Chapter 1

Introduction
CHAPTER- I
INTRODUCTION

It has been said “He who make two blades of grass grow where one grew before is the benefactor of mankind….. and he who obscurely works to find the laws of such growth is the greater benefactor of mankind” (Henry Augustus Rowland, 1848-1901). Plants have many diverse uses, which have a direct or indirect bearing on the civilization of human society. India is a vast country abounding in plant wealth and therefore it is very important to utilize these plant resources for the welfare of the countrymen. The late Prime Minister Nehru appropriately wrote in his foreword to the first volume of Wealth of India (1948), “Nevertheless, India is wealthy and the wealth of India is there, but in spite of this wealth the people are poor. The problem for us is to utilize this stored up wealth of the country in the soil, and under the soil for the benefit of Indian humanity.” It may be his remarks - are very significant because though the country is very rich in its plant wealth, the information about it is rather insufficient.

1.1 Evolution Of Grasses

Grasses are monocotyledonous plants belonging to “Poaceae” family, popularly known as “Gramineae”. As per available fossil records, grasses evolved on earth nearly 130 million years ago. Further, their diversification began about 20 million years ago during the Miocene period. This diversification occurred in different environments and continents. One salient feature is that in the process of diversification biotic and edaphic factors enhanced their future evolution and distribution. A large majority of grasses are herbs except Bamboos, which evolved during the Upper Cretaceous period. All grasses have a hollow stem. There are about 650 genera and over 10,000 sps. distributed throughout the world. In India there are 1,100 sps. of grasses distributed into four major grassland areas.

It may be well remembered and worth mentioning that the pastoral communities in human population gradually transformed from nomadic life to a settled life. It is quite natural, that anthropo-historically, world's grasslands have been
the sites where they settled - the vast grasslands not only provided them adequately the wild ancestors of some of the modern food grains but also plenty of game to hunt and eat.

Grassland is the land on which grasses and/or legumes constitute the dominant vegetation. The term 'grassland' is used to refer to ecosystem in which the dominant vegetative component is comprised of herbaceous species. Herbaceous species are important components of the ground layer of woodlands, but trees characterize and dominate the vegetation of these landscapes. The term grassland implies a landscape unit dominated by grasses. In India, these ranges from village grazing grounds and extensive low pastures of dry region in rolling grassy downs of alpine meadows - Himalayas. Natural grassland occurs in situations too arid for the development of closed forest but not so adverse as to prevent the development of a closed perennial herbaceous layer that is lacking in desert (Coupland, 1974). Approximately 45.0 million sq. km. area throughout the world in the tropics, temperate and alpine regions are covered by grassland which is approximately 24% of the vegetation cover (Shantz, 1954).

The grassland formation tends to dominate when the upper layers of the soil are moist for a considerable part of the year but a dry zone intervenes between the upper layers and the ground water or ground water-table reaches the surface, both conditions being unsuitable for the tree growth. Under such conditions the principal grassland type of the world are developed in the temperate belt, viz., the short grasslands of steppes and the tall grasslands of prairies. In the tropics the typical grassland formation is the savannah occurring in a climate which may be called humid from the extent of the total rainfall but with little rain from 3 to 8 months. The dry period, high temperature and evaporation of soil moisture in the tropics hinder the development of closed forests although scattered trees may be present in a landscape dominated by grass. Grasses are also capable of standing greater extremes of climate than trees, greater aridity, greater cold, wetter places. This accounts for the development of the frigid zone above the tree limit and the numerous edaphic habitats where grasses are dominant, e.g. marshlands, sandbanks etc. Rangelands are naturally occurring area of grasses. Forests, shrubs and open stands of trees. The plants and soils of rangeland ecosystems comprise greater than forty per cent (40%) of the
grasslands, meadows, tundra, deserts, shrublands, steppes, savannah’s and woodlands (Williams et al., 1968).

While, natural grasslands are those in which climate is the prime controlling factor under light and moderate grazing pressure by ungulates, the semi-natural grasslands are deforested areas, in regions of forest climate, that are held in the relatively stable condition by various natural and man-induced means such as flooding, moving, grazing and other treatments that prevents reinvasion of natural forest. This situation is applicable to many vidis in Panchmahals and Saurashtra.

The natural grassland areas have been used primarily either as crop land or as rangeland. Tillage is most intensive and began in earlier times, near the forest margin; an increasingly larger proportion of the land is devoted to grazing along the climatic gradient from forest to desert. Overgrazing has caused depletion of the grass cover in many areas and is a hazard to the continued productivity of rangeland. Overgrazing has caused some grassland to become desertic. The major management practice used in rangeland is to control the number of livestock and their distribution on range, so as to maintain substantial carrying capacity. Fig. I depicts an overall view of the grazing resources of India.
Semi-natural grasslands are being used for hay or pasture. The management regimes applied, determine the character of the plant cover. Because the climate
within which semi-natural grasslands occur is more favourable to plant growth they are more productive of forage than the natural grasslands.

In some places there is a natural grassland not because forests would not grow but because trees had no time to invade and occupy it and with many scrub species, once the land is covered with vigorous grass, tree seedlings find it hard to gain a foothold. With fire and grazing, which destroy the seedlings as soon as they come up, the pre-climax lasts indefinitely; similarly once a forest has been destroyed and grasses have gained ascendancy in secondary series, it may be very difficult for progression to continue and the formation may be arrested in the seral stage.

1.2 Adaptation of Grasses

The grasses are successful invaders and are capable of colonization in various habitats, due to their adaptability as indicated below:

(a) Grasses occur from hydrophytic to xerophytic environment.
(b) Many of them possess xeromorphic environment.
(c) Life-span annual to perennial.
(d) Habit from trailing to erect.
(e) Size from small to dendroid.
(f) Meristematic activity in the inter-calary regions.
(g) Rooting habit superficial.
(h) High reproductive capacity and reproduce sexually and asexually.
(i) Quick dispersal- ectozoic and endozoic.
(j) Wide ecological amplitude.
(k) Can withstand trampling, grazing and fire.
(l) Pioneer species in primary and secondary succession.
(m) Growth form is different and suits various ecological niches.
(n) Nodes have ability to produce roots and shoots.
(o) Position of buds is below the soil.
(p) Elasticity of grass internodes to bend.
(q) Grasses are tolerant to poor conditions.
(r) Grasses are mostly wind pollinated.
1.3 Grassland Categories In India

There are no true grasslands in India such as Steppes or prairies. Grasslands are termed as “bids” or “veedies” locally. Types and geographical distribution: R.O. Whyte (1957) has recognized eight types of grasslands in India based on their floral characteristics. Distribution of major grassland types in India (after R.O. Whyte, 1957):

(a) *Sehima-Dichanthium* type - Black soil: Western Hyderabad, Mumbai, Western Madhya Pradesh, Bhopal, South-east Uttar Pradesh, Western Andhra Pradesh, Mysore and Chennai.

(b) *Dichanthium-Cenchrus* type - Sandy loam: Plains of Punjab, Delhi, Rajasthan, Eastern Uttar Pradesh, Saurashtra, Kachchh, North Gujarat, Bengal, Bihar, Orissa, Northern Andhra Pradesh, Eastern Madhya Pradesh, Eastern Hyderabad, Travancore, Cochin, West Coast of Mumbai, Eastern Chennai.

(c) *Phragmites-Saccharum* type - Marshy locality: Tarai areas of Uttar Pradesh, Bihar, Bengal and Assam, Swamps of Sundervan, Kaveri delta of Chennai.

(d) *Bothriochloa* type - Paddy tract and high rainfall belt: Lonavala tract of Mumbai.

(e) *Cymbopogon* type - Low hills: Low hills of Western Ghats, Western Ghats. Vindhya, Satpura, Aravalli, Orissa.

(f) *Arundinella* type - Mountains: High hills of Western Ghats, Nilgiris, lower Himalayan regions in East Punjab, Himachal Pradesh, Uttar Pradesh, Bihar, and Assam upto 2000 meters.

(g) *Deyeuxia-Arundinella* type - Mix temperate climate: Upper Himalayan region in East Punjab, Himachal Pradesh, Jammu and Kashmir, Uttar Pradesh, Bengal, Assam.


Grassland Status - Categories In India

In Indian context, grassland ranges from village grazing grounds, extensive low pasture of dry regions to rolling grassy downs of alpine Himalayas (Yadav and Singh 1977). On the basis of moisture, three broad categories of grasslands have been identified by Puri (1960), which are as follows:
**Hydrophilous grasslands:** These types of grasslands appear as wet savannahs containing dominant species like *Erianthus elephantinus*, *Saccharum arundinaceus* and *Phragmites arundo* either on drier or wetter sites.

**Mesophilous grasslands:** These are typical types of moist deciduous forests found in U.P., where the predominant grasses like *Saccharum munja*, *S. narenga* and *Vetiveria zizanioides* can grow. These grasslands also resemble the savannah.

**Dry Grasslands:** On the plains like coastal sands and sandy habitats of the arid Kutch, *Dichanthium annulatum*, *Desmostachya bipinnata*, *Cynodon dactylon*, *Sporobolus helvolus*, *S. marginatus* and *Aeluropus lagopoides* form characteristic communities.

The grasslands are all existing due to biotic activities like lopping, burning, shifting cultivation and grazing, of the forests for the last several thousand years.

Grasslands face many severe problems like effect of rainfall, overgrazing, replacement of grass by other species and salinity. The first countrywide survey of the grazing lands was undertaken by the Indian Council of Agricultural Research (ICAR) during 1954-62, with the basic objective of solving some of the pertinent questions faced with respect to the management and improvement of grazing lands. While the work of the survey was still in progress, Whyte (1964) presented "Grassland and Fodder Resources of India" and described the grazing land types in the 4 agricultural zones of the country, mostly giving their composition and some agronomic aspects. The report of the Survey Team has been compiled by Dabadghao and Shankarnarayan (1973). The team selected 507 sites throughout the country in different climatic and soil types and collected information on floristic composition, density or plant cover, forage production (as air dry produce), plant vigour and plant succession.

In describing the grass cover of India, Dabadghao and Shankarnarayan (1973) have distinguished four major types.

1. The *Sehima - Dichanthium* type covers the whole of peninsular India (dry sub-humid zone except Nilgiri). The thorny bushes of the savannah rangelands are *Acacia catechu*, *Mimosa hamata*, *Zizyphus nummularia* and sometimes fleshy *Euphorbia*, along with low trees of *Anogeissus latifolia*, *A. pendula*, *Soymida febrifuga* and other deciduous species. The floristic list includes 24 perennial grasses and 129 other herbaceous species of which 56 are legumes. *Sehima* is more prevalent on gravel and the cover may be 87 percent. *Dichanthium*
flourishes on level soils and may cover 80 per cent of the ground. The grasslands of arid regions are found mainly in Rajasthan, part of Kutch and Saurashtra. These were studied by Shankarnarayan and Satyanarayan (1964).

(2) The Dichanthium - Cenchrus - Lasiurus type (semi-arid zone) extends to the northern portion of Gujarat, Rajasthan (excluding Aravallis), Western Uttar Pradesh, Delhi State and Punjab. The topography is broken up by hill spurs and sand dunes. Eleven perennial grasses, 45 other herbaceous species (including 19 of the Leguminosae) are listed. To this list may be added shrubby growth of Acacia senegal, Calotropis gigantea, C. procera, Cassia auriculata, Prosopis cineraria, Salvadora oleoides and Zizyphus nummularia which make the savannah rangeland look like scrub.

(3) The Phragmitis - Saccharum - Imperata type (moist sub-humid zone) covers the Ganga alluvial plain in northern India. The topography is level, low-lying and ill-drained. There are 19 principal grass species and 56 other herbaceous ones including 16 legumes. Bothriochloa pertusa, Cynodon dactylon and Dichanthium annulatum are found in transition zones. The common trees and shrubs are; Acacia nilotica, Anogeissus latifolia, Butea monosperma, Phoenix sylvestris and Zizyphus nummularia. Some of them are replaced by Borassus sp in the palm savannas especially near Sunderban.

(4) The Themeda - Arundinella grass cover extends to the humid montane regions and moist sub-humid areas of Assam, Manipur, West Bengal, Uttar Pradesh Punjab, Himachal Pradesh and Jammu and Kashmir.

1.4 The Morphology Of The Grass Plant (Bor, N.L., 1960.)

The simple plan of the grass plant is as follows. The vertical cylindrical hollow stem standing upon its roots is strengthened at intervals by transverse septa, known as nodes. The leaf-blades are borne on sheaths which encircle the stem. The sheaths arise alternately at the nodes and the series is distichous, i.e. the odd-numbered sheaths are directly above one another while the even-numbered are on the opposite side of the stem also above one another. The inflorescence consists of one or more spikelets each made up of a distichous series of scales in the axils of which are found the flowers. Fig: II shows the morphology of Cenchrus ciliaris.
Fig: II Showing the morphology of *Cenchrus ciliaris*. (Source: Bor.N.L, 1960)

1. plant $\times \frac{1}{4}$; 2. spikelet with supporting bristles (sterile branches); 3. lower glume; 4. upper glume; 5. lower lemma; 6. upper lemma; 7. palea of upper lemma; all $\times$ 4.
The Vegetative Shoot
Subterranean Parts:

Roots

Below the surface of the soil the base of the plant produces roots (actually from the lower nodes) and/or rhizomes, either of which or both, combination, anchor the plant very firmly to the soil. Indeed it is well known how difficult it is to pluck a tuft of grass from the ground. The roots of grasses are fibrous in nature.

The anatomy of root tips has been studied by a number of authors and it seems clear that the epidermal cell structure can be classified into the so-called "festucoid" plan, in which a long cell or cells is followed by a short cell which can give rise to a root hair, and the "panicoid" type, in which the epidermal cells are more or less the same length and any one of them can give rise to a root hair.

Certain species, in addition to the underground roots, develop aerial roots from their lower nodes. Zea mays is well known for this habit. Grasses will always produce roots from the nodes if pegged down on the soil and many species are geniculate at the base for a short distance, each node producing roots, until they finally assume the upright habit.

The roots of some grasses contain or are surrounded with mycorrhizal hyphae (Trisetum spicatum, Agrostis canina, Holcus lanatus, Brachypodium pinnatum and probably many more).

Rhizomes

Rhizomes are underground stems which, armed with a coriaceous terminal pointed bud, are able to force their way through the soil often to considerable distances. Sooner or later the rhizome comes to the surface, where it sends up a vertical stem which develops into a separate plant. This plant then sends out its own rhizomes in all directions. These organs are rightly called underground stems in as they are made up of nodes and internodes which are covered with scales which represent the reduced leaves and sheaths. The roots and rhizomes comprise the belowground biomass and their number and weight are significant since they indirectly affect productivity.
Aerial Parts

Culms

The stem of a grass plant, also known as the culm or haulm, is made up of a series of nodes separated by internodes. The nodes at the base of the plant are very close together and the lowest of them normally give rise to the roots. They are succeeded by much longer internodes which continue to grow in length from just above the nodes. (Most of the internodes of grasses are hollow (*Arundo, Phragmites*) but there are notable exceptions. The sugar cane *Saccharum officinarum* is quite solid and there are others in which the lumen is filled with snow-white pith (*Zea, Sorghum, Andropogon* spp., *Hyparrhenia* spp.) The pith is normally present in young stems but is gradually resorbed. In the underwater stems of *Zizania latifolia* the internodes are filled with septate sugary pith. *Capillipedium assimile* has a very hard solid stem which is much valued as a pipe-cleaner by smokers.

Some culms, *Eleusine, Dactyloctentum*, are soft and juicy and are liked by cattle. Others, like *Capillipedium assimile*, just mentioned, become so hard from the deposit of silica in the tissues that they are avoided by stock. Indeed, the amount of fibre and silica in a stem is in inverse proportion to its palatability. All stems contain chlorophyll to a greater or lesser degree in the outer cells, at least when young, but those that become woody and hard as they mature lose their chlorophyll to a large extent, if not entirely. Culms are mostly terete (compressed in *Poa compressa, Eleusine* spp.) but in many where a bud is developed in the axil of a sheath there is a groove in the culm adjacent to the bud. In woody culms this groove is well marked and has hard margins. Some culms are markedly ridged over the longitudinal vascular bundles close to the epidermis, others are very smooth. Most culms are glabrous and there are very few (some non-Indian species of *Aristida*) which are hairy all over. The close-fitting sheath prevents the growth of hair on the surface of the culm but many grasses are hairy below the nodes and below the inflorescence, e.g. *Saccharum spontaneum, Sclerostachya fusca, Eulalia siamensis* and many others.
Nodes

The nodes are transverse septa which serve to strengthen the stem. In the nodes, too, there is an anastomosis of the vascular bundles of the bud, leaf and vertical systems.

Branching And Prophyllum:

Branching of the stem in grasses always takes place at the nodes and the branch arises from a bud situated at the base of the sheath and between it and the stem. Between the shoot and the stem is found a membranous structure called the prophyllum. It is two-keeled, with a concave surface pressed against the main stem and two flaps which clasp or encircle the side branch. Before the bud develops into a branch the prophyllum is scale-like and entirely covers the bud. As the bud develops into a shoot the prophyllum also elongates until it assumes its palea-like form. Morphologically it is the first leaf of the developing shoot and probably represents the sheath on which the leaf-blade does not form. Beddows (1937) was able to distinguish various species of British grasses in a sterile condition from the shape of their prophylla.

Branching at the base of the grass stem is called "tillering" or "stooling". Tillering can be induced by grazing where by the dormant buds at the base are stimulated into activity and new shoots are sent forth.

Stolons

Stolons are creeping stems which are developed above ground, and produce from the nodes, leaves, flowering shoots and roots, the latter serving to anchor the prostrate stem to the soil.

Leaves

The foliage of the grass plant consists of the sheath, the ligule and the leaf-blade.

Leaf-Sheaths

The sheath originates at the node of the stem.
The Ligule

At the junction of the sheath and blade, on the inside, closely adpressed to the culm is a structure called the ligule. The ligules of grasses exhibit great variation in shape and texture.

Leaf Blades

At the top of the leaf-sheath is the leaf-blade, the chief organ of plant which, being free, except for its attachment to the sheath, has great scope for variation. As a general rule the grasses of the forest and forest margins have flat leaves which are lush green with little fibre, while those of the open country and desert regions develop more fibre and possess special devices to prevent excessive transpiration. Such leaves are often folded or rolled in various ways and are frequently glaucous in colour.

Leaf Characters.

(a) Leaf-bases: The bases of some leaves are provided with auricles, that is, curved tongue-like outgrowths from the basal tissue which encircle the stem. They do not appear to have any function. Some leaf-blades are joined to the sheath by what can only be described as a petiole.

(b) Lamina: The laminae of the leaves of grasses are folded, convolute or pleated (Setaria section Ptychophyllum) in the bud and the majority become flat as they mature.

(c) Apices: The tips of leaves are usually acute or acuminate and very scabrid.

(d) Surface: The upper surface of the leaf is often rougher, more hairy and darker green than the lower surface. The roughness is due either to the nerves being scabrid or to the surfaces being covered with tubercle-based hairs.

(e) Margins: The margins of some leaves are furnished with very small teeth so that they are razor-sharp.
(f) **Texture:**
The leaves of forest grasses are soft and in periods of drought hang limp and flaccid. In the species of the desert and dry habitats the leaves are more rigid and fold up or roll up to prevent desiccation.

(g) **Nervation:**
The vascular system of the leaf-blade is visible as a rule on the surface as die veins. The midrib is always quite definite but the lateral strands are quite faint.

The stem and the leaves form the above ground biomass and their number and weight affect productivity. So, their growth is of paramount significance to a researcher.

**The Reproductive Shoot**

**The Inflorescence**

The inflorescence of the grass plant is produced on shoots which may be terminal and axillary or very often only terminal.

Inflorescences may be divided into (1) spikes, (2) racemes, (3) spike-like racemes and (4) panicles.

**The Flower**

The flower consists of gynoecium, androecium and lodicules.

1.5 **Uses Of Grasses** (Bor, N.L., 1960.)

1. **Food**

Cereal grasses provide the staple food of hundreds of millions of people. Apart from the above a number of other grasses are cultivated for their grain and also for fodder.

2. **Fodder Grass**

In fodder grass, proportion of leaf to stem is preferred and a high proportion of fibre in the stem and leaves is definitely unpopular with grazing animals.
In India, however, where a large proportion of cattle live in a state of semi-starvation, everything containing chlorophyll is eaten. The hungry animals even eat grasses which are usually avoided because of the sharp callus and the dangerous awns and callus.

The following lists of species which can be described as good fodder grasses, liked by cattle, are roughly divided into four habitats: (1) plains, moist; (2) desert areas and sea coasts; (3) hills, moist; and (4) hills, dry. Areas with a high or moderately high rainfall are the moist areas, found mainly in south and north-east India. The desert areas are mainly in the north-west where the dry hills are also found.

**Plains, moist**

*Andropogon ascinodis*, *A. lividus*, *A. pumilus*, *Arthraxon prionodes*, *Axonopus compressus*, *A. affinis*, *Bothriochloa intermedia*, *B. pertusa*, *Brachiaria brizantha*, *R. mutica*, *B. lata*, *R. ramosa* and most species of *Brachiaria*, *Cenchrus ciliaris*, *C. pennisetiformis*, *C. setigerus*, *Chloris gayana*, *Chrysopogon aciculatus*, *Ch. Fulvus*, *Ch. Orientalis*, *Ch. Serrulatus*, *Echinochloa colonum*, *Eleusine indica*, *Elytroporus spicatus*, *Eragrostis ciliaris*, *E. curvula* and other species *Euchlaena mexicana*, *Hackelochloa granularis*,


**Desert areas and sea coasts:**

*Aeluropus lagopoidcs*, *A. Macrostachyus*, *Artstida ciliata*, *A. plumosa*, *A. pungens*, *Cenchrus prieurii*, *Chloris virgata*, *Chrysopogon aucheri*, *Cryptis schoenoides*, *Cymbopogon jwarancusa*, *C.schoenanthus*, *Dactyloctenium scindicum*, *Desmostachya bipinnata*, *Digitaria nodosa*, *Erempogon foveolatus*, *Hyparrhenia hirta*, *Ischaemum pilosum*, *I.muticum*, *Lasirus sindicus*, *Latipes senegalensis*,

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Orizopsis hymenoides, Paspalatum vaginatum, Sporobolus africarms, S.marginatus, S.spicatus, Tragus biflorus, Tricholaena teneriffae, Urochondra setulosa.

Hills, moist


Hills, dry

Bouteloua spp., Bromus inermis, B.japonicus, Cymbopogon schoenanthus, Digitaria nodosa, Festuca rubra, Bromus mollis, B.oxyodon, B.tectorum, Bothriochloa caucasica, B.ischaemum, Koeleria cristata, Pennisetum lanatum, P.orientalis, Stipa himalaica

Introduced or exotic fodder grasses


With such a wealth of indigenous species, which are nutritious as well as palatable, it seems strange that so many exotics have been introduced and tried out.
Some of these have given very spectacular results, notably *Panicum maximum, Pennisetum clandestinum* and *Brackiaria brizantha*, but one wonders whether the indigenous species will not prove better and more economical in the long run.

There is plenty of evidence that the indigenous grasses if cultivated and fenced from cattle give very high yields of green stuff and can be made into palatable hay and silage.

### 3. Soil Binders And Moisture Conservers

Grasses in deserts areas not only develop large numbers of roots and rootlets, but also send rhizomes or stolons, or both, the latter rooting at the nodes and sending up flowering stems, and the former burrowing below the surface, breaking surface every now and then to form a new plant which again sends out rhizomes. In this way a soil becomes stabilized. In sandy areas the parts above ground are almost as important since the stem slow down driven sand so that it is deposited on the surface. Certain species for the fixation reclamation of sand dunes in areas of low rainfall (40 cm per annum) are *Panicum antidotale, P. turgidu, Lasiurus sindicus, Saccharum munja, Cenchrus* spp etc. On the seashore *Spinifex littoreus, Halopyrum mucronatum, Paspalus vaginatum, Ischaemum muticum, Polytrias amaura, Latipes senegalensis* all help to stabilize moving sand. *Myriostachya wightiana* and *Paspalum vaginatum* are useful colonizers of coastal flats.

### 4. Other Uses Of Grasses

Besides food and fodder, grasses are sources of essential oils eg.*Cymbopogon, Vetivera, Bothriochloa* and source of paper pulp eg.*Arundo donax, Saccharum spontaneum, Phragmites karka* etc. Some grasses have medicinal uses eg. *Agropyron repens, Cymbogon schoenanthus, Vetiveria zizanioides, Desmostachya bipinnata* while some grasses are poisonous eg. *Brachiaria brizantha, Digitaria eriantha, Sorghum sudanense, Paspalum scrobiculatum*. Many grasses are ornamental eg. *Rhyncelytrum repens, Lagurus ovatus, Lamarckia aurea*.

Some are selected for making lawn eg. *Imperata cylindrica* and *Chrysopogon aciculatus*. Besides these major uses grasses may also be used for thatching eg. *Imperata cylindrica*, for walls eg. *Arundos donax*, for matting eg. Bamboo culms, for ropes eg. *Eulaliopis binata*, for ornaments eg.*Vetiveria zizanoides*, for stuffing

### 1.6 Taxonomy

Taxonomically the following topics are also considered in addition to the gross morphological characters, in so far as they are known, when considering the relationships of grass species or tribe:

1. The basic number of the chromosomes and whether they are large or small.
2. The leaf-anatomy both internal as well as surface.
3. The first seedling-leaf, whether narrow and erect or spreading and broad.
4. The number, shape and size of lodicules.
5. The nature and size of the embryo.
6. The shape and size of the hilum.
7. The nature and position of the root-hairs.
8. The nature of the starch-granules, whether simple or compound.
9. Physiological make-up.
10. The nucleoli.
11. The nature of the shoot apex.

The classification (Bor, N.L., 1960,) of the *Cenchrus* plant chosen for study is as follows:

**Group 1: Panicoideae-Paniceae**

*Raram Adans.,* Fam. Pl. 2, 35, 397 (1763).

Key to the species *Cenchrus*

1. Bristles or spines of the involucre antrousely scabrid:-
2. Bristles connate at the base only:-
3. Annuals; involucres with a wide naked connate base; inner bristles stouter at the base, subequal, ciliate on both margins; outer long, flexuous, scabrid, up to 2 cm long.

   *C. prieurii*

3. Perennials; base of the involucre small, elliptic, naked; inner bristles not very stout at the base, ciliate on the margins, not more 1-5 cm long

   *C. ciliaris*

2. Bristles connate into a cup 1-3 mm long:

   4. Cup up to 4 mm in diameter; surface not woolly:

   5. Inner bristles very slender, widened into a cup at the base, tapering to a setiform tip; the outer bristles slender, numerous

   *C. pennisetiformis*

5. Inner bristles rigid, flattened and subulate, acute at the tip, not drawn out; the outer few are absent

   *C. setigerus*

4. Cups 6-8 mm in diameter; surface finely pubescent

   *C. pauciflorus*

6. Bristles numerous, connate at the base only; outer in one row, eventually spreading or reflexed, hook-like; inner glabrous on the back.

   *C. biflorus*

6. Bristles comparatively few, connate, forming a deep cup, very rigid; Spiny; inner bristles very broad, usually very hairy at the base dorsally

   *C. echinatus*


1.7 Objectives :-

*Cenchrus ciliaris* is a desert semiarid sp. and it is palatable and nutritious for livestock herd. A lot of work is being done at CAZRI, Jodhpur, Rajasthan. Since Gandhinagar, the capital of Gujarat has lots of official open spaces which are always going to be unhabited; a study of this nature can promote fodder production in a scientific manner. The dynamics of production of palatable grasses would involve, to begin with the seeds- storage and germination, growth of the plants and biomass production and also storage of biomass so produced for future use. Hence, *Cenchrus ciliaris* was selected with the following objectives.

(1) To study seed storage and viability of *Cenchrus ciliaris*.

(2) To study the dynamics of mixed cropping of *Cenchrus ciliaris* with *Dichanthium annulatum* and *Sehima nervosum*.

(3) Study of effect of different concentrations and combinations of fertilizers on growth, flowering and biomass production of *Cenchrus ciliaris*.

(4) Study of effect of clippings on overall biomass productivity of *Cenchrus ciliaris*.

(5) Study of effect of different sowing time on growth, flowering and biomass production of *Cenchrus ciliaris*.

(6) Study of effect of different concentrations and combinations of fertilizers on nutritional value of *Cenchrus ciliaris*.

(7) Study of Post-harvest physiological(nutritional) changes in above ground biomass of *Cenchrus ciliaris*.