Cereals

RICE

Oryza sativa (2n=24)

Rice is one of the oldest cultivated crops. The two cultivated species of rice are

i) *Oryza sativa* - Asian rice

ii) *O. glaberrima* - African rice.

The three races in cultivated Asian rice are

i) indica

ii) Japonica (Sinica)

iii) Javanica.

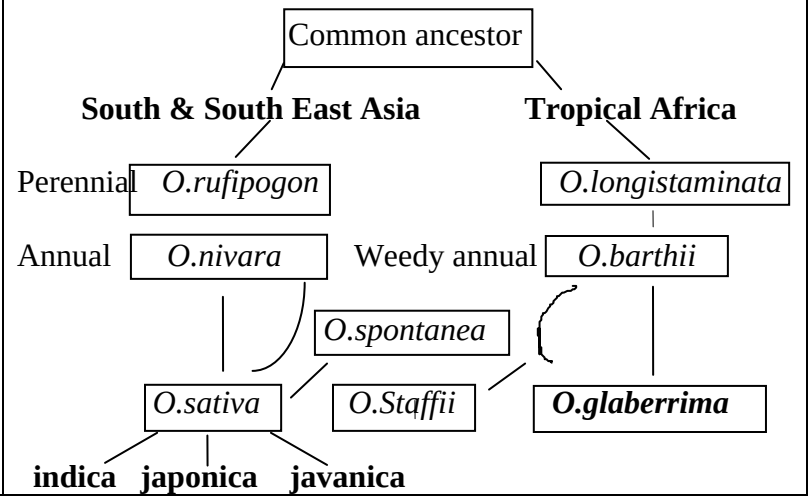
Origin of cultivated rice.

The views regarding the origin of rice can be grouped in to two classes viz.,

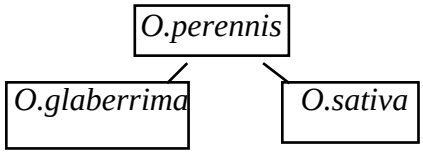
a) Polyphyletic origin

b) Monophyletic origin.

i.**Polyphyletic**: Originated from several species. According to this theory, the two forms of cultivated rice viz., Asian rice *O.sativa* and African rice *O.glaberrima* have evolved independently in their respective regions from several species.



ii. **Monophyletic** : According to this theory both Asian rice and African rice arose from a common parent (O.*perennis*). This view is the most accepted one because both Asian rice and African rice are similar except in glume pubescence, ligule size and colour of pericarp which is red in African rice.



According to polyphyletic origin the present day rice varieties have originated from several species. According to monophyletic origin a single species has given rise to all varieties of cultivated rice. Viz.,

Oryza sativa

Oryza glaberrima

most of the modern rice workers believe that origin of cultivated rice monophyletic. From *oryza perennis* rose the Asian rice in South East tropical Asia and African rice in the upper valley of Niger River in Africa.

Species in the genus oryza:

According to the latest view the genus *oryza* include 20 wild species. Out of these two are cultivated diploids viz. *O.sativa* and *O.glaberrima* and rest are wild species which include both diploid and tetraploid forms.

Botanical name	Chromosome No.	Genome	Origin
O.sativa	24	AA	Asia
O.nivara	24	AA	Asia
O.meridionalis	24	-	Australia
O.longistaminata	24	AA	Africa
O.rufipogan	24	AA	Asia
O.glumaepatula	24	-	America
O. grandiglumis	48	CCDD	America
O.glaberrima	24	AA	Africa
O.barthii	24	AA	Africa
O.australiensis	24	EE	Australia
O.latifolia	48	CCDD	America
O.alata	48	CCDD	America
O.eichingeri	24	CC	Africa
	48	BBCC	
O.minuta	48	BBCC	Asia
O.punctata	48	BBCC	Asia
O.officinalis	24	CC	Asia
O.granulata	24	-	Asia
O.meyeriane	24	-	Asia
O.ridleyi	48	-	Asian
O.longiglumis	48	-	New Guninea
O.brachantha	24	FF	Africa
O.schlechter	-	-	New Guinea

RICE

Related species of rice and their contributing characters in rice improvement.

Species	Genome	Useful traits
O.alata	CCDD	High biomass production
O.australiensis	EE	Drought tolerance, BPH resistance
O.barthii	AA	Drought avoidance, BLB resistance
O.brachyantha	FF	Yellow stem borer and leaf folder resistance
O.eichengeri	CC	BPH, GLH, WBPH resistance
O.grandi glumis	CCDD	High biomass production
O.granulata	unknown	Shade tolerance, adaptation to acrobic soils
O.latifolia	CCDD	High biomass production
O.longistaminata	AA	Drought tolerance
O.meridionalies	AA	Elongationability
O.meyeriana	Unknown	Shade tolerance, adaptation to aerobic soils
O.minuta	BBCC	BPH, GLH, WBPH, BLB and blast resistance
O.nivara	AA	Grassy stunt virus resistance
O.officinatis	CC,BB,CC	BPH, GLH, WBPH resistance BPH resistance
O.prnetate	BB, BBCC	BPH resistance
O.ridleyi	unknown	Shade tolerance, stemborer, blast and BLB resistance
O.rufipogon	AA	Source of CMS

Wild Species: There are twenty valid species in the genus *oryza* of these two are cultivated i.e.

Oryza sativa

Oryza glaberrima

In the remaining 18 species nine are diploid ones.

Six - tetraploid ones

Two - mixed diploid

One - chromosome number not reported.

Some of the wild species utilised in breeding programme are

Oryza perennis - Co 31 GEB 24 x *O. perennis*

Oryza nivara - IR 34 One of the parents is *O.nivara* resistant to grassy stunt disease.

BREEDING OBJECTIVES

1. High yield potential
2. Adaptability and stability of yield
3. Early maturity.
4. Resistance to lodging and shattering
5. Resistant to cold temperature.
6. Resistant to salinity and alkalinity
7. Resistant to diseases.
8. Resistant to pests
9. Improved grain quality
   a) Grain shape and size
   b) Texture of Endosperm and quality of starch in Endosperm
   c) Aroma & Cooking quality
   d) Colour of kernel
   f) Milling out turn
10. Breeding for alternate source of dwarfing gene.
11. Breeding varieties suited for direct seeding
12. Breeding varieties for dry lands
13. Breeding varieties for deep water conditions
14. Breeding varieties for export - scented rice
15. Breeding varieties to control wild rice
16. Breeding varieties to suit any other local conditions.

1. High yield potential

Grain yield of rice is a complex character. It is influenced by many morphological traits and physiological process. These along with interaction of environment decide the yield potential. It is necessary to assemble in the rice variety a desirable combination of genes for those plant characteristics, that will enable the rice plant to give higher yields.

To get higher yield we must have an ideal plant type. The ideal plant type is

- Short stature.
- Thick, Stiff culm
- Compact panicle that hold the plant erect.
- Short, narrow, erect leaves to effectively utilise solar radiation.
- high tillering

- Non / low photo sensitivity
- Nitrogen responsive
- Flag leaf angle should not be more than 40^0.

2. Adaptability and stability of yield :

Wide adaptability across locations is desired since rice is grown over a large variety of agroclimatic zones which are varying. IRR1 varieties are having wide adaptability. Characteristics associated with wider adaptability are

- low sensitivity to temperature variations.
- low sensitivity to changes in light intensity.
- Resistant to wide spectrum of pests and diseases.

Across seasons refers to the consistency with which a variety produces satisfactory yield in an area where biotic and abiotic conditions may vary every season of a year. Tolerance to local fluctuations in biotic and abiotic stress is important.

3. Early maturity:

This character is desired to have multiple cropping. It is also helpful to overcome terminal drought and to escape from pest and diseases.

In rice the optimum early maturity will be around 105 days. When the duration is reduced still further, the yield is also reduced correspondingly.

CR 666, Akashi, Co 41 are varieties having less than 100 days duration.

4. Resistant to lodging and shattering.

This is also a complex character. Non lodging lines will have

- Short stature
- Thick strong culm
- Short internode
- Leaf sheath tightly encircling the culm.

Grain shattering is also a complex character. Wild rices are having this character. So while using wild rice as parents this should not be linked with desirable trait which is to be transmitted.

5. Resistance to cold temperature

More suited to cumbum valley and Gudalur taluk of Nilgiris. Japonica rice varieties are more cold tolerant

MDU 2 cold tolerant (Co 25 x IR 8)

6. Resistant to salinity and alkalinity :

Parts of Trichy and Dharmapuri districts of Tamil Nadu face this problem.

Old varieties : SR 26 B, Gettu, Dasal.

Latest Co 43 (Dasal x IR 20), ADT 35, TRY 1, TRY 2

7. Resistant to Diseases:

Blast, Helminthosporium, bacterial leaf blight, Tungro virus are some of the important diseases . Blast resistant varieties :

IR 20, Medium duration
Co 37 - short duration
Co 25 - Long duration

Grassy stunt : *O. nivara*.
Blast and BLB : *O. minuta* tetraploid.
resistant Co 45 - resistant to RTV, Blast and BLB.
PY 3 - RTV, BLB

8. Resistant to pests:

Brown plant hopper, Stem borer, Rice gall midge are important pests.

Stem borer donor : TKM 6
IR 20, (IR 262 x TKM 6)
PY 3 - Bharathidasan - Resistant to BPH
O.officinalis BPH Resistant

9. Improved grain quality

a) Grain shape size and texture

Rice cultivars can be classified based on the size, shape and texture of the grain. According to FAO the trade grades are

Length :

Extra long	-	over 7 mm length
Long	-	6 to 7 mm
Medium	-	5 to 5.99 mm
Short	-	below 5mm.

Shape :

Based on Length / Breath ratio.(L/B ratio).
Basmathi, Ponni, Slender - over 3 L/B
IR 20 Medium - 2.0 to 3.0 L/B
Co 37 Bold - 2.0 to 2.39 L/B

Texture :

Two main types are recognised

1. Hard starchy grain with (translucent) vitreous fracture
2. Soft dextrinous grain with opaque fracture. Known as glutinous rice.

Hard starchy types are the major one consumed. They differ in their translucency, hardiness and presence or absence of abdominal white depending on starch content. They remain dry and flaky when cooked. Soft dextrinous grain become sticky and clot on cooking and usually used for special dishes (puttu rice). These types are preferred by people using chop sticks for eating.

b) Aroma and Cooking quality:

Some varieties give aroma when it is cooked. Varieties like Basmati scented rice there will be elongation in the cooked rice also. The aroma is due to certain chemicals present in endosperm. An alkaloid PANDAMARILACTIONE is the cause of fragrance. This alkaloid is present in the leaves of Pandanus also.

E.g. Basmati 370
Zeeraga Samba
ADT41

Kalabath
Seetha bogam

The cooking quality vary with the variety and grain type. Long grain varieties remain dry and flaky when cooked, while medium and short grain varieties are sticky and chewy. Preference for a particular variety differs with use. In evaluating rice varieties cooking tests are conducted for

a) amylose content,
b) Water absorption properties
c) gelatinisation test.
d) grain elongation ratio
e) protein content
f) par boiling quality
g) milling out turn.

c) Nutritive value :

Protein in brown rice is about 8% while in polished rice it is about 7% Inheritance of protein content is complex. It depends on environment and nitrogen application. When protein content is increased there will be lowering of lysine content.

d) Colour of kernel :

The preference for particular kernel colour varies with region to region. In Kanyakumari and Kerala red rice is preferred. Depending on local needs the varieties are to be evolved.

TKM 9 - Red rice, (TKM 7 x IR 8)

e) Milling out turn

The unhusked rice grain is known as Rough rice or paddy. The miller converts it to brown rice by scouring off the outer bran layer. The value of rough rice depends largely on its milling quality which is determined by head rice and total rice that is obtained from rough rice.

Head rice : Whole grain and large broken pieces.

Total rice : includes all rice recovered after milling.

10. Breeding for alternate source of dwarfing gene

All the present day cultivars are result of breeding with dwarfing gene Dee - Gee - Woo - Gen there is danger in using the same source. If Dee - Gee - Woo - Gen becomes susceptible to a new pest or disease, the whole programme will collapse. So it is necessary to seek alternate sources of dwarfing gene. Efforts are underway to identify alternate source thro' conventional and non - conventional breeding techniques.

11. Breeding varieties suited for direct sown conditions.

This again a location specific problem. In cauvery delta region getting cauvery water becomes an uncertainty these days. To minimize water requirement direct sowing

of rice is recommended. The varieties for direct seeding must be quick growing and suppress weed growth.

12. Varieties suited for dry land conditions

In certain parts of Ramnad and Chengalpet rice is grown as dryland crop. Local land races like kurivikalayan and puttu rice are grown. To suit these needs varieties are to be evolved.

13. Deep water paddy:

Areas in tail end parts of cauvery delta need deep water paddy. It is again a location specific problem

TNR 1 and TNR 2.

14. Varieties suited for export

The scented rice Basmati 370 is exported to Arab countries. The limitation in this programme is Basmati 370 grown in all areas cannot be exported. The importing countries prefer the Basmati Rice grown is valleys of Himalayan Range only. The rice grown in those area alone pass the chemical test. This must be due to effect of environment. Efforts are underway to identify export quality scented varieties grown in other parts of the country.

15. To breed varieties to control wild rice:

This again a location specific problem.. In states of Bihar, Maharastra, Madhya pradesh and Punjab the wild rice *O. sativa* var. *fatua* is often creating problems. So it is necessary to have marker genes in cultivated rice to isolate them from wild ones. Purple colour stem is a marker.

16. Breeding varieties to suit any other local problems.

E.g. - to identify varieties to cultivate in areas of turmeric cultivation where a short duration 70 days rice variety can be fit in between two turmeric crops

Satari - short duration (70 days).