

Forest Tree Breeding Center Forest Bio-Research Center

Forestry and Forest Product Research Institute in Japan(FFPRI)



Forest Tree Breeding Center(FTBC) and Forest Bio-Research Center(FBRC)

Forest Tree Breeding Center(FTBC), and Forest Bio-Research Center(FBRC) are the largest institute of forest tree breeding in Japan.

FTBC have 4 Regional Breeding Office. The number of staff is 128 (1 Apr.2017).

The main services are developing new varieties, collection and conservation/preservation of forest tree genetic resources and international technical cooperation.

- Developing new varieties

Superior varieties for growth and wood quality (fast growth, trunk straightness and mechanical strength.)

Superior varieties for resistance against damages (Pine wilt nematode, snow pressure)

Superior varieties for environmental and other services (pollen free or less pollen)

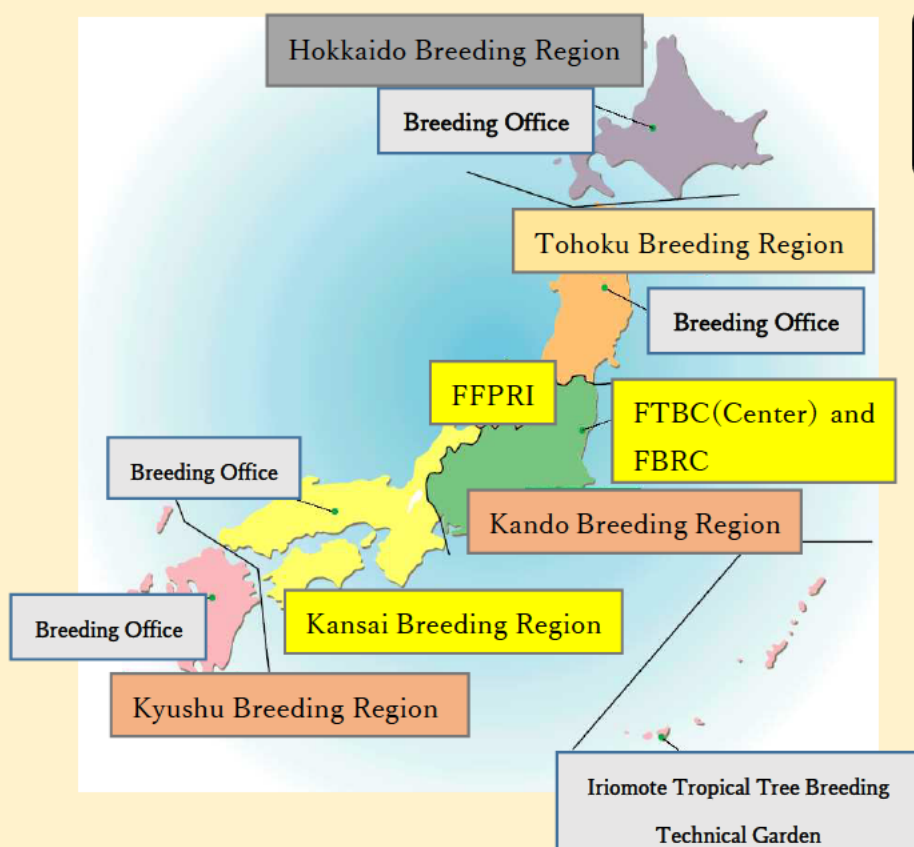
- Collection and conservation/preservation of forest tree genetic resources

Breeding materials for new varieties (Cedar, Cypress, etc.)

Endangered tree species and natural heritage trees (as a part of biodiversity national strategy)

- International technical cooperation

Developing breeding technique to adapt to climate change through international technical cooperation and collaborative research.



5 Breeding Regions
One Center, 4 Breeding Office

Considering...

Climate condition, tree species

Areas of administrative organization

【Breeding Region】

Hokkaido : larch, hybrid larch, sakhalin fir, yezo spruce,

Tohoku : cedar(snow area), larch, red pine, black pine

Kanto : cedar(less pollen), larch, cypress, black pine

Kansai : cypress, cedar(less pollen), red pine, black pine

Kyushu : cedar(clonal forestry), cypress, black pine, lukyu pine

Development superior varieties for growth

FTBC selected about 9000 plus trees (Cedar, Cypress, Pine, etc.) which are superior for growth (wood volume).

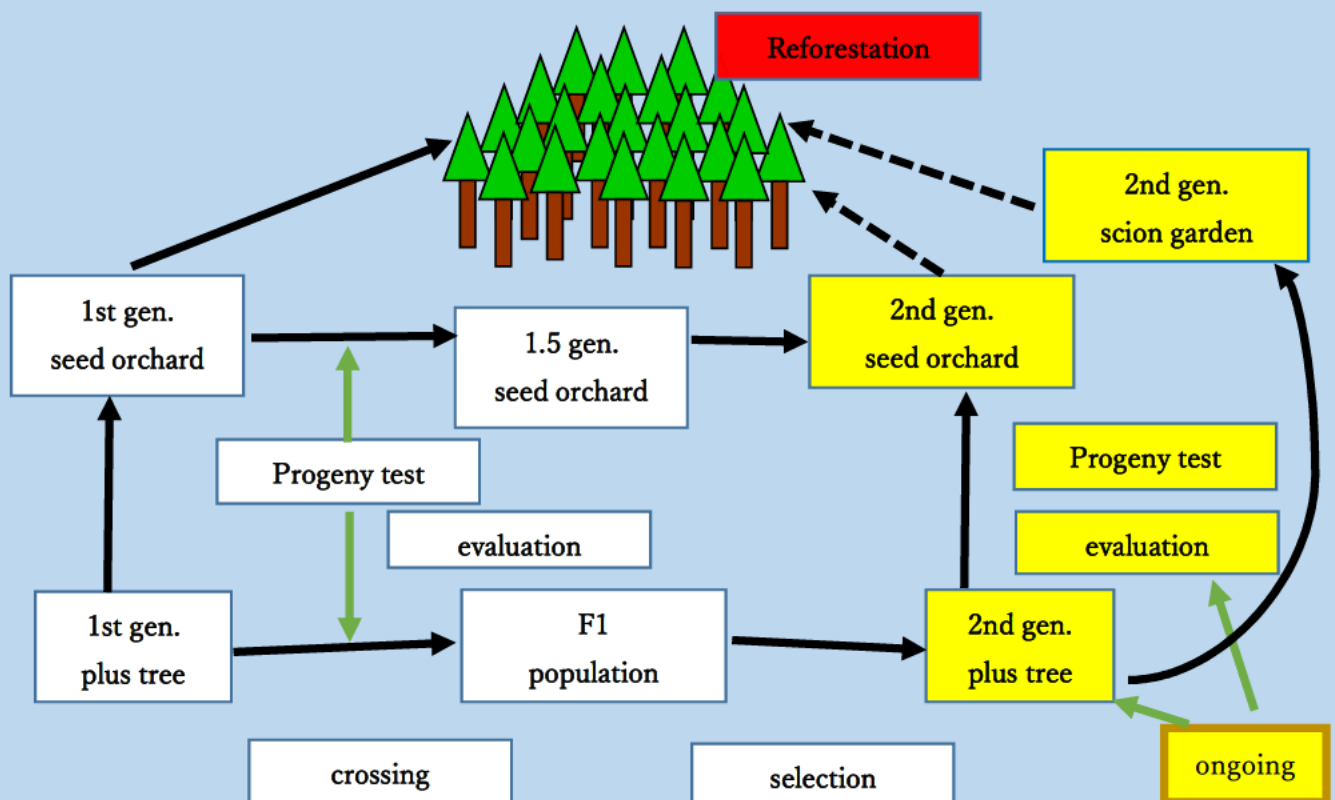
To evaluate genetic ability of the plus trees, FTBC has planted 2,400 progeny test forests (3,200ha in total). FTBC has been conducting periodical (10 years, 20 years, 30 years old) monitoring of the progeny test forests. As results of these progeny tests, FTBC developed 287 superior varieties for growth from plus trees (first generation). FTBC conducted control crosses by use of superior first generation plus trees and grew population of subsequent generation. FTBC selected 757 second generation plus trees among the population by 2016.



Excellent early growing
F1 individual
Age: 5 years
Height 7 m
(2.8m in 1st generation
plus tree)

Age: 10 years
Height 12.8 m
(5.9m in 1st generation
plus tree)

Current status of tree breeding



Tolerant varieties against pine wilt nematode

FTBC is leading in research and development of pine wilt nematode (*Bursaphelenchus xylophilus*) tolerant varieties. In 1971, FFPRI researchers detected that nematode causes the pine wilt diseases. Upon this result, FTBC started selection of pine wilt nematode tolerant varieties and succeeded in its development.

The pine wilt nematode damages are spreading to China, Korea, and Europe (Portugal and Spain).

FTBC has been carrying out research and development of pine wilt nematode tolerant varieties 429 new varieties are developed by 2016. As of 31 March 2017, 35 seed orchards of red pine (*Pinus densiflora*) and 46 seed orchards of black pine (*Pinus thunbergii*) have been established by resistant varieties.



Pine wilt nematode (1mm length)
Carried by Longhorn beetle



① Selection of the candidate

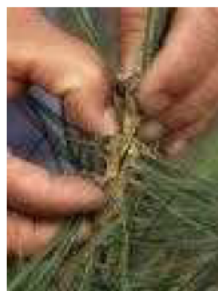


Selection at severe damaged area



Collection of the branch for grafting

② 1st, 2nd inoculation tests



Grafting



Inoculation



Resistance
variety:
Almost alive

Ordinary
pine: Most
dead or dying

Judgement

246 red pine varieties
183 black pine varieties

③ Establishment of seed orchard

35 seed orchards of red pine

46 seed orchards of black pine



④ Planting



449,000 seedlings of red pine
1,368,000 seedlings of black

Development of pollen free and less pollen varieties

FTBC is leading in research and development of pollen free and less pollen varieties.

The allergy associated with tree pollen has been one of the social-medical issues in Japan. The number of Japanese cedar pollinosis is over 25 % of the population. FTBC is carrying to develop less pollen varieties, pollen less than 1 % of the ordinary tree, of Cedar (*Cryptomeria japonica*) and Japanese cypress (*Chamaecyparis obtusa*) plus tree stock. Moreover, pollen free varieties of Cedar are also developed from stock of breeding materials in 2004 and 2007.

Hybrid trial between pollen free varieties and plus trees are being carried out for development new pollen free varieties with superior growth and wood quality.

FTBC developed 153 new cedar varieties (less pollen), 55 cypress varieties (less pollen), and 2 cedar varieties (pollen free or male sterile).

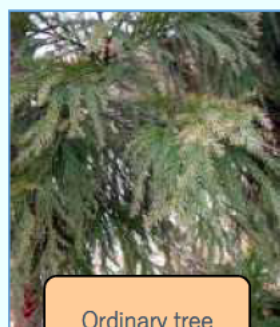
Coping with pollen allergy

Less pollen variety

less than approx. 1 % of the ordinary tree



Less pollen variety



Ordinary tree

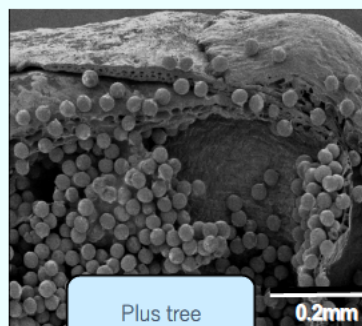
153 varieties

Seed orchard,
scion garden

Planting stock

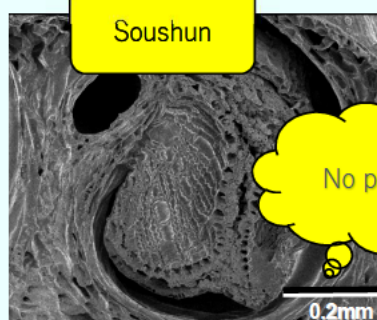
Male sterile variety, Soushun

Electronmicroscope photo of pollen sac



Plus tree

X Crossing

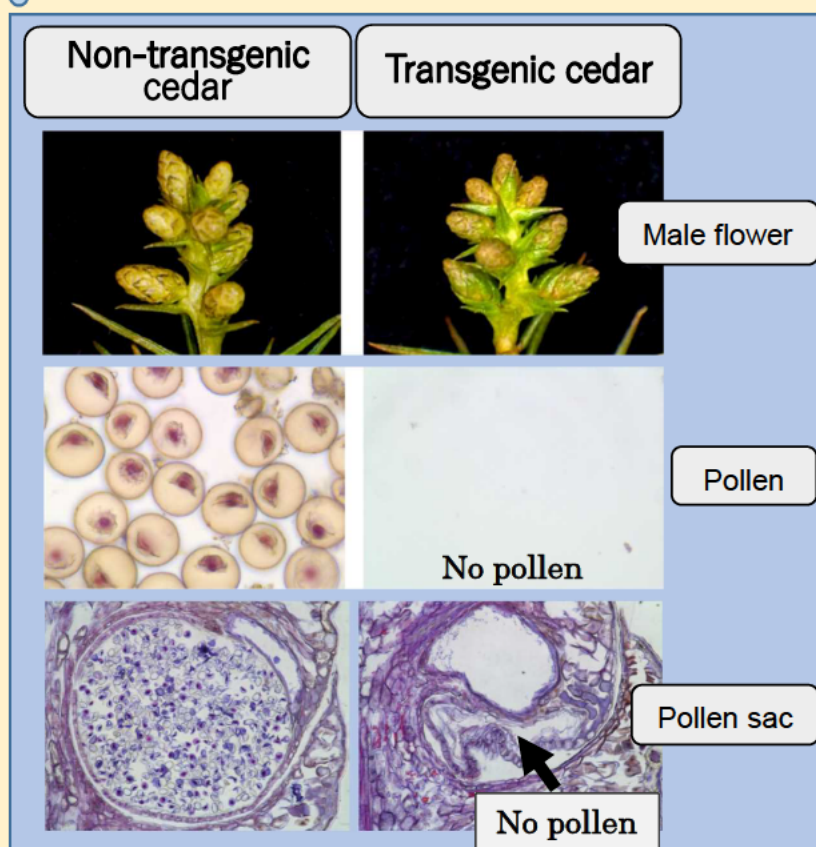


Soushun

No pollen

Male sterile
variety with
superior growth,
wood quality

Genetic engineering research for pollen free varieties development



Genetic engineering technique has a potential in improving a particular trait efficiently in a short period.

FBRC is conducting to develop new pollen free varieties of *Cryptomeria japonica* (Japanese cedar) with superior growth and wood quality by genetic engineering technique.

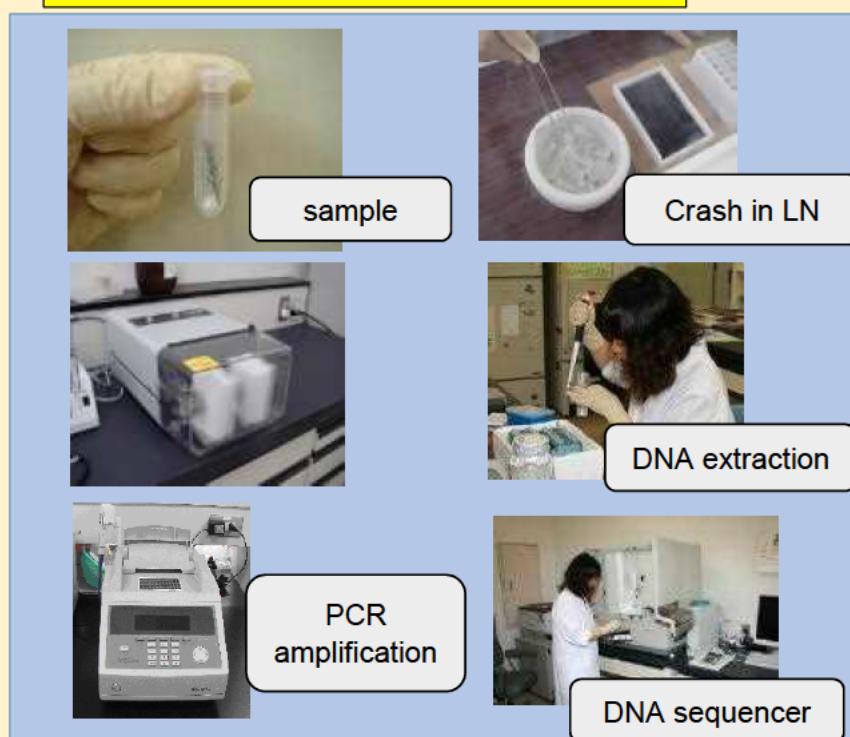


The field trail in the isolated field

Comparison of male flowers between non-transgenic and transgenic

Current status of tree breeding -DNA -makers-

Utilization of DNA analysis technique



FTBC is developing DNA analysis technique for accurate identification of each variety, because it is difficult to distinguish each variety from appearance.

FTBC prevents the mistake of confusion of varieties by use of this technique.

This technique is also used for identification or estimation of pollen parent in breeding materials.

Propagation and dissemination of new varieties

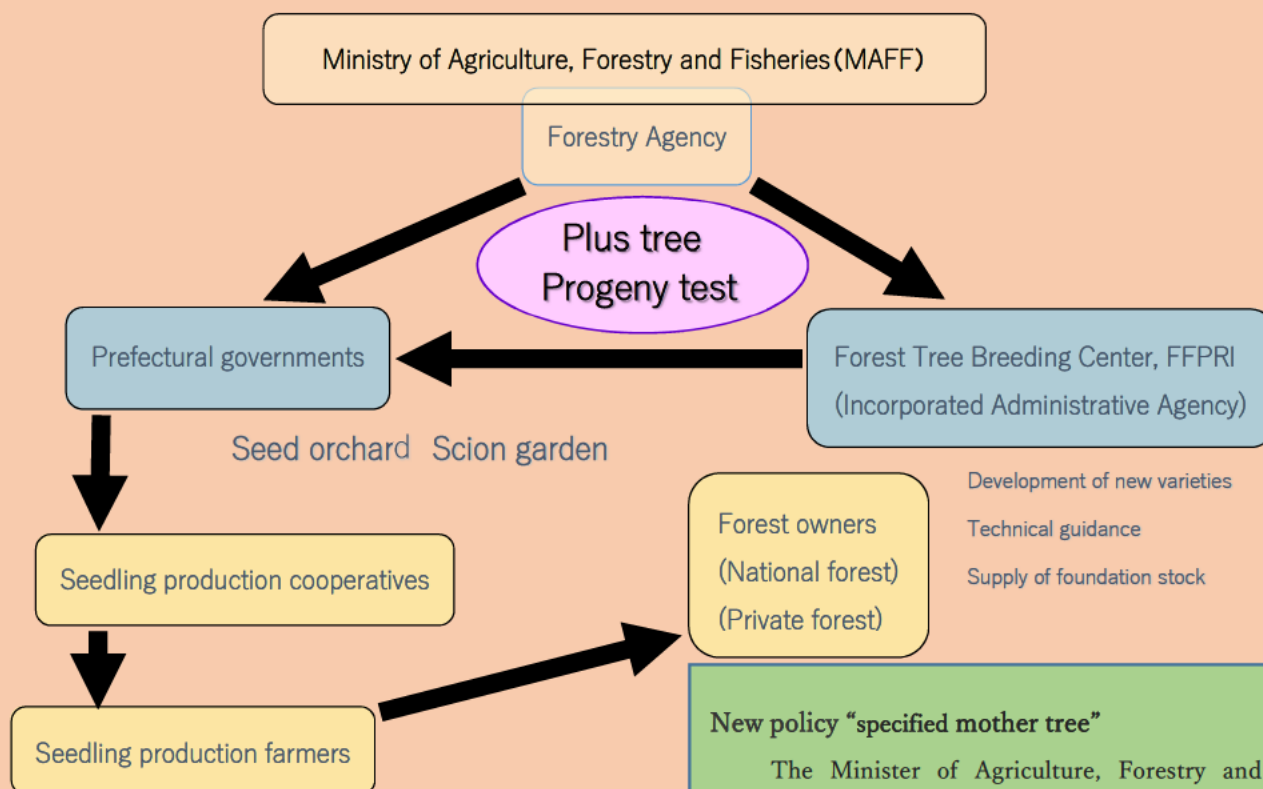
FTBC is serving as a core organization for distribution of new varieties clones to the local government seed/scion orchards which are functioning as the authorized regional seed/scion supply centers for private nurseries.

FTBC is providing the clones of the developed varieties to seed/scion orchard in prefectures

Prefectural governments develop and improve seed orchard and scion garden. Prefectural governments distribute seeds and scions to seedling production cooperatives

Forest owners get seedlings from seedling production farmers. The bred seedlings of cedar and cypress account for about 70% of all amount of seedling production of Japan.

Network of Tree Breeding



New policy "specified mother tree"

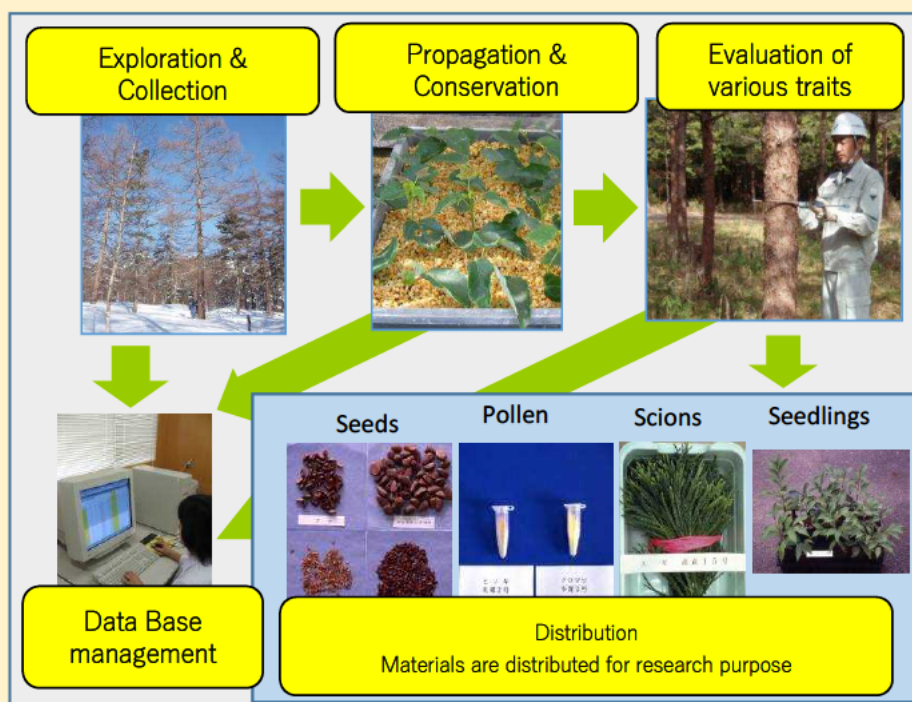
The Minister of Agriculture, Forestry and Fisheries has designated a superior tree of growth as a specified mother tree. MAFF encourages the use of seedlings obtained from specified mother trees for afforestation.

FTBC have selected superior trees mainly based on 2nd generation plus trees.

FTBC also is prompting its dissemination by distributing the foundation stock

Outline of forest tree gene bank program

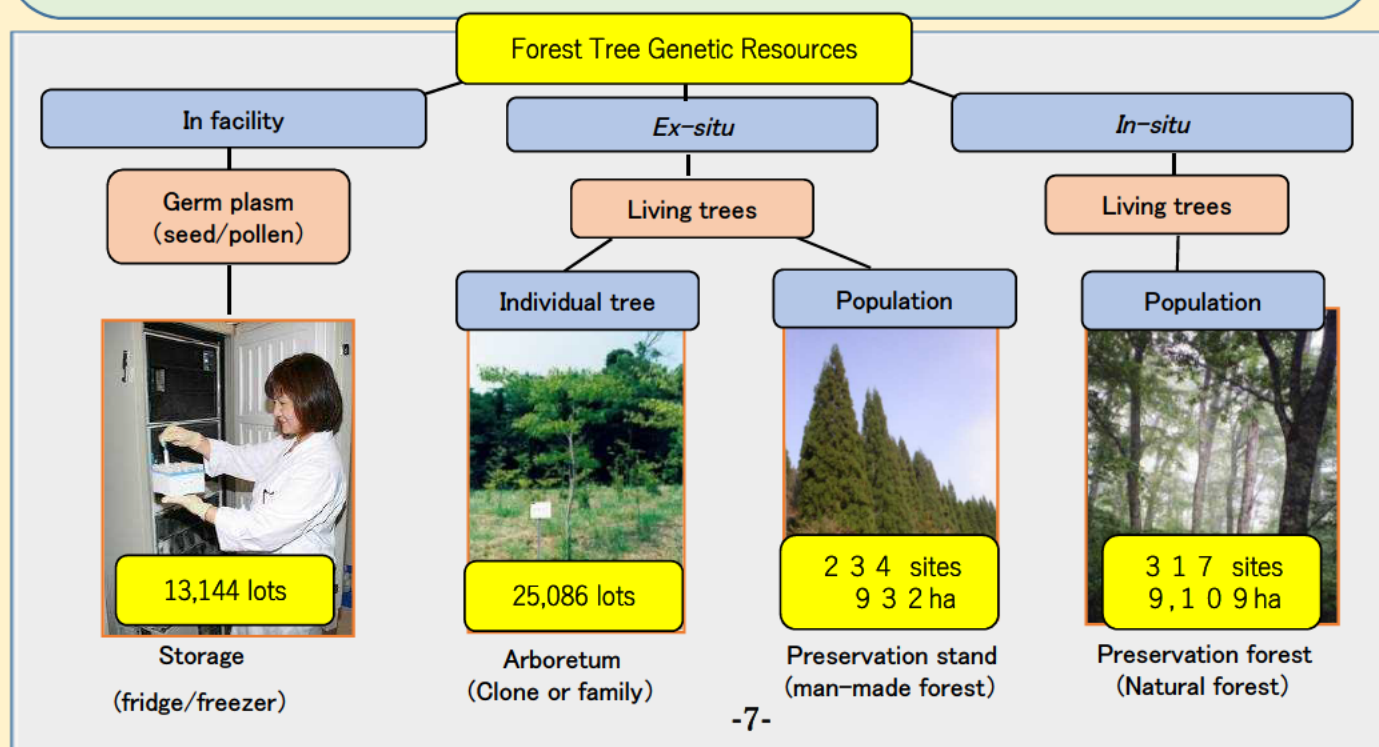
FTBC is the solo implementation agency for forest tree gene bank program in Japan. With taking due consideration to application value of genetic resources and/or needs and priority of conservation, FTBC is systematically conducting exploration and collection of genetic resources, and conserving/preserving such resources by seeds, pollen or propagated individuals. FTBC is also conducting trait evaluation of collected genetic resources for identification of potential use as well as distributing such resources for research purposes.



Status of conservation/preservation of forest tree genetic resources

Since forest tree genetic resources includes various species which are long-lived and big in size, both *in-situ* and *ex-situ* conservation of targeted genetic resources are mainly applied. To meet various demands, conservation by the form of seed or pollen is also conducted.

As of March 2016, 13,144 strains of germ plasm (seed and pollen) and 25,086 living individual strains are under conservation/preservation. *In-situ* conservation is applied to 317 sites of gene conservation natural forest (9,109ha) and *ex-situ* conservation is applied to 234 sites of gene conservation planted forest (932ha).



Trials for conservation/preservation of the endangered tree species

Case study of *Morus boninensis* and *Pinus amamiana*

Morus boninebsis



Morus boninebsis
in Haha-iima island



Shoot formation



Acclimatization process in pot



Planting

Morus boninebsis, which is native in three islands of the Ogasawara Islands, is under the category of "Endangered" of the red list of the Min. of the Environment.

Due to high quality wood for furniture use, large stock of *Morus boninebsis* in those area have been intensively harvested. Only around 200 individuals in small groups or in isolation are remaining in three islands. Moreover, these remaining trees are difficult in natural regeneration mainly by introduction of invasive alien species *Bischofia javanica* and goats.

FTBC is now conducting a project in which *Morus boninebsis* will be clonal propagated and clonal saplings will be transshipped to those islands.

Pinus amamiana



Pinus amamiana



Artificial crossing



Cone



Germination of *Pinus amamiana*

Pinus amamiana, which is native in Yakushima and Tanegashima islands, is under the category of "Endangered" of the red list of the Min. of the Environment.

Kyushu Regional Breeding Office is conducting ex-situ propagation and conservation approaches. Through artificial crossing technique improvement, mature seed ratios through artificial crossing have been improved by 20 times than natural crossing.

Development of forest tree breeding techniques associated with international cooperation

Breeding of drought tolerant trees for adaptation to climate change in drylands of Kenya

Partner: Kenya Forestry Research Institute, Kyushu University, Japan International Cooperation Agency

Duration: 2012-2021

Species : *Melia volkensii*, *Acacia tortilis*

Purpose: To select and improve superior varieties of *Melia volkensii* and *Acacia tortilis* which have useful traits for plantation development in drylands of Kenya.



Seed Orchard



Training in Japan



Dispatch of short term experts

Breeding of *Calophyllum inophyllum* to contribute towards coastal disaster prevention

Partner, Duration: Taiwan Forestry Research Institute, 2011-2021 Pacific Community, 2012-2022

Species: *Calophyllum inophyllum*

Purpose: To select superior trees which have useful traits to develop coastal disaster prevention forest.



Calophyllum inophyllum



Test plantation in Taiwan

Demonstration test of artificial crossing techniques of *Acacia mangium* and *Acacia auriculiformis* in Vietnam

Partner: Oji Green Resources Co.,Ltd.

Duration: 2013-2022

Species : *Acacia mangium* × *Acacia auriculiformis*

Purpose : To select superior trees of *Acacia* hybrid



Artificial crossing



Test plantation



Candidate of superior tree

Joint collaborative research in tree breeding with Finland

Partner: Finnish Forest Research Institute

Duration: 2010-2020

Species : *Picea abies* × *Picea glehnii*

Pinus sylvestris

Purpose : To develop effective techniques for artificial hybridization between *Picea abies* and *Picea glehnii*. To exchange of information related to pine wilt nematode resistance of *Pinus sylvestris*



Artificial pollination

Picea glehnii x *Picea abies*



Cultured nematode

Research facilities in forest tree breeding



Crossing(hybridization) green house



Genetic engineering research facilities



The largest Specific net house



Facilities for conservation of tree seeds and pollen

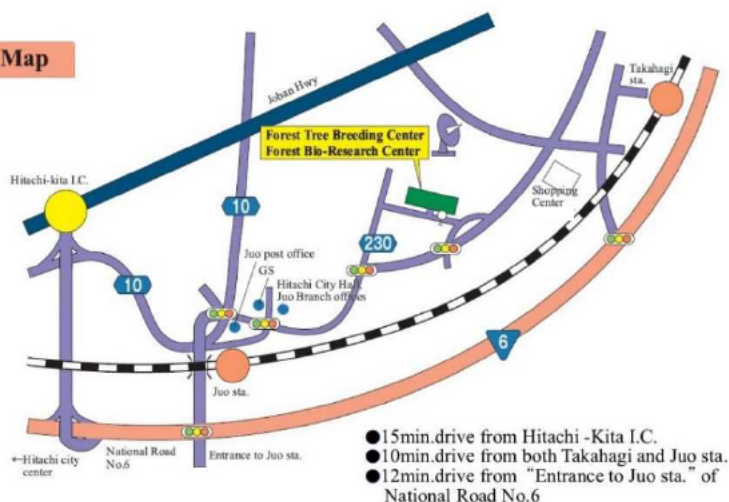


Inoculation test of Pine wilt nematode to *Pinus sylvestris*



Iriomote Tropical Forest Garden

Map



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