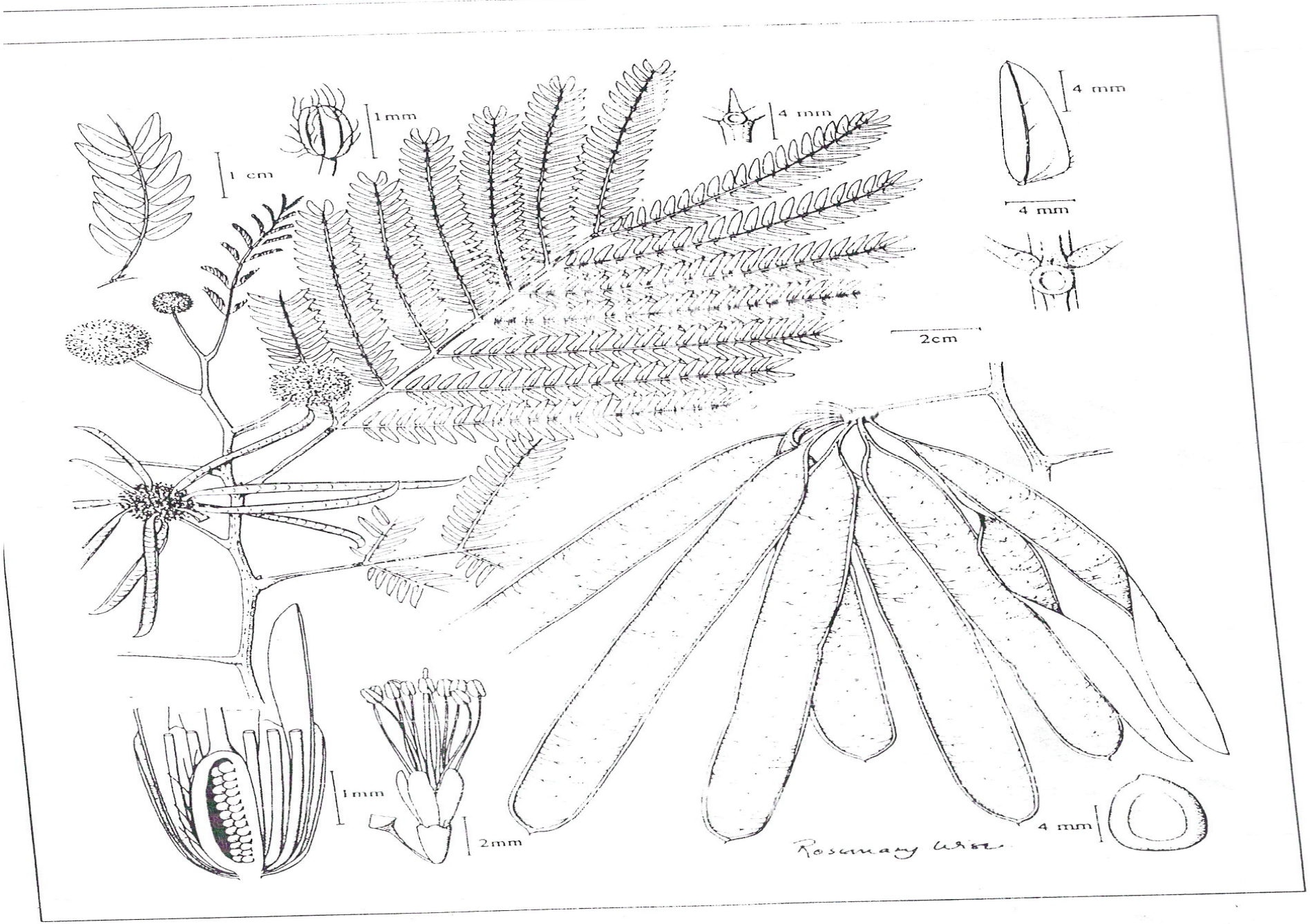
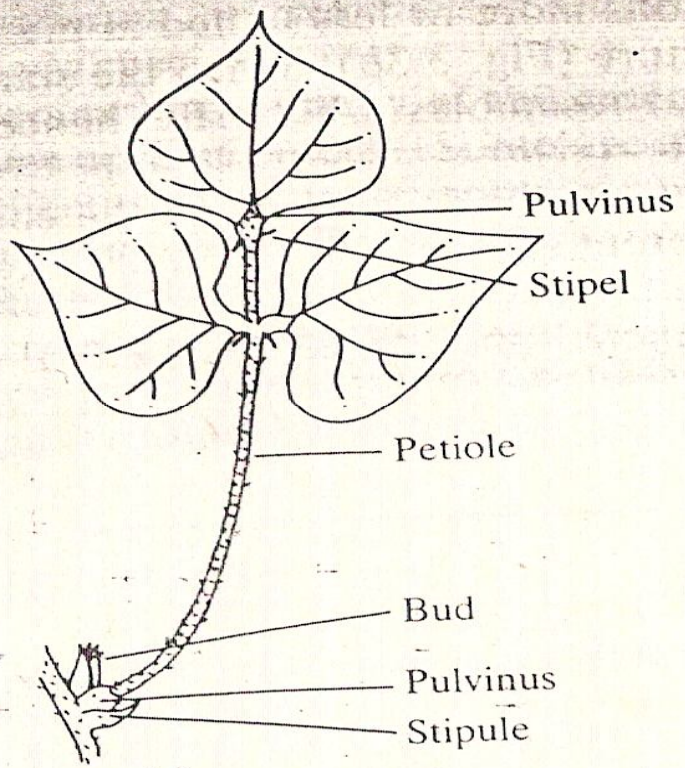
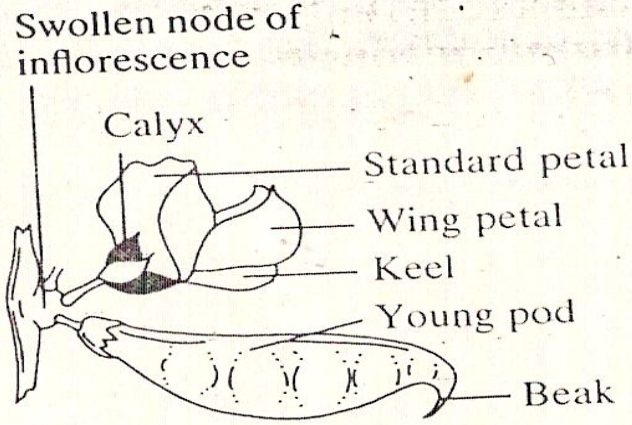


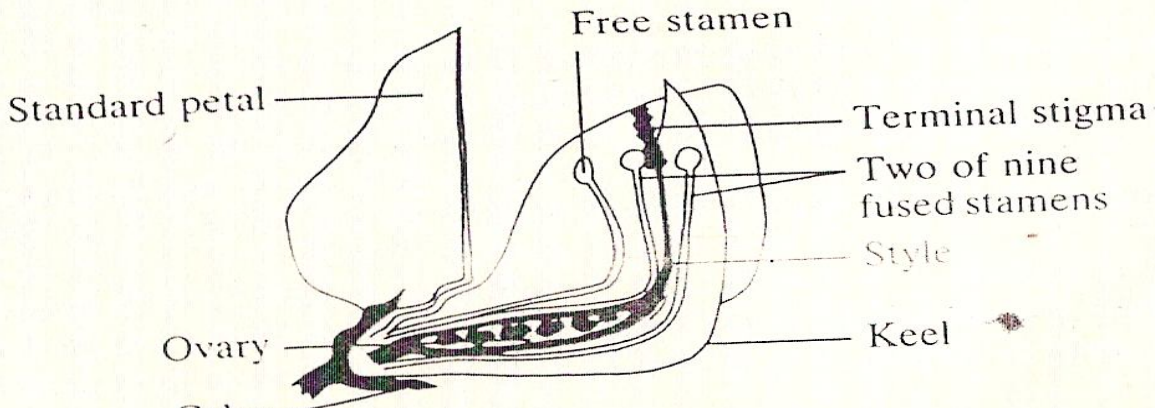
Figure 42 *Leucaena leucocephala* subsp. *glabrata*


Pulvinus
Stipel
Petiole
Bud
Pulvinus
Stipule

(*a*)


Swollen node of inflorescence
Calyx
Standard petal
Wing petal
Keel
Young pod
Beak

(*b*)


Free stamen
Standard petal
Terminal stigma
Two of nine fused stamens
Style
Keel
Ovary
Calyx

(*c*)

SYSTEMATICS OF PASTURE PLANTS

- Gramineae (grass family) and leguminoseae (legume family) are divided into lower or minor categories of the tribes, genera and spp. (Lawrence, 1951)
- Tribes are group with certain phylogenetic (evolutionary) relationships.
- A genus comprises of plants with common reproductive structures. Which extends beyond morphological differences to genetics, cytologic, physiologic, ecologic and geographic relationships.
- The generic name of a plant is the first of the words making up the botanical binominal e.g Chloris gayana .

Species consists of a natural population of plants with common morphological characteristics (phenotypically similar), having a common ancestry and capable of replacing like types (Lawrence 1951) it is identified taxonomical by the secondary name of the binominal used as a scientific name. this group is the most important botanical unit for the pasture agronomist and cattleman, since plants of species may have broad adaptability to diverse soil and climatic conditions.

The species is a particular interest to the plant breeder, who brings together introductions of the species from different sources and searches for the type which excel in adaptation, herbage yield, persistent e.t.c which may be released as cultivars e.g *Chloris gayana* 'Masaba'.

•'varieties' are morphological variants and subdivisions of the species. In botanical literature, they will be written with the specific name e.g *Panicum maximum var. Ntchisi, Imperata cylindrical* var. africana to distinguish it from those of other area.It can refer to plant population of the same species which differs from another one in one or more recognizable inherited characteristics.

'Cultivars' is the internationally recognizable term for the agricultural variety . A cultivar is a cultivated population of plants with recognized, morphological, physiological, chemical or other differences. They may follow generic, specific or common names e.*g Desmodium* Greenleaf. *Desmodium intortum* Greenleaf or *desmodium Greenleaf*.

Ways of classification

- The earliest system of classification were based on pre selected characteristics, such as form or habit e.g. trees, shrubs, herbs, annuals, biennials, perennials.
- Carolus Linnaeus(1707-1778) a Swedish, revolutionised plant classification through sexual system of flora characteristics especially stamens and pistils.
- But attention is now on microscopic and submicoscopic features of spines, hairs, spores, pollen grains, starch grains, cellular inclusions e.t.c.

- Later knowledge of cytology in determining chromosome number, size and morphology, behaviour and structure in meiosis led to establishing cytotaxonomic relationships.

- -Biochemical properties of plants have been studied to been studied and used by taxonomists, for a long time e.g essential oils, pigments, alkoids, flavonoids, glycosides, and non protein free amino acids, which is chemotaxonomy.

- -Immunological studies of proteins yields measures of taxonomic relationship. The implications of each development is that plants are always reclassified but this does not alter plant adaptability and response to management practices.

Nomenclature

- Scientific names (botanical or Latin names) may be long, unfamiliar or difficult to pronounce but it has the following advantages:
- 1. Same names used in all languages.
- 2. Uniform binomial (two names)
- 3. Binomials are exact in delineating a species.
- 4. Descriptive (for those versed in Greek and Latin)
- 5. The choice of names is governed by international rules of botanical nomenclature

- - Common names (called vernacular, colloquial, folk names) it depends on language of a place and descriptive (sword bean, lemon grass-*Cymbopogon flexuosus*) or bear name of a person (Rhodes grass-*Chloris gayana*), location (Townsville stylo-*Stylosanthes humilis*) or associated with a habitat (beach grass-*Ammophila spp*).
- - May refer to genus e.g desmodium. Its use can be confusing and misleading.
- 1. Restricted to one language or dialect, and perhaps to one locality.
- 2. Names are indefinite
- 3. Are not regulated by a constituted authority.
-

Classification & distribution

- Grasses
- Graminae (Poaceae) is a large botanical family with about 10,000 spp. grouped into some 650 genera and genera into 50-60 tribes; with sub families of 2 to 12.
- 3 group are of interest- Festucoid group-temperate grasses; Panicoid group- tropical and subtropical and Chloricoid group- few tropical cultivated and a number of valuable wild grasses the tropical and warmer areas of North American .
- Examples of festucoid- Tribes of Triticae (Agropyron spp) Festuceae (Festuca, Dactylis, Lolium, poa) Bromeae (Bromus), Aveneae (Avena,Arrhenetherum) Agrostideae (Agrostis, Alopecurus, Phleum)
- Panicoid- Paniceae or mellinidae (*Panicum*, *Brachiaria, Digitaria, Mellinis*, Pennisetum, Cenchrus), Andropogoneae (Andropogon, Hyparrhenia, Sorghum, Lasiurus, Themedia) and Maideae (Zea, Euchlaena, Tripsacum)
- Chloridoid- chlorideae (Chloris, Cynodon) and Eragrosteae (Eragrostis, Dactyloctenium, Eleusine)

Legume

- Order- Leguminosae (Fabaceae) family is divided into three distinct groups or families- Mimosoideae, Caesalpinoideae, Papilionoideae and subfamilies- Mimosaceae, Caesalpinaceae and Papilionaceae of the botanical order Leguminosae.
- Only two spp of mimosoideae are important to us – *Leucaena leucocephala* and *Desmanthus virgatus*, although a number of shrubs and trees are browse plant of Acacia spp.
- A number of Caesalpiniodeae are cultivated for fodder and only very few are used as natural browse plants.

- Species of Papilionoideae are widely grown as pasture or fodder crops and are of considerable important for natural grazing or browsing. It is a large subfamily with 200 genera and some 12,000 spp. distributed throughout the world.
- Leguminosae in general are of tropical origin with Caesalpinaceae as the most primitive type .
- 17 tribes of Papilionoideae are recognized . With important ones as Indigofera, Aeschynomeneae, Sesbanieae, Genisteae, Psoraleae and Trifolieae but majority of legume in cultivation belongs to the tribes – Stylosantheae, Desmodieae and Phaseoleae. The above tribes especially the last three are distributed all over the world, with Desmodieae and Phaseoleae concentrated in Latin American.

Centre of distribution

- **TROPICAL GRASSES**
- 1. East Africa- species of *Brachiaria, Cenchrus, Chloris, Cynodon, Panicum, Setaria,* and *Urochloa*
- 2.South Africa- species of Digitaria and urochloa

  3.Arabia, Pakistan, and Northern India – *Cenchrus*
- 4.Subtropical South American- *Axonopus, Bromus, Paspalum and Sorghum*

- LEGUMES
- 1.Centres of high species density exist in Central America, Bolivia, Southern Brazil, and Paraguay- *Macroptilium, Desmodium and Leucaena*
- 2.Central and Southern American- *Centrosema, and Stylosanthes*
- 3.East Africa – *Glycine and Macrotyloma spp*
- 4.Southern African- *Lotononis*
- 5.Southern-East-Asia-*Pueraria, Vigna, Calopogonium, Indigofera*

PASTURE IMPROVEMENT PROGRAMMES AND BREEDING

Pasture improvement and development programmes may be initiated through a number of different approaches.

1. The first approach is based on improved management and utilization of existing natural pasture resources.

2. The second approach is to replace existing natural vegetation with introduced pasture species.

3. While a third method is a combination approach, where an introduced species may be over sown into existing native pasture.

The basic philosophy is that the existing species in the region are well adapted to the environment and research and management seeks to increase or at least maintain the most productive species for animal production.

Improvement of grassland takes many forms. 1. stock control and controlled grazing, and this has often led to a change in botanical composition without the deliberate introduction of new species.

2. casual or deliberate introduction of legumes, notably in Australia, and this has been linked with the recognition and correction of major and trace element deficiencies, particularly phosphorus and molybdenum.

3. A further stage of improvement is reached when new grass species are introduced deliberately, often with and an accompanying legume, with or without the destruction of indigenous grasses.

Selection of species or cultivars

- In selecting a new grass or legume; or in replacing an older one with and improved cultivars of the same species; the following points should be considered:

- A. Characters required in the pasture plants. The species or cultivar characteristics are important. They are :
  1. High yield of good quality forage and re-growth potential.
- 2. Ease of establishment or propagation.
- 3. Palatability
- 4. Length of vegetative stage of growth
- 5. Response to applied fertilizers
- 6. Persistency
- 7. Tolerance to drought, grazing, cutting and burning
- 8. Seeding habit
- 9. Ease of eradication
- 10. Ability to associate with other species.

- B. Other points are:
- 1. Adaptation – to the general region and local conditions
- 2. Intended use – continuous or rotational grazing, hay, silage, greenchop, rotation grazing, soiling.

- 3.Availability of seed or planting material
- 4.Value of land-especially if the new grazing land is to be intensively used

- 5.Topography of land –mechanizable or steep
- 6.Type or quality of animals to be grazed or fed
- 7.Managerial skills of cattleman

Approaches to plant introduction

- 1.Through correspondence with other research institution or agencies
- 2. Evaluation of existing species and cultivars by major institutions in regions with similar environmental conditions
- 3.Assess the climatic comparisons or the phytogeographical distribution of species in the areas.

- Organization of plant introduction
- Plant introduction group has a number of functions, the basic ones are:
- Acquire new plant accession and organize their introduction into the country
- Organize the documentation of all introduction
- Provide initial screening, description, and evaluation
- Build up seed stocks and planting materials and to maintain seed stocks for future testing or breeding programmes
-
-

- In larger organizations, will be involved in toxonomic studies, phytogeographical studies of species distribution, and plant collecting expeditions.
- Primary evaluation stage - 1. Provide a quarantine check of introductions
- 2. Build up seed stocks or vegetative planting materials
- 3. Describe the morphology, phenology and growth
- Characteristics of the accession.
- Records kept throughout the growing season must be include: Growth habit
- Leafiness
- Vigour
- Time of flowering- length of flowering period
- Seed set- mount harvested
- Effect of low or high temperatures
- Regeneration
- Incidence of pests and diseases
- Nodulation in the case of legumes
-

Second stage of evaluations aimed to examine the agronomic characteristics under field sward conditions

- Competition

- -Stress
- -Productivity
- -Vigour of the sward- through estimation of botanical composition
- -Persistence- plant counts at establishment and subsequent survival
- -Potential feeding value- *in*-vitro digestibility studies, intake studies with penned sheep.

Scheme of pasture and forage crop characterization (adapted from Mott and Morr, 1969)

1. Introduction	Observation	Breeders lines
	Selection	
2. Small plot clipping	Varietal tests	Regional tests
	Chemical analyses	Advances selection
	in-vitro digestibility	
3. Agronomic	Sowing densities	Cultivars
management	Fertilizer studies	
	Grass-Legume mixtures	
	Cutting treatments	
4. Animal response	*in-vitro* digestibility	Product per animal
	in- vivo digestibility	Product per animal
	Stocking rate	Economic returns
5. Feeding systems	Pasture sequences	Animals output
	Hay and silage	Economic return
	Supplementary feeds	

METHODS OF PROPAGATION

- **Tropical grasses are established vegetatively or from seed.**
- **Vegetative: if it is simple or cheaper, or when the purity and uniformity of hybrid clones or clones of cross-polluting grasses should be maintained as example in clone cultivars or hybrids of Bermuda grass(*Cynodon dactylon*).**
- **Stoloniferous and rhizomatous species can be propagated by pieces of stolons or rhizomes spread on the ground and buried in by subsequent harrowing or discing.**
- **Large tufted grasses, such as elephant grass (*Pennisetum purpureum*), *Tripsacum laxum*, large varieties of *Panicum maximum* etc are planted in rows by splits or sprigs.**
- **When planting, the top portions of grass should be cut off as the splits with uncut stems and leaves would almost invariably die because of the loss of water through the leaves. Long roots should also be cut short because the old rots would any how die out and the plants develop new roots and live on them. It is advisable to pile the splits loosely , water the pile and cover them with sacks for a few days, until the new roots begin to appear. Planting is normally done in rows the distance between the rows depending on plant size and local custom; Planting is done by hand or by special machines as those for planting sugar cane or adapted for tobacco planters. Elephant grass is normally planted by stem cutting; the stem should not be very young and cut to pieces each having about three nodes. The stems are stuck into the soil with two nodes underground.**

- Establishment from seed is usually more difficult in the tropics than under temperate conditions because:
- 1. Seeds are often not in ready supply
- 2. Mostly small
- 3. Drought can kill small weak seedlings
- 4. A clean, not too fine seedbed as free from weeds as possible should be prepared
- 5. Seed is then broadcast or drilled in rows.

- Seed rates vary and can be recommended with some certainty only if the quality of seeds i.e. its purity and germination is known. Seed quality can be expressed as percentages of PGS (pure germinating seed), PVS (pure variable seed) or PLS(pure live seed). It can generally recommended not to plant seed immediately after harvesting but after some six months of storage, but seeds stored for 2 or more years should be re-examined for germinability.
- Fertilizers are given before, during and after sowing; phosphorus in form of double or single super phosphate is usually given before and during the sowing; N is given in its nitrate form, ammonium form or as urea. Time of application is a controversial issue; some recommend about the sowing time and some during the dry season to be released at onset of rains. Nitrogen is often applied after each grazing or cutting.
- If weeds are a problem, the early management includes mowing before the weeds get to flowering stage, at a time when grass plants are still weak and this may reduce grass-weed competition and result in a better establishment; if the weeds include palatable species, early grazing can replace or supplement mowing.
-

LEGUMES

- are established almost exclusively from seed although growing some creeping species from roots cuttings had been attempted and in perennial species of ***Arachis***, this is a normal method of establishment.
- Stem cutting of a number of perennial leguminous species can root and produce vegetative progenies of cross-pollinated plants, for examining the effects of environment on genetically identical material, etc.
- Seed bed- for farm sowing is prepared in the usual way and seed is sown preferably in rows, especially in grass/legume mixtures in which the two components are often sown in alternate rows.
- Seed rates differ widely depending mainly on seed size: the number of seeds/kg ranging from 2-2.5 thousand in species of *Mucuna* to over 3million in *Lotononis bainesii*.
- Similarly considerable proportion of hard seeds i.e. seeds which remain viable in the soil for months to several years without germination. The presence of hard seed is normally an inheritable character, it can be reduced by selection and in species or cultivars grown for a number of generations, the percentage of hard seed is usually negligible; on the other hand it can be very considerable, especially in recently introduced species. The presence of hard seeds is apparently an adaptive feature which prevents all seeds from germination at the first opportunity and then dies if a sudden drought occurs.
- Water cannot penetrate through the seed skin or testa of hard seeds and remain un imbibed .

- Methods of removing hard seed
- 1. Soaking in water for some 24hours or longer can reduce the proportion of hard seeds but the reduction is relatively small.
- 2. Mechanical scarification (seed scratching)
- -using hammer mill
- -Rubbing seeds with and paper if the amount to be treated is small.
- 3. Soaking in concentration Sulphuric acid is perhaps more reliable and efficient method of reducing the percentage of hard seed, duration of time take 2 to 20- 25minutes to determine experimentally. Then thoroughly wash with water.
- - hard seed should be treated before inoculation with Rhizobium, if seed is inoculated it should be sown as soon as possible after the inoculation but delays in sowing are much less harmful if seed has been pelleted, Rhizobium bacteria of the Cowpea group lose their ability to grow and can die at a temperature of 400c and above, during or after sowing, Hot weather is harmful to Rhizobium inoculated small seeds which require shallow sowing.
- Fertilizers used for the legumes include mainly phosphorus in the form of double or single super phosphate; the latter is preferred as it contains Sulphur, the deficiency of which can be reducing the vigor and productivity of the legume. Potassium is another nutrient commonly used as fertilizer. The legumes are sensitive to deficient in micronutrient and Molybdenum is particularly important for Rhizome activity. On soil deficiency in boron and copper these nutrients have to be added. The tolerance of legume to Aluminum and Manganese varies. *Stylosanthus humilis* and *Lotononis bainesii* are more tolerant then many others.

PHYSIOLOGY OF PASTURE PLANTS

- The majority of tropical grasses are either indifferent to day length (Tripsacum dactyloides, Acroceras macrum) or are short day plants and flower earlier under short than long photoperiods (Hyparrhenia hirta, Sorghum halepense); there are however, tropical spp (Paspalum dilatatum) which flower easier and earlier under longer than shorter photoperiods.
- Herbage production follow the pattern of flowering but in the majority of grasses long photo periods stimulate herbage growth and production.
- For temperate grasses, the productivity of photosynthesis in terms of amounts of synthesis organic matter increases with the increase in light intensity up to 15,000- 25,000 lux above which, productivity of photosynthesis do not increase further.

However, in tropical grasses, photosynthetic productivity increases further and reaches it maximum at 50,000-60,000 lux and sometimes even at higher light intensity, and can be much greater than in temperate grasses provided that light intensity is sufficiently high.

The tropical grasses that response in the above way to light intensity belong to the tribes- Panicoid and Chloridiod. While, Festucoid grsses differs and the above differences can be linked with leaf anatomy. In Panicoid and Chloridiod grasses, the cells are known as Kranz-type cells while those of Festucoid are known as non-Kranz cells. In Festucoid grasses, the photosynthetic process is of the so-called Calvin or C3 cycle while that of Panicoid and Chloridiod is known as C4 pathway.

In C3 cycle, the initial products of Carbon assimilation are 3-phosphoglyceric(3-carbon) acids or hexosphosphates are further utilized for formation of carbohydrates with optimum temperatures of 15-20ºC while for C4 the initial products of photosynthesis are 4carbon acids- malate, asparagate, oxalo-acetate with optimum temperature of 30-40ºC.

Grasses tend to be more aggressive than legume in mixture due to the differences in their photosynthetic pathways. Most tropical grasses are C4 plants while the legumes are C3 plants. Hence grasses utilises sunlight energy better than legumes which leads to higher structural carbohydrate formation and this forms the reason grasses are higher in fibre than legumes.

The importance of legumes in agriculture as arable fodder and pasture crops and as components of natural grasslands and perhaps also their wide spread throughout the world depends as it is universally known on their ability to fix atmospheric nitrogen in symbiosis with rhizobium bacteria found in the legume root nodules

Some rhizobium bacteria are highly specialized and can enter into symbiotic relationship only with certain specie of legume; some are less selective and live and work actively in a few species, usually closely phylogenetically related and there are also promiscuous or indiscriminating bacteria which can innoculate a large number of species which belong to the so called cowpea type; they can be in an active symbiosis with a number of tropical legumes, one widely spread in poor and acid soils of the tropics and conversely, most of the tropical legumes can be inoculated and the same cowpea rhizobium.

There are not much differences in the physiology of legumes and they adapt to lots of climatic conditions. Rainfall is the only major climatic factor affecting legumes in the tropics while temperature can have effects on temperate legumes.

Leaf Anatomy of C3 and C4 plants

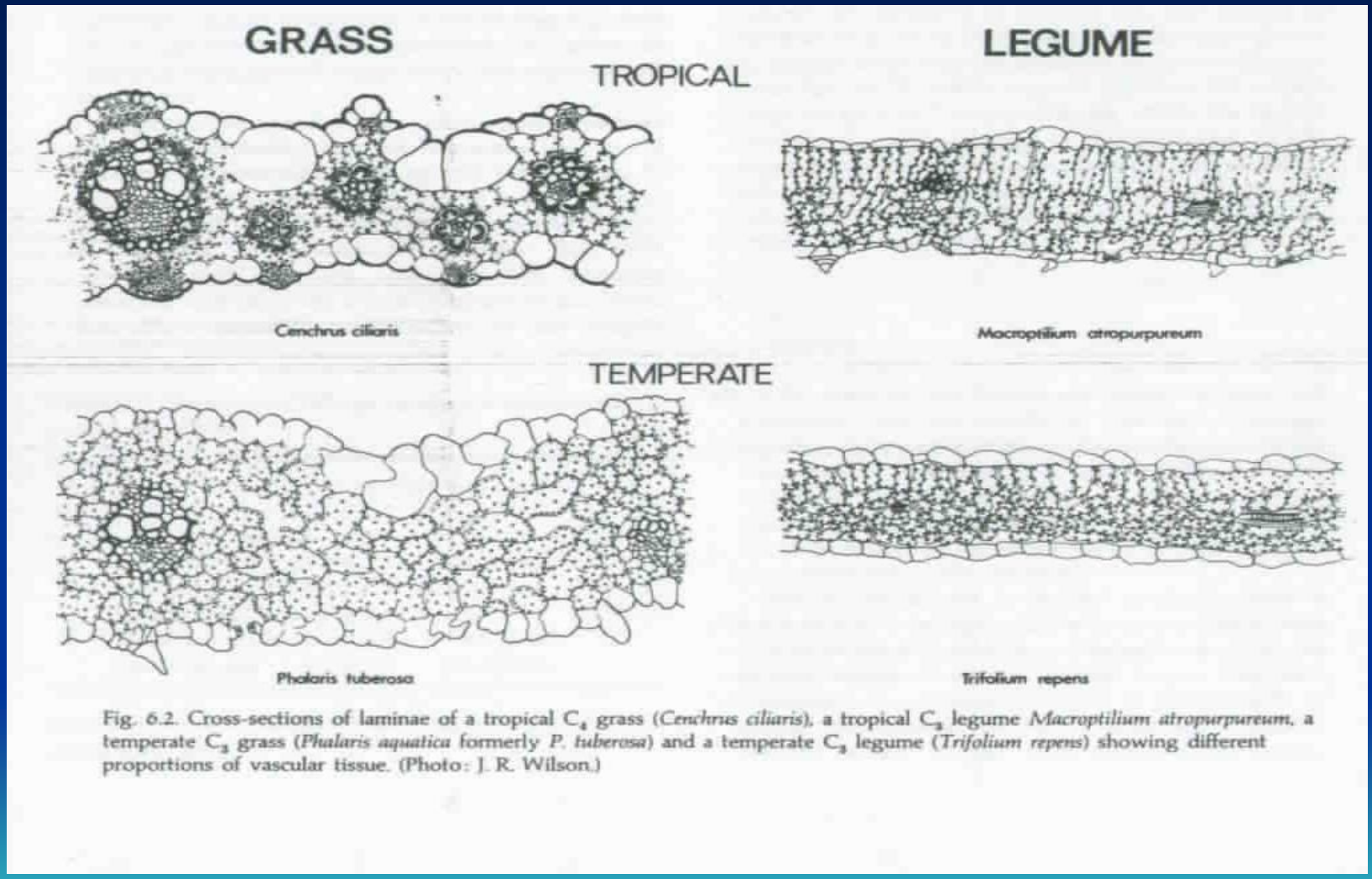


Fig. 6.2. Cross-sections of laminae of a tropical C_4 grass (*Cenchrus ciliaris*), a tropical C_3 legume *Macroptilium atropurpureum*, a temperate C_3 grass (*Phalaris aquatica* formerly *P. tuberosa*) and a temperate C_3 legume (*Trifolium repens*) showing different proportions of vascular tissue. (Photo: J. R. Wilson.)

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

- 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

- **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.
- **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 unicinatum* 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 evolvement 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 vegetation rather than climate itself. (Critchfield, 1966; Trewartha, 1954-1968)
- Wladimar Koeppen, 1900- German biologist- world climates.

Vegetation maps