BREEDING FORAGE CROPS

Procedures in breeding forage crops are based upon the same genetic principles utilised in the breeding of other crops. Yet, forage breeding presents certain difficulties which must be recognised and understood by the breeder. The difficulties arise from the diversity in pollination of the different species, irregularities in fertilization and seed setting, the perennial nature of most forage species, and differences in the evaluation and maintenance of new strains. Examples are :

(a) Most important forage species are cross pollinated. The heterozygosity in cross-pollinated species makes it difficult to propagate and maintain the identity of lines.
(b) Self incompatibility is common in many forage species, limiting the extent to which they may be inbred.
(c) Many forage species have small floral parts, making artificial hybridization tedious.
(d) Some grasses reproduce largely by apomixis (seed setting without union of sperm and egg) presenting problems in crossing and obtaining gene recombination.
(e) Many forages are poor seed producers, or produce seed of low viability
(f) Many forages produce weak seedlings and stands are not easily established.
(g) Isolation and clean land on which new strains may be increased without contamination are not always available.
(h) The initial evaluation of selected plants or lines in the breeding nursery is generally based on the performance of spaced plants or rows, which may not accurately represent the performance of the strain in a thickly seeded stand as grown by the farmer.
(i) Forage species are often seeded in mixtures with other species which complicates the evaluation of individual strains.
(j) Strains may perform differently with different systems of grazing management
(k) Most forages are long-lived perennials and many years are required to evaluate persistence and productiveness of new strains.
(l) Many forage species are polyploids, which increases their genetic complexity.

Varieties released

1.	Cumbu napier hybrid grass	: **NB 21** from Ludhiana **BN 2** from West Bengal **CO 1** (PT 2787 x *P. purpureum* ; Merkeri) **CO 2** (PT 8369 A x *P. purpureum*) **CO 3** (PT 1697 x *P. purpureum*)
2.	Cenchrus (*Cenchrus glaucus*)	: **CO 1** (Selection from Kangaysm Local ; FS 391)
3.	Fodder sorghum	: **CO 27** (CO 11 x *S. halepense*) - inter specific hybrid derivative.
4.	Maize	: **African Tall** (Composite)
5.	Cumbu	: **CO 8** (732 A x Giant Bajra) (Composite)
6.	Lucerne	: **CO 1** (Mass selection from Coimbatore local)
7.	Cowpea	: **CO 5** (Gamma ray mutant from CO1)
8.	Velimasal	: **CO 1** (Introduction from Thailand in 1967)
9.	Lucaena	: **CO 1** (Hawaian Giant) selection from K.28

10. Deenanath : **CO 1** (Gamma ray mutant from Pusa 3)
11. Guinea grass : **CO 1** (Clonal selection from Coimbatore local)
12. Muyal masal : *Stytosanthes scabra* - Introduction from Australia cv. Fitzoroi.

Breeding

The two main groups of forage crops are grasses and legumes. For grasses the following characteristics are important and should receive attention in any breeding programme.

1. Yield of digestible nutrients and their distribution.
2. Persistence - Perennially
3. Ease of reproduction.
4. Ease of management.
5. Palatability

1. **Yield of digestible nutrients and their distribution :** Yield in terms of both quantity and quality is more important. Quantity depends upon genotype as well as environment the quality characters include protein, fat, fibre, carbohydrate, minerals and vitamins. This depends on nature of the species, stage of growth when it is cut for grazing.
2. **Persistence :** The persistence of the herbage is also influenced by the vigour and growth habit of the species, and its tolerance to drought and temperature variations. Persistence is lacking in grasses due to disease, pests, drought, excessive grazing. Persistence can be increased by agronomic methods than by breeding. However this character is also to be borne in mind while taking up breeding programmes.
3. **Ease of reproduction :** High foliage yield often associated with poor seed set. So a compromise is to be arrived while taking up breeding programme.
4. **Ease of management :** The forage grass must have high seedling vigour so that it can be established easily. Since grasses are grown as mixtures there cannot be separate management practice for them. It has to grow along with other crops.
5. **Palatability :** It is not linked with nutritive value. But palatability decides the intake of forage/fodder. Leafiness and succulents are more important.

Based on the above the objectives of forage crop improvement may be :

1. Ability to grow well and quickly both independently and in association with legumes.
2. Resistance to pests and diseases, drought and frost.
3. Suitable growth habit - Short types or grasses for grazing. Tall types for hay making.
4. Prolific seeding and non seeding types, ease of vegetative reproduction.
5. Elimination of undesirable characters such as HCN in sorghum and Sudan grass, coumarin in sweet clover, steaminess in grass or dry, pithy culms, presence of awns and leaf shedding.

Breeding procedures

Forage crops, based on their mode of pollination can be divided into following groups.

1. Largely cross pollinated : Eg. *Pennisetum, S.halapense,Cynadon,* Lucerne.
2. Largely self pollinated : Eg. Sudan grass, *Vicia*
3. Largely apomictics : Eg. *Panicum maximum, Paspalum dilatatum*
4. Largely dioecious : Eg. *Poa arachinifera* (Pasture grass)
5. Sterile : *Digitaria procumbens*

Breeding methods normally adopted are of three types

1. **Self pollinated crops :** Controlled hybridization and selection, back crossing and selection, mutation breeding.
2. **Cross pollinated crops:** Individual plant selection, Mass selection, Inbreeding and hybridization, Recurrent selection, Synthetics, Composites.
3. **Apomictics :** Clonal selection and propagation. Controlled hybridization and propagation where there is some amount of seed set.

A. **Forage grasses**

1. Guinea grass *Panicum maximum*
Origin : Africa

Breeding objective - To get high yielding varieties with drought and cold tolerance, more protein, high leafiness, amenable for frequent harvest.

Method

Though there is seed set in this crop, they do not mature simultaneously. So vegetative propagation is the best method.

Crosses can be made between selected parents and the best hybrid can be clonally propagated.

Introduction
True seed sowing & selection
Clonal selection
Hybridization and selection
Mutation

2. Napier grass : *Pennisetum purpureum* or Elephant grass
Origin : South Africa

Clonal Napier identified this and it was named after him.
It is Rhizomatous, perennial and tall growing.

Improvement

Clonal propagation is the method. Another inter-specific cross and maintenance by vegetative propagation.

3. Cumbu Napier hybrids

P. glaucum (Diploid, 2n = 14) *x* *P. purpureum* (Tetraploid, 2n = 28)

↓

Triploid (2n = 21)
Sterile
Vegetative propagation

Napier grass is season bound flowering will be during Oct-Dec only. So crossing between Cumbu x Napier grass is done at that time easily. Use of Cumbu as female - identification of selfed one in shorter period possible.

Breeding Objectives

1. High yielding varieties with less oxalate content.
2. Less pubescence and serration.
3. Drought resistant
4. More leafiness and amenable for multicut.

Methods

1. Introduction
2. Selction
3. Hybridization
   - Intervarietal
   - Interspecific

***4. Cenchrus* sp.** Kolukkattai grass

Cenchrus ciliarus - White kolukkattai
Cenchrus setigerus - Black kolukkattai
Cenchrus glaucus - Blue buffel

Origin : India

Propagation by seeds and slips
Apomictic lines are also available
Pusa giant cenchrus : Hybrid between

Cenchrus ciliaris (India) x *Pennisetum ciliare* (USA)

Sterile, Clonal propagation.

CO 1 Neela Kolukattai pillu: released from Department of Forage crops, TNAU.

5. Marvel grass

Dicanthium annulatum
D. cariconum

A small genus of perennial grasses, rarely annuals, distributed in all tropical regions. Six species occur in India of which two are important as fodder grasses. It is considered as one of the best grasses in India.

Seed setting is poor. So rooted slips are used for propagation.

Improvement

By crossing and vegetative propagation.

6. Johnson grass - *S. halapense*

It is native of Africa. It was taken to USA by colonel Johnson and hence named after him. In S. India it occurs both as 2n = 20 and 40 forms. Because of rhizomatous condition it will spread easily

Coll x *S. halapense* - CO 27 fodder cholam.

B. Forage legumes

Based on pollination behaviours forage legumes can be classified as

1. Self pollinated
   Arachis marginata, Clitoria ternatia.
   Desmanthus virgatus, Macrotylema uniflorum
   Phaseolus trilobus, Vigna trilobus
2. Often cross pollinated
   Mass selection.
   Single plant selection,
   Hybridization and selection,
   Mutation. Eg. *Vigna*. sp. Co5 (Co1 cowpea irradiated)
3. Cross pollinated
   Red clover, Lucerne
   Many of the cross pollinated species are self sterile - Lucerne
   Lucerne ; *Medicago sativa*
   Origin : South West Africa
   Bur clover *Medicago hispoda*
   Black medicago *M. lupulina*

Medicago sp

The genus includes 65 species native to Europe. Some of them are weeds and some are useful for forage.

M. sativa - Lucerne
M. lupulina
M. falcata useful fodders

POLLINATION

In alfa alfa bees are the most important insect pollinators. Pollen is dispersed by an explosive action commonly known as **tripping**. When the keel petal is pressed by the weight of the bees, the stamens and stigma are snapped upward and came out free of keel just like a spring action. The insect is struck by the staminal column and a mass of pollen is carried by it.

Artificial pollination in Lucerne can be made without emasculation because of the self sterility nature. The occasional self fertile lines can be identified with the use of marker genes. While making artificial pollination care must be taken to take the operation in screen houses where the visit of insect (honey bee) is prevented.

Selfing is done with the help of bagging the flowers.

Breeding methods

1. Introduction
2. Mass selection
3. Hybridization and selection
4. Synthetics and composites
   Ranger alfa alfa of USA
5. Poly cross method: in forage crops for the development of multiplant synthetic

This is adopted to develop a multiplant synthetic in vegetatively propagated forage crops. The first step is collect a number of desirable plants and form a source nursery. From the nursery twenty five to fifty superior plants are selected and grown in isolated nursery. Random cross pollination takes place in the isolation. The seeds are harvested and grown as progeny rows. Then the best ones are selected and clonally propagated.

These selected clones are again raised in isolation for random crossing and a synthetic is established.