Casuarinas are nitrogen fixing multipurpose trees belonging to family Casuarinaceae. Predominantly, they are native to Australia and Fiji island. There are about 17 species of trees and 79 species of shrubs occurring in the Casuarinaceae family. It is known as Saru in Hindi and Gujarati languages. They are adapted to various soil and environmental conditions. In India, Casuarina was first introduced from Australia during 1868 as fuel for locomotives. Later on the cultivation of the species spread to coastal areas of Tamil Nadu, Andhra Pradesh, Orissa and West Bengal. Mainly two species of Casuarina - *C. equisetifolia* and *C. junghuhniana* are presently being cultivated in India. At present, India is the largest Casuarina growing country in the world with an estimated area of 5 lakh hectares of plantations.

C. equisetifolia and *C. junghuhniana* are fast growing trees and fix nitrogen through a symbiotic relationship with a soil bacterium called Frankia. The roots of Casuarina produce nodules where in the bacteria fix nitrogen.

Plantation *of C. junghuhniana*

Plantation *of C. equisetifolia*

Flowering and Fruiting

Casuarinas start flowering from first year onwards after planting. Flowering occurs twice in a year - during February to March and October to November months. Male and female flowers are produced on separate individuals (dioecious). Pollination occurs mainly through wind. Fruits ripen during July to September months. Fruits are woody cones and seeds are winged and minute. One kilogram contains about 3 lakh seeds and at present, the costs of the seeds vary from Rs.1500 to Rs. 11,000. The genetically improved seeds from Casuraina seed orchards, are being sold @ Rs. 11,000/kg.

Propagation

Casuarinas can be propagated through seeds as well as vegetative methods. In nursery, seeds are sown in mother beds of 10 m x 1 m size filled with sand, soil and farmyard manure in 1:1:1 ratio. Seeds are mixed with fine sand and seed beds are treated with 0.1% Bavistin and 0.2% Chlorpyriphos for avoiding fungal and termite attack. In the initial phase, watering is given twice in a day but water logging should be avoided. Seed germination occurs in 7 to 10 days. Saplings with 3-5 leaves are transplanted in polybags and kept in shade house for hardening.

Clonal propagation: Casuarinas have a potential to produce coppice shoots from young trees. Two year old trees are cut up to 60 cm from the ground level to produce maximum number of sprouts with high rootability. Cladode cuttings are widely used for rooting and treated with 0.1% Bavistin for avoiding fungal attack. IBA (Indole-3 Butyric Acid) 2000 ppm is used for rooting. Cladode cuttings is dipped with IBA from bottom and planted in root trainers filled with coco peat or vermiculite. Then root trainers are kept in poly tunnels and watered through fine spray. Watering is done three times in a day. Generally, rooting occurs after 20 days.

Though Casuarinas are mainly coastal species, their cultivation can be done in both coastal and inland areas. They can grow generally in sandy, red, saline alkaline and acidic soil except heavy clay and waterlogged areas. They can tolerate pH range of 4.5 to 9.5.

Plantation

Rooting of cuttings

Rooted cuttings

Clonal plants or saplings raised in polybags/root trainers are planted in pits of 30 cm x 30 cm x 30 cm size and are given a basal dose of 10 g of super phosphate. The recommended spacing between plants is 1.5 m x 1.5 m (5 feet) and thus in one hectare area about 4000 trees can be planted. In initial stage, 3-4 weedings are needed. Water soluble fertilizers like Mono Ammonium Phosphate (MAP) is given at the rate of 5, 8, 10, 12 and 18 kg per acre respectively during one month, 6 months, 12 months, 18 months and 24 months age for realizing better growth. Pruning of side branches at the age of 12 and 18 months are needed so that straightness of stem and improvement in diameter can be achieved. The harvesting rotation age for the purpose of paper pulp wood is 3 years under irrigation and 5 years under rain fed conditions. A yield of 70-80 tons of pulpwood is expected from one hectare, if the trees attain minimum of 12 cm height and 25 cm d.b.h. The average price of debarked Casuarina wood was stable at Rs. 4000/ tonne for 5 years from 2014 onwards. However it increased to Rs. 5000/- per tonne since 2019 onwards.

Uses

They are widely used as poles for construction, pulpwood, and fuel wood and also provide environmental services like shelterbelt, windbreaks and reclamation of salt-affected and mined areas. Casuarina improves the soil fertility and thus saves the cost of chemical fertilizer, when planted in farmlands. In Tamil Nadu, a Casuarina Maize agroforestry model with a density of 325 trees per hectare has been found profitable. Besides these, fuel, food, fodder and small timber are also obtained. *C. junghuhniana* roots have been found to possess broad spectrum antioxidant and anti inflammatory properties and thereby have potential use in therapeutics.

Poles are used for building construction

Wood is used for paper making

Disease and pest

The major diseases reported in Casuarinas are blister bark, damping off and root/collar rot. Damping off disease occurs in Casuarinas at nursery stage, which can be controlled by treating seeds with 0.1% Bavistin with proper drainage. The blister bark disease is caused by the fungus *Trichosporium vesiculosum* and can be controlled by drenching of root zone and spraying with Diathane M- 45 or Bavistin 0.1% as preventive measures. The root/collar rot are caused by fungus *Ganoderma lucidum*. Spraying of 0.25% Copper Oxychloride controls root/collar rot diseases. The major insect pest problems in Casuarinas are bark eating cater pillar, mealy bug and termite. Bark eating caterpillar is the most serious insect pest of Casuarinas and can be controlled by removal of feeding parts and application of Dichlorvos 15 ml/liter. Mealy bug can be controlled by application of Dimethoate @ 0.2%. Termites can be controlled by application of Chlorpyriphos @ 0.2%.

Casuarina improvement work at AFRI

Proven clones of *C. equisetifolia, C. junghuhniana* and their hybrids have been procured from various agencies like IFGTB, Coimbatore, APPM, Andhra Pradesh and Tamil Nadu News Print Limited (TNPL). Among these, some clones exhibit fast growth, good stem straightness and better wind resistance, where as others have high pulp yielding, salt tolerance and coppicing ability. AFRI is raising quality plants of Casuarina for research and sale purpose.

Details of various Casuarina clones assembled at AFRI:

I. *C. equisetifolia* clones

S.No	Clone Name	Clone Origin	Salient features
1	AFRI-18	CE 5 IFGTB	Fast growth & suitable for alkaline soil
2	AFRI-19	CE 6 IFGTB	- do-
3	AFRI-11	CE 7 IFGTB	- do-
4	AFRI-20	TN 1 Tamil Nadu	Fast growth & high pulp yield
5	AFRI-21	TN 2 Tamil Nadu	- do-
6	AFRI-22	TN 3 Tamil Nadu	- do-
7	AFRI-23	TN 4 Tamil Nadu	- do-
8	AFRI-30	TN 5 Tamil Nadu	- do-
9	AFRI-24	TNPL 1 Karur	Fast growth & high salt tolerance
10	AFRI-25	TNPL 2 Karur	- do-
11	AFRI-26	TNPL 3 Karur	- do-
12	AFRI-27	TNPL 4 Karur	- do-
13	AFRI-28	TNPL 5 Karur	- do-

II. *C. junghuhniana* clones

S.No	Clones	Clone Origin	Salient features
1	AFRI-8	CJ-9 IFGTB	Fast growth, good straight stem & high pulp yield
2	AFRI-17	CJ-10 IFGTB	Fast growth & high salt tolerance
3	AFRI-1	CJ-WB-I IFGTB	Fast growth & suitable for wind resistance
4	AFRI-2	CJ-WB-2 IFGTB	- do-
5	AFRI-3	CJ-WB-3 IFGTB	- do-
6	AFRI-9	CJ- WB-4 IFGTB	- do-
7	AFRI-10	CJ-WB-5 IFGTB	- do-
8	AFRI-13	CJ-7 IFGTB	Fast growth & high salt tolerance
9	AFRI-14	CJ- 1 (Marakkanam) IFGTB	Fast growth
10	AFRI-15	IFGTB II Generation veedoor	Fast growth & coppicing ability
11	AFRI-16	IFGTB II Generation veedoor	- do-
12	AFRI-29	AP-1 Andhra Pradesh	Fast growth, good straight stem & high pulp yield

III. *C. equisetifolia* x *C. junghuhniana* hybrid clones

S.No	Clones	Clone Origin	Salient features
1	AFRI-4	CH-1 (CH-17) IFGTB	Fast growth, good straight stem & high pulp yield
2	AFRI-5	CH-2 (CH-18) IFGTB	- do-
3	AFRI-6	CH-4 (CH-22) IFGTB	- do-
4	AFRI-7	CH-5 (CH-25) IFGTB	Fast growth & high salt tolerance
5	AFRI-12	CH-6 IFGTB	- do-

Vegetative multiplication garden

Vegetative multiplication garden has been established at AFRI, nursery with 30 clones each with five ramets in 3 replications. In future, these clones will be coppiced and coppice shoots will be rooted for producing improved clonal planting stock.

VMG of Casuarina spp. at AFRI Nursery, Jodhpur

Multilocation clonal evaluation trials

Three clonal trails-one in Rajkot and two in Bhavnagar in Gujarat with 30 clones have been planted during August 2018. These trials are laid out in a Randomized Block Design with 5 replications and 3 trees per plot at spacing of 2 m x 2 m. Survival ability of clones in these locations and their growth rate are being evaluated periodically. The initial growth assessment indicated that *C. equisetifolia* x *C. junghuhniana* hybrid clones are performing better in all three places. These field trials will be evaluated up to 4 years and better performing clones will be multiplied and supplied to the end users for cultivation in Gujarat.

Casuarinas are used as host plant in Sandalwood plantation

Clonal trial in inland area at Rajkot, Gujarat

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CASUARINAS:
Multipurpose Nitrogen Fixing Plants

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