

## **SORGHUM (*Sorghum bicolor*) $2n = 2x = 20$**

Sorghum is one of the most important food crops in a semi – arid tropics.

**Origin:** S.E. Africa

### **Distribution:**

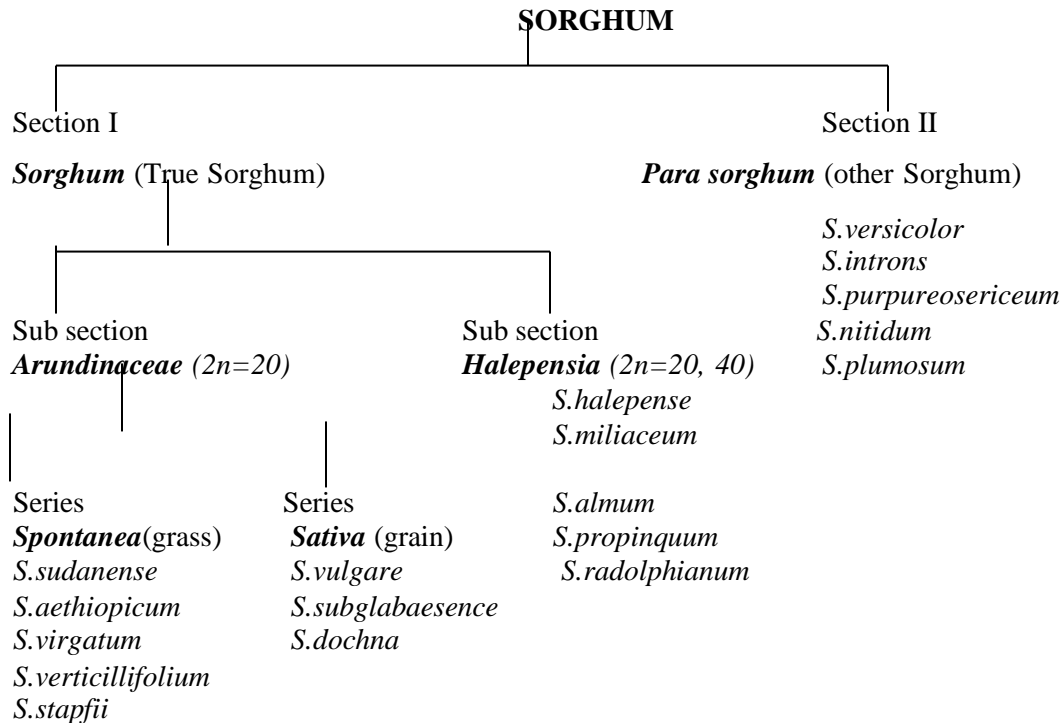
A number of land races, wild forms found in S.E. Africa, says the origin Ethiopia in Africa from there it spread to other parts of world. It is grown in Africa, south and central India, China, Argentina, Australia and south and central plains of US.

### **Progenitor of sorghum**

1. *S.arundinaceum*
2. *S.verticilliflorum*
3. *S.sudanense*
4. *S.aethiopicum*

## Classification :

Right from 16<sup>th</sup> century there were number of classification for the genus Sorghum. The famous among them is **Snowden's** classification (1936) later refined by Garber (1950) and by Dogget (1970).



The latest classification was done by **Harlan and De Wet** (1972).

1. *Bicolor* (B): Grain elongate, glumes clasping the grain which may be completely covered or 1/4 exposed.
2. *Guinea* (G): Grains flattened dorso-ventrally.
3. *Caudatum* (C): grains asymmetrical, glumes 1/2 the length of the grain.
4. *Kaffir* (K): Grains symmetrical (spherical), glumes clasping in varying length.
5. *Durra* (D): Grains rounded obovate, wedge shaped at the base and broadest slightly above the middle; glumes very wide.

According to them, the cultivated sorghum *Sorghum bicolor* is divided in to five basic races based on the coverage of glume on the grain

## B reeding objectives

1. High grain yield
2. High forage yield
3. Breeding for non-lodging sorghums.

4. Dual purpose genotypes with high grain and fodder biomass potential per unit time.
5. Early maturity
6. Resistance to biotic stresses (diseases like grain mold, downy mildew, rusts, leaf blight, leaf spots etc.
7. Resistance / Tolerance to insects like shoot fly, stem borer, gall midge etc.
8. Resistance to abiotic stresses like salinity, drought with resistance to low HCN content
9. Breeding for quality characters like bread making, redgrain for biscuit making protein and lysine content.
10. Breeding for special traits like sweet sorghums and striga resistance.
11. To isolate alternate sources of cytoplasmic genic male sterile lines

### **B reeding Procedure:**

Sorghum is often cross pollinated crop. So to maintain varietal purity isolation distance of 400 meters is necessary. Compared to other often pollinated crop like red gram, maintenance of inbreds is easy in sorghum. By putting brown paper and selfing the genetic purity can be maintained.

**1. Introduction :** Varieties of milo and kafir sorghum introduced from USA are used in conversion programme to convert the local long duration photo sensitive varieties to short duration, non-photo sensitive lines.

**2. Selection :** Old varieties like Co1, Co2, Co4 are all selection made from local land races.

### **3. Hybridization and selection**

#### **a) Inter varietal**

(IS 4283 x Co 21) x CS 3541, Three way cross derivative Co 25

(MS 8271 x IS 3691) - Single cross derivative Co26

#### **b) Inter specific**

Co 27 Sorghum. (Co11 x *S. halapense*)

### **4. Heterosis breeding :**

Use of CMS lines.

CSH 5 2077 A x CS 3541

### **5. Mutation breeding :**

X ray mutant from CSV 5 (148)

Co 19 is a natural mutant from Co 2

### **6. Back cross method :**

By following backcross method of breeding sorghum conversion programme was initiated. The long duration photosensitive germplasm was converted in to photo insensitive short duration sorghums. This was done at USA Similar programme was done at ICRISAT also.

### **7. Population improvement :**

With the use of cytoplasmic genetic male sterility as well as genic male sterility we can go for population improvement. The local land races can be used as pollinators and by half sib family selection, we can isolate lines. We can follow recurrent selection idea to develop superior inbreds.

### **8. Use of Apomictic lines :**

Some apomictic lines have been identified which can be utilised in breeding programme and by vegetative propagation we can fix up heterosis. E.g. R473 from Hyderabad.

### **B reeder centers:**

International sorghum improvement work is carried out by ICRISAT (International Crop Research Institute for Semi Arid Tropics)

In India at Directorate of Sorghum Research (DSR), Hyderabad

### **Practical Achievements:**

Hybrids are developed by using cytoplasmic genetic male sterility combined kafir 60 Varieties: CSV<sub>1</sub> CSV-2, CSV -4, M35-1, CSV-13  
Hybrids: CSH-1, CSH-2, 3 etc for *kharif* and CSH 7, 12, 13 for *Rabi*

## **PERAL MILLET (*Penisetum americanum*) (Bajra – Bulrush Millet) (2n=14)**

Pearl millet is also known as Bajra, is an important food crop of semi arid tropics. It is also grown as fodder crop

**Origin:** W. Africa

**Distribution:**

Africa, India, Pakistan, South East Asia, USA and Europe

**Taxonomy :** The genus *Pennisetum* is having more than 140 species. Stapf (1954) has divided the genus *Pennisetum* in to five sections *viz.*,

1. Gymnothrix
2. Eupennisetum
3. Penicillaria
4. Heterostachya
5. Brevivalvula

The cultivated *Pennisetum glaucum* belongs to the section penicillaria.

**Progenitors :**

1. *Pennisetum purpureum*
2. *P. qumulatum*
3. *P. orientale*

### **Origin and putative parents.**

Stapf included 32 species in *Penicillaria*. Of these 32 species found in Africa, six annuals are considered wild and probable ancestors of the cultivated one. They are

1. *P. perottettii*
2. *P. mollissimum*
3. *P. violaceum*
4. *P. versicolor*
5. *P. adonense*
6. *P. gymnothrix*

The cultivated species of *Pennisetum* is believed to have originated through hybridization with these six species.

## **Breeding objectives :**

### **1. Breeding for high grain yield**

To get high yields the following plant characters are necessary

- a) more number of tillers
- b) well filled, compact, long panicle.
- c) heavy grains.
- d) Uniformity of ripening.

Under irrigated conditions photoperiod insensitivity and early maturity are essential for multiple and relay cropping.

### **2. Breeding for improved grain quality.**

It can be achieved by incorporating yellow endosperm to improve vitamin A content or white endosperm to improve protein content.

### **3. Breeding for drought tolerance :**

This can be achieved through evolving lines having shorter duration so that they can escape drought, lines with more adventitious roots, lines with high leaf water potential and high chlorophyll stability index are to be evolved.

#### 4. Breeding for disease resistance

Downy mildew is the major disease. Ergot and smut comes next. Of late, rust at late stage is also becoming a major problem.

Lines having Local Bellary cytoplasm (732 A) are observed to be downy mildew resistant.

#### 5. Breeding for alternate source of cytoplasm in male sterile lines.

Original Tift 23 A evolved at Tifton, Georgia is highly susceptible to downy mildew. Because of this the HB series went out of cultivation. The indigenous 732 A obtained from Bellary is resistant. Similarly L 111A of Ludhiana is also tolerant.

A<sub>1</sub>, A<sub>2</sub>, A<sub>3</sub> and A<sub>4</sub> are there 732 A belongs to A<sub>4</sub> cytoplasm.

#### 6. Breeding for to have high forage value :

The forage cumbu must have following characters.

- a) high sugar content in the stem juice
- b) Increased leaf number with more breadth.
- c) Digestibility.

### Breeding Procedures

1. **Introduction** : Hybrid bajra from Punjab.

Tift 23 A from USA

2. **Selection** : Pure line selection : Co 2, Co 3,

#### 3. Hybridisation and selection

Interspecific hybridisation.

*Pennisetum glaucum*                      x                      *P.purpureum*



Cumbu napier hybrids.

#### 4. Heterosis breeding : Hybrid bajra

In earlier days before the identification of male sterile lines utilising the protogynous nature hybrids were released. The hybrids were produced by sowing both parents in the ratio of 1:1.

After the discovery of cytoplasmic genic male sterile line Tift 23A by Burton in Tifton, Georgia led to development of hybrids. Earlier hybrids of India viz., HB1, HB2 to HB5 were produced utilising Tift 23 A. But due to susceptibility to downy mildew they went out of cultivation. Even before the discovery of CGMS lines by Burton it was discovered by Madhava

Menon and his coworkers at Coimbatore. Unfortunately due to failure of publishing it was not recognised.

To overcome the problem of downy mildew male sterile lines L 111A and 732 A were isolated and at present used in breeding programme.

There are number of CMS lines developed by private agencies like Nath seeds, Mahyco, Mahendra.

#### **5. Population improvement :**

ICRISAT entry WCC 75 is an example for population improvement. This was developed from world composite by recurrent selection method. It was developed from derivatives of numerous crosses between diverse sources of germplasm and Nigerian early maturing land races known as 'Gero' millets. Another example is ICMV 155 of ICRISAT.

#### **6. Synthetic varieties :**

Synthetics are produced by crossing in isolation a number of lines tested for their GCA. E.g. ICMS 7703.

It is a result of crossing between 7 inbred lines of India x African crosses

#### **7. Mutation breeding**

At IARI Tift 23 A was gamma irradiated and 5071 A resistant to downy mildew was evolved. With this the hybrid NHB 3 was evolved (5071 A x J 104)

#### **B reeding centers:**

International Crops Research Institute for Semi Arid Tropics (ICRISAT,) Hyderabad

All Indian Pearl Millet improvement project (AIPIP) Jodhpur (Rajasthan)

#### **Practical achievements**

Varieties: PS B – 8, PSB 15, mukta

Hybrids : HHB 45, HHB 50 from Hissan GHB 30, GHB – 27 from Gujarat

## **FINGER MILLET (*Eleusine coracana*) (2n = 36)**

### **Ragi**

The common name finger millet is derived from finger like branching of panicle – Ragi is derived from Sanskrit word Ragika.

**Origin:** According to Vavilov – Africa

According to Decandolle – India

**Distribution:** India, Africa, Pakistan.

**Progenitors :** *E. indica* is wild in India and Africa

*E. stricta* is wild only in Africa

**Wild relatives :**

The genus *Eleusine* comprises of 11 species of which 6 are diploids and 5 are tetraploids.

1. *Eleusine indica*
2. *Eleusine oligostachya*
3. *E. tristachya*
4. *E. poranansis*
5. *E. jaegeri*
6. *E. flacifolia*  
(2n = 36)
1. *Eleusine coracana*
2. *E. africana*
3. *E. longipoides*
4. *E. verticillata*
5. *E. cagopoides*

**Breeding objectives:**

1. Higher yields
2. Early maturity
3. Better quality
4. Resistance to diseases
5. Resistance to pests
6. Resistance to Abiotic stress

**B reeding techniques**



### **1. By introduction**

Indaf 5 Ragi from Karnataka.

### **2. By selection**

Pure line selection. Earlier varieties were all evolved by pure line selection.

### **3. Hybridization and selection**

The African types are with long fingers, bold grain with stiff straw. Further they are photosensitive and have an even grain maturity. Because of this character they are not recommended for cultivation in India. The Indian types are with short fingers, small grains and photo insensitive. The African types are utilised in hybridization programme, to develop extra long fingered varieties coupled with disease and drought resistance. The Indian African cross derivatives are known as Indaf varieties which are interspecific.

Other state varieties

E.g. Indaf 5

cauvery x IE

929 Indaf 9

### **4. Heterosis breeding :**

Artificial induction of male sterility through use of gametocide, GA3, 2-4-D are being attempted.

**5. Mutation breeding :** T20 - mutant from AKP -7.

### **Practical achievements:**

Varieties saroda, Kalyani, Simhadri, Padmavathi, Ratnagiri, Godavari, Gauthami