SORGHUM

***Sorghum bicolor* (2n = 20)**

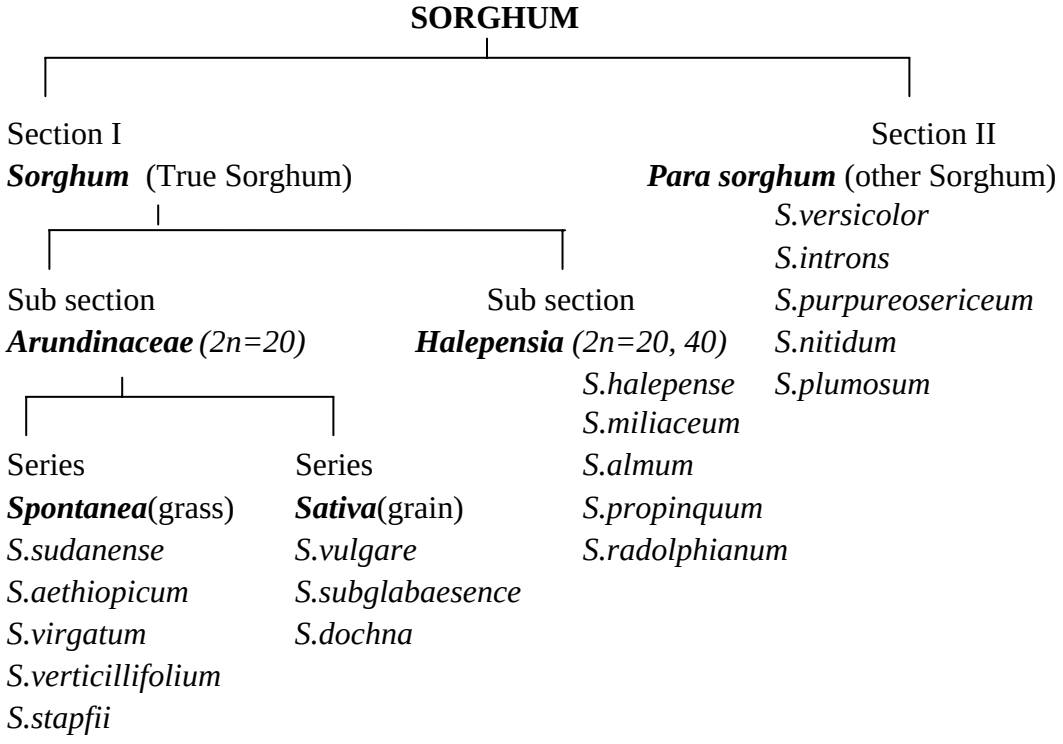
Origin : Africa

Progenitor of sorghum

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

Classification :

Right from 16th 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).

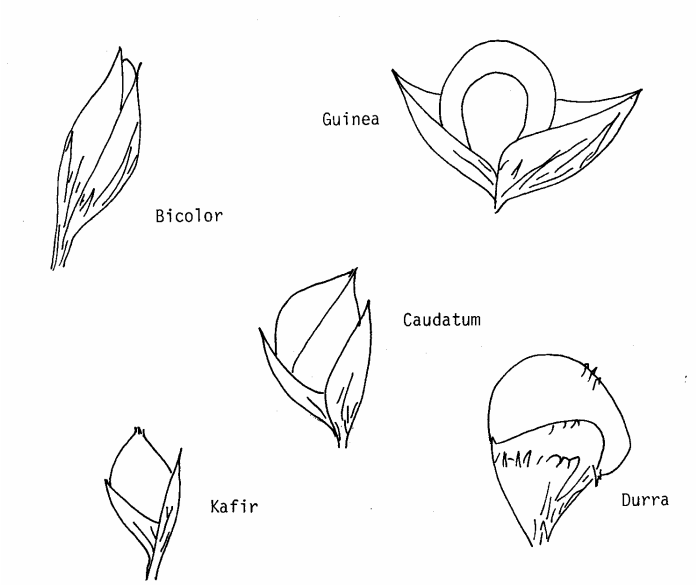


Fig.1. Five basic races of sorghum based on coverage of glumes

1.Bicolor (B): Grain elongate, glumes clasping the grain which may be completely covered or ¼ 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 the coverage of glume on the grain (Fig 1).

Hybrid races :
This consists of all combinations of the basic races.

1.Guniea	bicolor	(GB)	6.Guinea	kaffir	(GK)
2.Caudatum	bicolor	(CB)	7.Guinea	durra	(GD)
3.Kaffir	bicolor	(KB)	8.Kaffir	caudatum	(KC)
4.Durra	bicolor	(DB)	9.Kaffir	durra	(KD)
5.Guinea	caudatum	(GC)	10.Durra	caudatum	(DC)

Wild *Sorghum* sp. of Tamil Nadu:

S.halapense : Both *2n = 20* and *2n = 40* forms are available utilized for forage sorghum improvement.

S.sudanense : Utilized for improvement of forage sorghum.

S.nitidum : Found in Kodai Hills. Processes shoot fly resistance and dormancy.

S.staffii : Found in Southern districts, used for inducing dormancy.

Cultivated sorghum

Grouped in to two a) Tall, tropical late maturing adapted to short day length photo sensitive, longer internodes. E.g. Land races.

Land races of sorghum

1. Peria manjal cholam -
2. China manjal cholam -
3. Sen cholam
4. Talaivirichan cholam
5. Vellai cholam
6. Irungu cholam
7. Makkattai

b) Temperate, dwarf plant adapted to longer day length, photo in sensitive, shorter internodes, long panicles, high yielding varieties.

Breeding objectives

1. High yield : Productivity genes are present in *durra*, *roxburghi*, *Caudatum* and Zera - Zera.

Direct components : Panicle length and breadth panicle weight, number of primary branches, number of seeds / panicle and 100 seed weight.

Indirect components : Plant height, leaf area index endosperm texture.

2. Short duration - to fit in multiple cropping programme. Co22 is the shortest duration having a duration of 70 days. The drawback in this variety is it is dwarf and farmers who are in need of cattle feed may not cultivate this. 105 - 100 days is optimum. This can be grown in two seasons instead of a long duration land race. E.g. Co25 - Co 26.
Tropical lines having dominant maturity gene Ma and temperate lines having recessive ma gene.

3. Breeding drought resistant varieties with low HCN content in the early stages of growth :

75% of sorghum is grown under rainfed condition. It is highly essential to breed varieties, which can with stand initial as well as terminal drought. Further in dry land varieties there will be high HCN content in the stem during early vegetative phase. This limits the use of varieties as cattle feed. To over come this it is essential to breed varieties with low HCN content. Low HCN content exhibits partial dominance reaction. More than one gene involved in controlling this trait.

4. Breeding non - lodging sorghum

This is essential for southern districts, The hybrid sorghum kovilpatti tall (90 days duration) grown during N.E monsoon has a tendency to snap at nodes and lodge at maturity. This leads to considerable loss. To replace this the new hybrid COH3 having duration of 105 days was introduced. But it was not suitable because it could not withstand terminal drought. Dwarf character is conditioned by genes DW_1 to DW_4.

5. Resistance to pests

Shoot fly, stemborer, midge and earhead bug are the important pests of sorghum. Sources like *S. nitidum*, *S. virgatum* are available against pests. Some of the land races like local irungu cholam are resistant against shoot fly. Efforts are under way to evolve resistant varieties.

Resistance may be - Non preference for oviposition because of presence of trichomes.

Antibiosis - Silica content in the plant body

Recovery resistance by producing side tillers.

6. Resistance to diseases :

Sorghum downy mildew, helminthosporium blight, grain mould are the important diseases. The inheritance is complex and poly genic.

7. Breeding for sweet sorghum

Because of self sufficiency in rice, use of sorghum as human food is fast dwindling. So to find out alternate uses for sorghum, breeding sweet sorghum is one strategy. From the stem juice, ethanol can be produced which is a renewable source of energy. Brazil stands first in this. There are two types of sorghums.

a) **Syrup varieties** - Syrup for table purpose can be produced from this. This is also suitable for ethanol production.

b) **Sugar varieties** : contains more of sugars and less of combustible organics. Not suitable for ethanol production compared to syrup varieties.

Normal sorghum contains 12 %, TSS (Brix) where as sweet sorghums contain around 18% TSS. The juice will be extracted and sterilised. After sterilisation the juice is treated with yeast. After 48hrs, distillation is done to extract alcohol. Around 45% alcohol is recovered.

8. To breed red grain varieties suitable for biscuit making

Madurai - Tirumangalam area biscuit is made from Sencholam

Salem - boiled red grain used for consumption.

The variety Paiyur 2 is a red grain variety.

9. Breed varieties with nutritional quality :

Normal protein = 7-8 % with 1.9 to 2.5% lysine, 9.3 to 11.6% leucines

Increase in protein upto 12% is possible, but the problem is disability.

Two high lysine Ethiopean lines IS 11167 and IS11758 with 15% protein. The hl gene is monogenic recessive and seeds are shrivelled and red in colour.

10. To satisfy local needs

Small pearly white grain is used for preparing 'Kali' which has high keeping quality. S.*roxburghi* (Talai virichan cholam) is suitable and is grown in many districts. The varieties Co19 and Paiyur 2 are examples.

11. To isolate alternate sources of cytoplasmic genic male sterile lines.

The existing CMS lines are having A_1 cytoplasm as base. There are other sources viz., A_2 , A_3, A_4 and A_5. But all of them are in grassy sorghum and susceptible to

foliar diseases. This we have to improve. There are local ones like Maldandi 35 GA, G.I.A. but they are season bound and long duration.

Breeding techniques :

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
CoH 4 296 A x TNS 30

5. Mutation breeding :

X ray mutant from CSV 5 (148)
Co21 (699 Tall)
Co 19 is a natural mutant from Co 2

6. Back cross method :

Co 20 peria manjal cholam.

(Bongan hilo x Co1 Peria manjal cholam). Co20 Peria manjal cholam. Striga resistance was evolved by back crossing. 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 Hydrabad.

Future thrust

1. Characterisation of released varieties and hybrids.
2. Differentiation of A_1, A_2, A_3 and A_4 cytosteriles thro' molecular markers
3. Diversification of male sterile lines.
4. Use of Apomictic lines to develop hybrids.

Sorghum varieties suitable for Tamil Nadu.

Variety	Parentage	Duration
K5	Reselection from IS 3541	95
K7	K3 x M 35-1	110
Co19 (Talaivirichan cholam)	mutant from Co 2	145
Co 25	Three way cross derivative	105
Co 26	MS 8271 x IB 3691	110
Co 27	Co 11 x *S.halapense*	60
Co21	mutant of CSV 5	105
K 8	IS 12611 x SPV 105	85
K 9	M 36200 x Tenkasi vellai	120
K 10	K 7 x SPV 102	115
K 11	K 7 x A 6552	115
Paiyur-1	Co19 x Co24	145
BSR - 1	multiple cross derivative	110
Paiyur 2 (Sencholam)	PLS from IS 15845	95
Hybrids :		
CoH 2 (Kovil Patti Tall)	2219 A x IS 3541	90
CoH 3	2077 A x Co 21	110
CoH 4	296 A x TN 30	110
CSH 5	2077 A x CS 3541	100