

Nurturing rich and beautiful forests for the future generation



Forestry and Forest Products Research Institute

Incorporated Administrative Agency

Forestry and Forest Products Research Institute
Forest Tree Breeding Center
Forest Bio-Research Center

Professionals in forest and development



Forestry and Forest Products Research Institute (FFPRI) is the largest research institute on forest, forestry, and forest products in Japan. Forest Tree Breeding Center (FTBC) and Forest Bio-Research Center (FBRC), both of which are under FFPRI, have been engaged in forest tree breeding by development of genetic superior varieties, speed-up breeding process through high-tech application, collection and conservation/preservation of genetic materials, and cooperation of forest tree breeding in the developing countries.

【The largest institute of forest tree breeding in Japan】

- FTBC-FFPRI, the largest center of forest tree breeding in Japan, has developed more than 1,800 new genetic superior varieties of forest tree species.
- FTBC is also 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.
- As one of the world prime research institutes in forest tree breeding, FTBC is **leading in research and development of pine wilt nematode resistant varieties and pollen free and/or less pollen varieties, and snow pressure resistant varieties**, in which other countries have not developed.
- FTBC is carrying out its R/D taking due consideration of regional climate difference and associated species diversity with four regional breeding offices, i.e. Hokkaido, Tohoku, Kansai and Kyushu, and Iriomote tropical forest tree breeding garden where tropical and sub-tropical forest tree species are main targeted species.

【The only forest tree gene bank in Japan】

- FTBC is the only forest tree species gene bank, and the scale of gene stock in forest tree species is the largest in Japan.
- Conservation/preservation forms in FTBC are classified into three types, i.e. standing tree (23,000 varieties of 750 species), seed (8,200 varieties of 490 species) and pollen (2,700 varieties of 65 species). In addition to *ex-situ* conservation/preservation above, 570 stands of 10,000 ha in national forest are designated as *in-situ* conservation/preservation area.

【Advanced research facilities in leading forest tree breeding R/D】

- Upon establishment of FBRC in April 2007, genetic engineering research has been enhanced in scale using the largest facilities designated for forest tree species genetic engineering in Japan.
- The largest tissue culture laboratory for forest tree species propagation in Japan has been utilized for commercial based mass propagation of pollen free *Criptomeria* variety "Sohshun".

tree breeding research



Main tasks

01 [Development of new varieties]

- Varieties superior to growth and wood quality (Fast growth, trunk straightness and mechanical strength)
- Varieties superior to resistance against damages (Pine wilt nematode, snow pressure)
- Varieties superior to environmental and other services (Allergy associated with pollen)

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02 [Collection and conservation/preservation of forest tree genetic resources]

- Breeding materials for new varieties
- Endangered tree species and natural heritage trees (as a part of biodiversity national strategy)

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03 [International technical cooperation]

- Development of breeding techniques of major forest planting tree species abroad
- Transfer of breeding techniques

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Development strategy of new varieties and its outputs

Varieties superior to resistance against diseases/pests attack or severe weather conditions

- 260 pine wilt nematode resistant varieties have been developed
- 45 snow pressure resistant varieties have been developed

Varieties superior to growth and wood quality

- 8,700 individuals from cedar, cypress, pine and others were selected as plus trees and have been conserved/preserved
- 287 individuals out of 8,700 have been further selected as new varieties with good growth and trunk straightness

Varieties superior to environmental and other services

- Pollen free: 2 pollen free cedar varieties, i.e. Sohshun and Mie pollen free No.1 have been identified
- Less pollen (less than 1% pollen production): 135 cedar and 55 cypress varieties have been selected

Varieties superior to wood quality

- 229 less twisted larch varieties have been selected

Application of high technology to forest tree breeding

- Tissue culture techniques for cedar and cypress propagation
- Genetic engineering techniques

**Status of dissemination of the improved varieties :
About 70 percent seedlings/saplings for forest planting
are from the improved varieties (cedar and cypress)**

(Forest tree breeding and its history)

Nurturing rich and beautiful forests through artificial planting will require genetically superior seedlings/saplings which can grow under severe natural environment over several decades.

In Japan, preliminary trials related to tree breeding will be found in Obi and Hita area. People in those areas have selected plus trees and propagated saplings from plus trees' scions more than 400 years.

National based tree breeding program started around 50 years ago. In 1954, Forestry Agency launched a nation-wide project of plus trees selection for timber production increase and enhancement of multiple functions from planted forests.

As a core implementing organization for tree breeding in Japan, five Regional Forest Tree Breeding Stations were established under Forestry Agency in 1957.

As a part of structural reform of the central government, Forest Tree Breeding Center has become an incorporated administrative agency under the aegis of Min. of Agriculture, Forestry and Fisheries in 2001. Furthermore, in 2007, Forest Tree Breeding Center has merged into Forestry and Forest Products Research Institute which is also an incorporated administrative agency.

Tree breeding program has been initiated from plus trees selection project, then with reflection of emerging damages/problems inside and/or outside forests, pine wilt nematode resistant varieties, snow pressure damage resistant varieties, pollen free and/or less pollen varieties have been also developed.

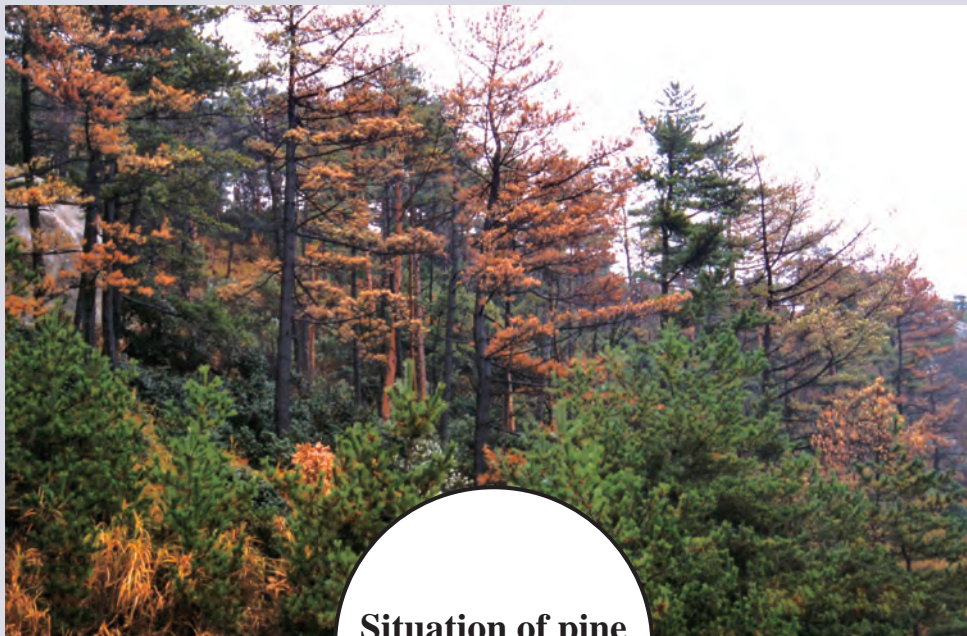
Development of pine wilt nematode resistant varieties

① Situation of pine wilt damage

The pine wilt damage is an epidemic caused by pine wilt nematode invasion into xylem of pine tree. The pine wilt nematode, which is around 1 mm length, is carried by a longhorn beetle.

Although such damage has been reported since early 1900, the outbreak damages have been observed in various parts of western Japan since 1960's. Such damages proceed to invade eastern and northern Japan and now all area except Hokkaido and Aomori prefectures are under such infected area.

With collaboration with the prefectures' research centers, FTBC is carrying out research and development of pine wilt nematode resistant varieties. 260 new such varieties are developed by 2008.

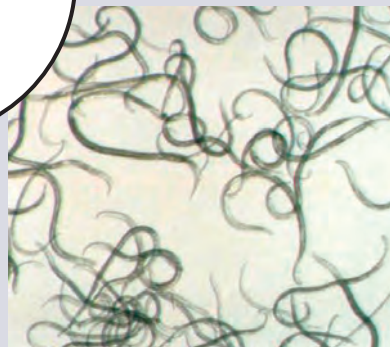


Situation of pine wilt damage



Longhorn beetle (*Monochamus alternatus*)

The imago longhorn beetles carry pine wilt nematodes and fly from a pine tree to another one.



Pine wilt nematode (*Bursaphelenchus xylophilus*)
(0.6 mm to 1.0 mm length)

Pine wilt nematodes invade into xylem of pine tree from an open score of the young needle caused by longhorn beetle bite. The propagated nematodes in xylem will cause pine wilt soon.

② World advancing research and development in Pine wilt

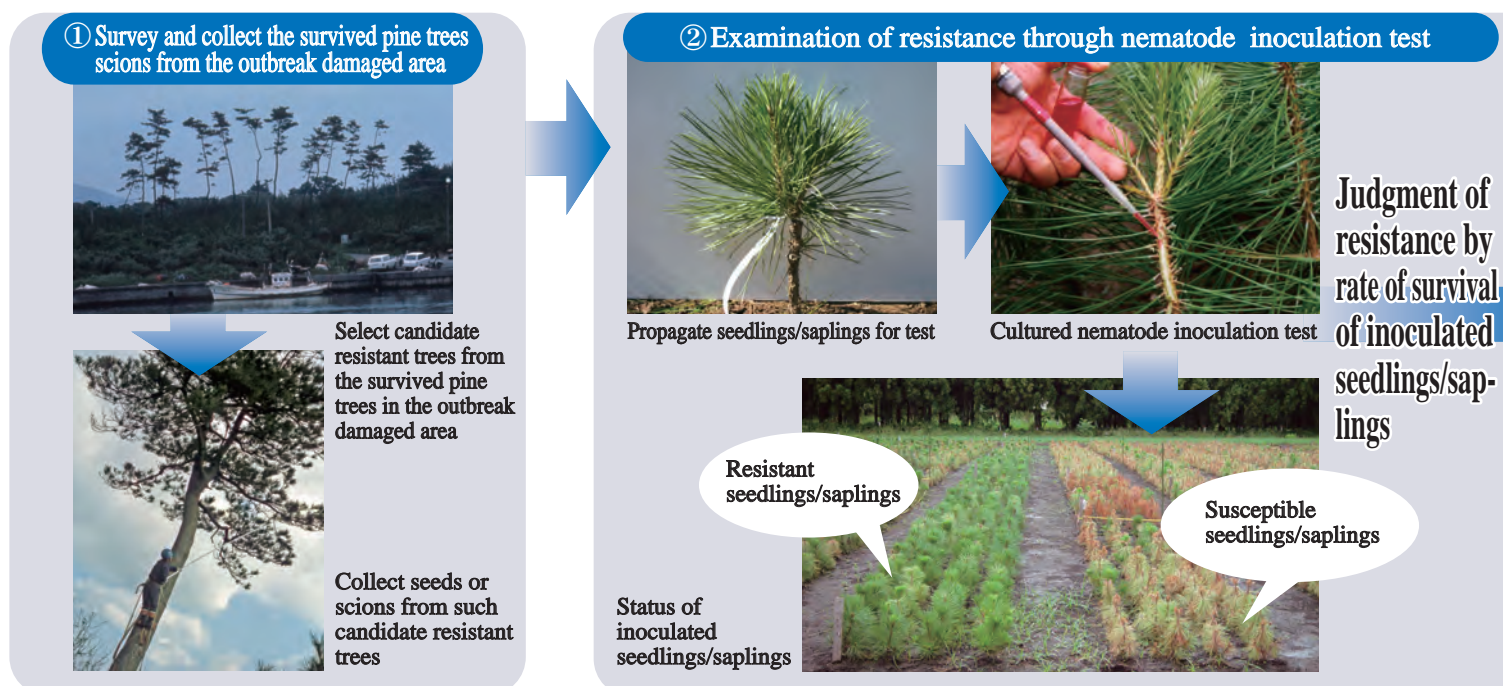
In 1971, FFPRI researchers determined that nematode causes the pine wilt diseases. Upon this result, FTBC started selection of pine wilt nematode resistant varieties and succeeded in its development.

The pine wilt nematode damages are spreading to China, Korea and Europe such as Portugal and became one of the major threats on Pine species in the world.

〈Chronological table of pine wilt nematode damages and its countermeasures in Japan〉

1905	The first damage report in Nagasaki Prefecture
1941	Research committee on countermeasures associated with pine damages met in Hyogo Prefecture
1951	Forest pests and diseases control act has been proclaimed
1971	Dr. Kiyohara and Dr. Tokushige of FFPRI determined that nematode causes the pine wilt through their nematode inoculation test on the sound pine trees
1977	Special measures act on pine wilt diseases control has been proclaimed
1978	Pine wilt nematode resistant varieties development project started
1982	Second special measures act has been proclaimed
1985	FTBC has developed 92 resistant varieties of <i>Pinus densiflora</i> and 16 resistant varieties of <i>Pinus thunbergii</i>
1992	Third special measures act has been proclaimed
	Pine wilt nematode resistant varieties development project in northern Japan started
2009	Accumulated number of resistant varieties 182 varieties of <i>Pinus densiflora</i> 78 varieties of <i>Pinus thunbergii</i>

③ Development methodologies of pine wilt nematode resistant



nematode resistant varieties

In Anhui province of China, the outbreak damage on *Pinus massoniana* was reported and they have requested technical support through JICA. FTBC has started to extend its support in pine wilt nematode resistant varieties development project in Anhui province since 2001.

〈Chronological table of pine wilt nematode damages in the world〉

1932	Pine (wilt) nematode found in the U.S.
1979	Base upon the report by Dr. Kiyohara and Dr. Tokushige in 1971, a massive field survey was carried out in the U.S. and found pine wilt nematode from the wilted <i>Pinus nigra</i> planted in Missouri
1980	Continued massive survey reported that pine wilt nematode found from the exotic pine species planted more than 20 states. Since indigenous pine species have not been damaged, this pine wilt nematode seemed to be native in the U.S.
1982	The pine wilt nematode found from the emaciated <i>Pinus banksiana</i> native in Canada The pine wilt nematode found from the wilted <i>Pinus thunbergii</i> in Nanjing, China
1985	The pine wilt nematode found from the wilted <i>Pinus luchuensis</i> in Taiwan
1988	The pine wilt nematode found from the wilted <i>Pinus densiflora</i> and <i>Pinus thunbergii</i> in Korea
1999	The pine wilt nematode found from the wilted <i>Pinus pinaster</i> in Portugal
2001	JICA project in Anhui province started

varieties

As of 31 March 2009, 182 varieties of *Pinus densiflora* and 78 varieties of *Pinus thunbergii* have been selected as resistant ones.

③ Development of seed orchards

As of 31 March 2009, 31 seed orchards of *Pinus densiflora* and 32 seed orchards of *Pinus thunbergii* have been developed by resistant varieties.



Resistant seed orchard developed by resistant varieties

④ Production and dissemination of resistant seedlings



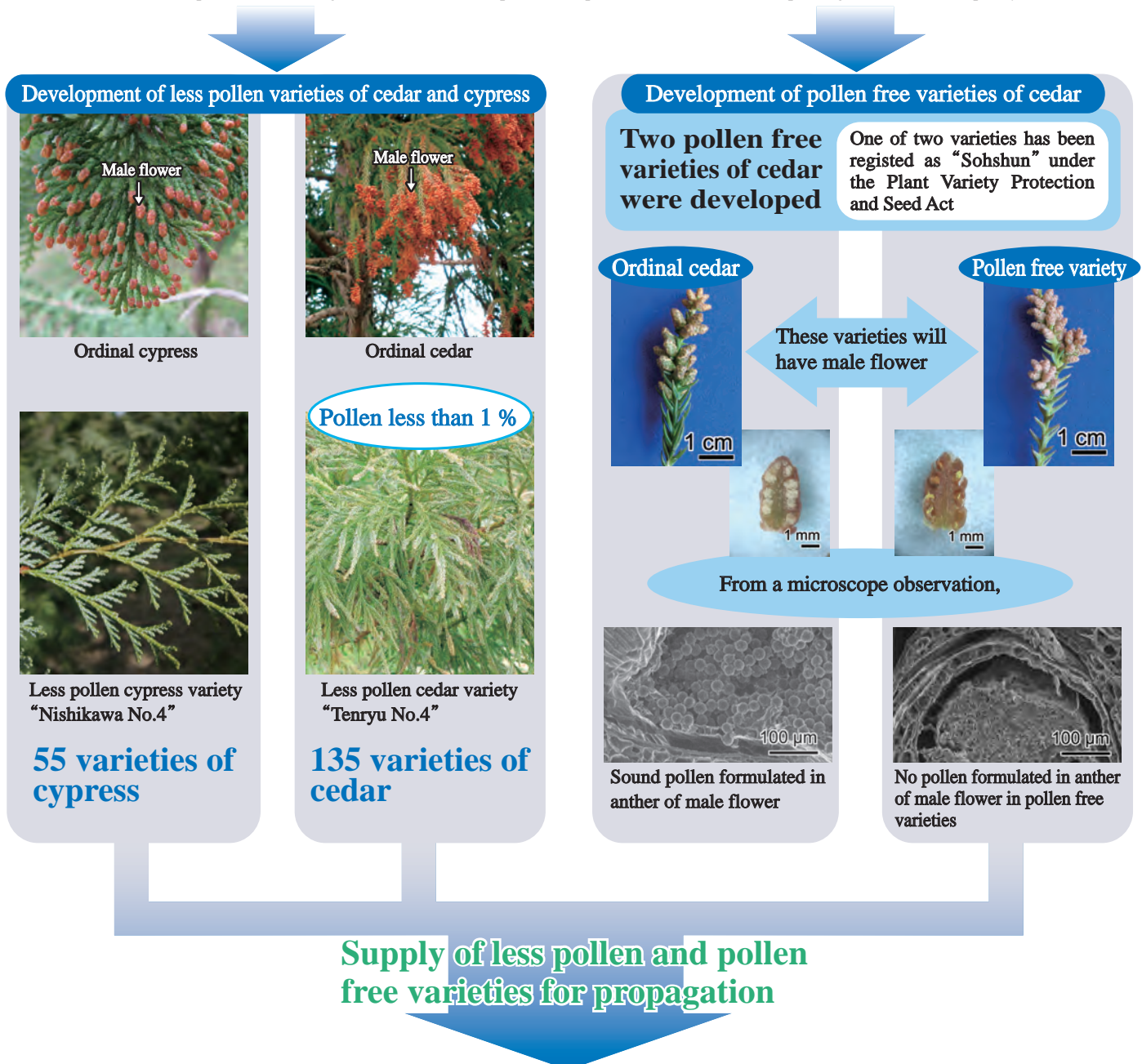
Propagated resistant seedlings are mainly planted in the coastal conservational area

Development of pollen free and/or less pollen varieties

① Status on the research and development

The allergy associated with tree pollen has been one of the socio-medical issues in Japan. FTBC in collaboration with prefectural research centers is carrying to develop less pollen varieties of *Cryptomeria japonica* and *Chamaecyparis obtusa* plus trees stock. The term “less pollen” will be defined by no or seldom male flowering in the average flowering seasons and little (less than 1 %) male flowering in the abundant flowering seasons.

Moreover, pollen free varieties of *Cryptomeria japonica* are also developed from stock for breeding materials in 2004 and 2007. Such varieties will have male flower but no pollen formulated in anther of male flower. Hybrid trials between no pollen varieties and plus trees are being carried out for development new pollen free varieties with superior growth and wood quality.



② Propagation and dissemination of pollen free and/or less pollen varieties

FTBC is providing the clones of the developed varieties to seed/scion orchards in prefectures as ortets while maintaining those strains.

Clonal propagation by cuttings seems to be advantageous for pollen free and/or less pollen varieties, because the targeted trait will be copied and maintained. However, as the number of scions gained from an ortet is limited, mass propagation by cuttings did not be realized. FTBC developed a new propagation technique by using half size (less than 10 cm) scions for cuttings. This new “Micro-cutting propagation technique” leads scion orchards in prefectures to introduce mass propagation system by cuttings. Moreover, FTBC is conducting mass propagation of a pollen free variety by tissue culture technique under a contracted basis.

Maintaining strains of developed varieties (Strain garden)



Cedar strain garden

Propagation of developed varieties



Micro-cutting propagation technique

Development and improvement of seed/scion orchards in prefectures



Hedged miniature size seed orchard* of less pollen varieties



Tissue culture propagation technique

Production of seeds and scions

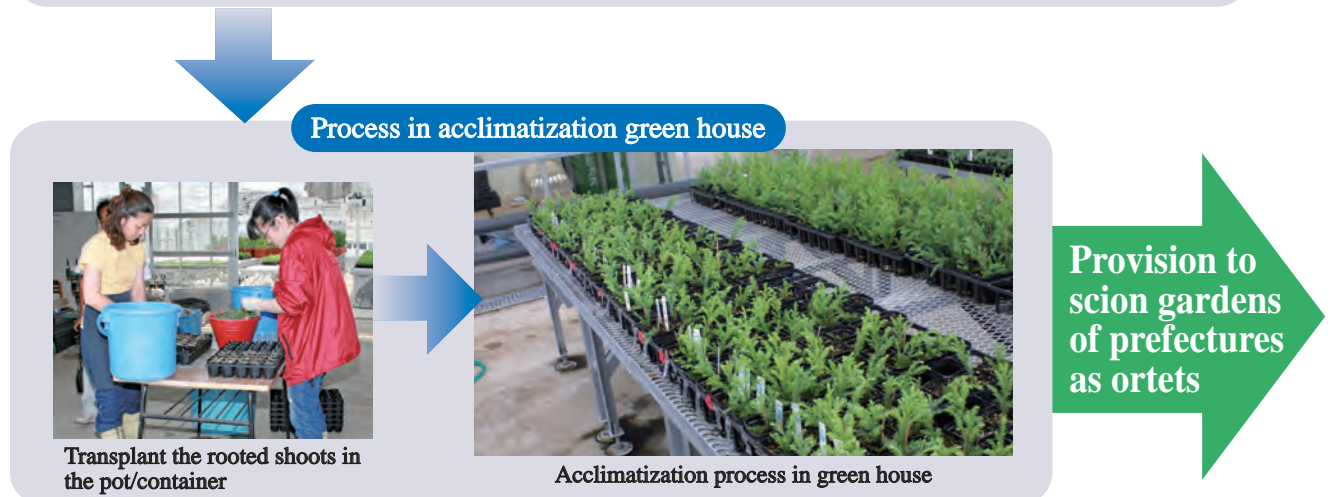
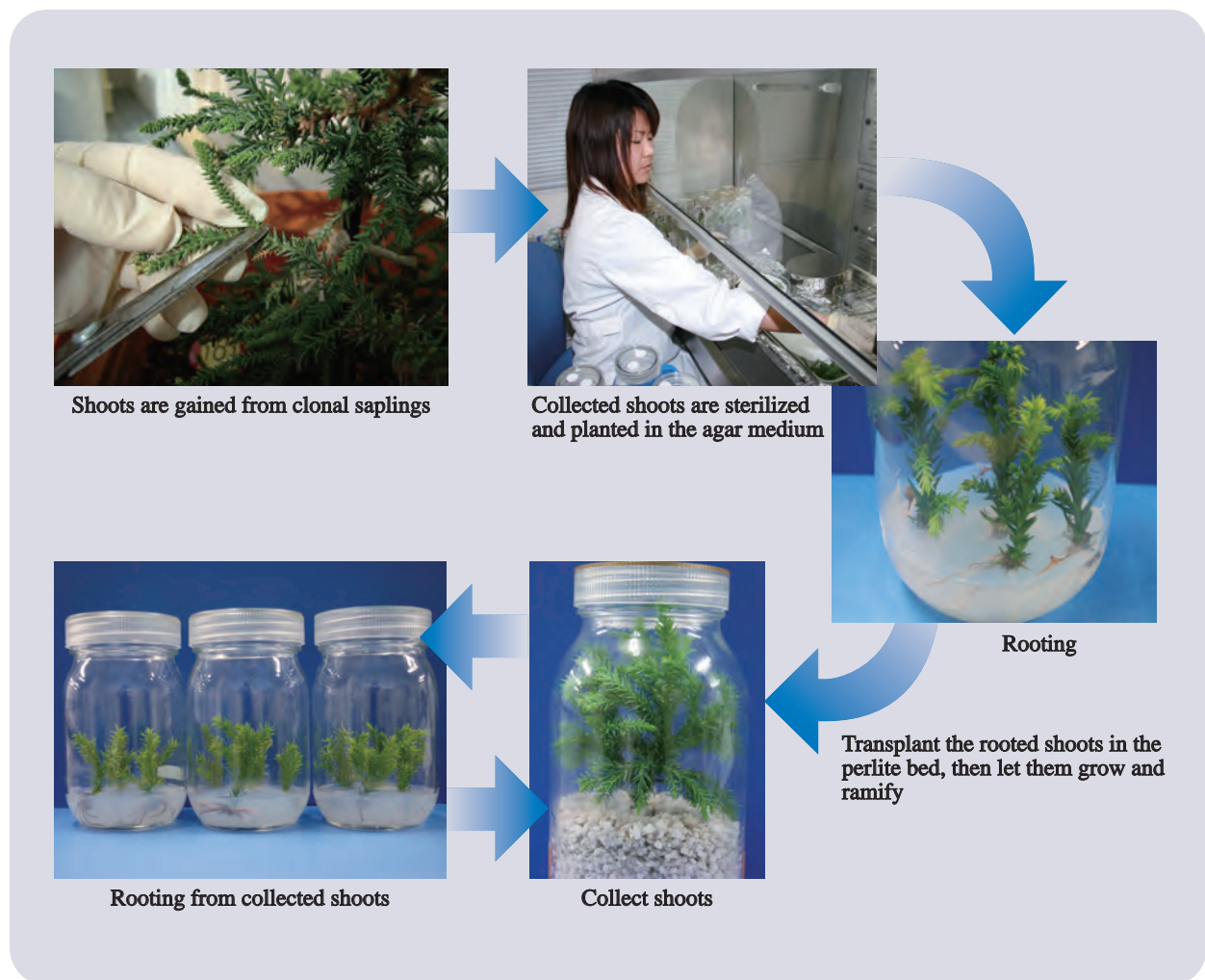
*Hedged miniature size seed orchard: Size of ortets are small and hedged. Planting space of ortets is narrow. This orchard leads higher efficiency in operations and easy improvement/replacement of ortets.

Seedlings/saplings production by private nurseries

To be planted in the forest particularly in urban area

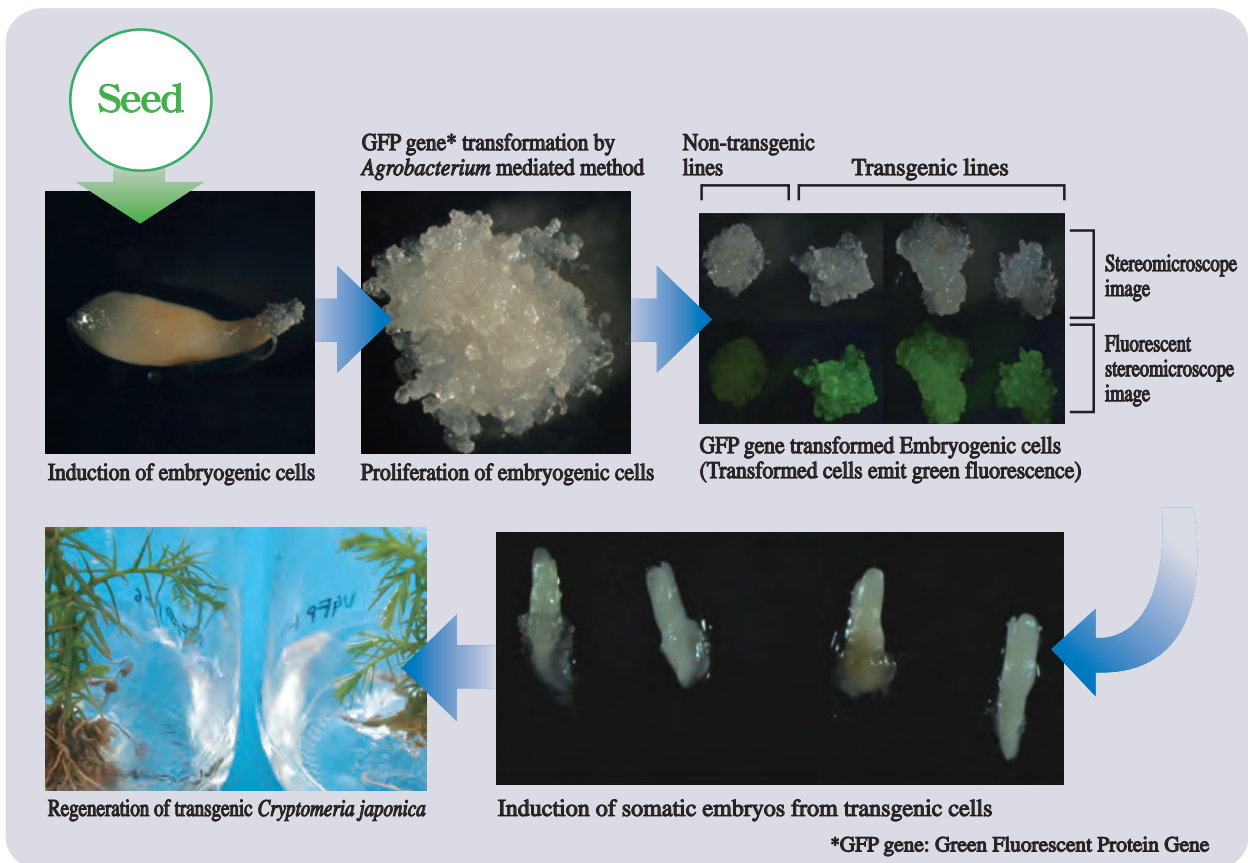
③ Mass propagation by tissue culture of pollen free variety

FTBC is conducting a project basis mass propagation of a pollen free variety by tissue culture technique under a contract.



④ 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 also conducting to develop new pollen free varieties with superior growth and wood quality by genetic engineering techniques.



Research for genetic transformation of *C. japonica* plus trees for male sterility

Examples of applied methods for male sterility of *C. japonica*

1. Suppression of specific gene expression, which is controlling male flowering or pollen development
2. Destruction of male flower or pollen under development stages

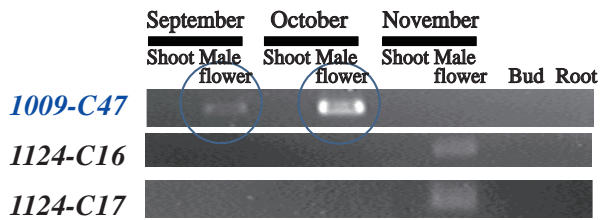
In order to proceed the above technical methodologies

It is necessary to identify the genes that regulate male flower or pollen formation
 Now, FBRC is isolating the male flower specific genes that are expressed during male flower formation

By using the male flower specific genes

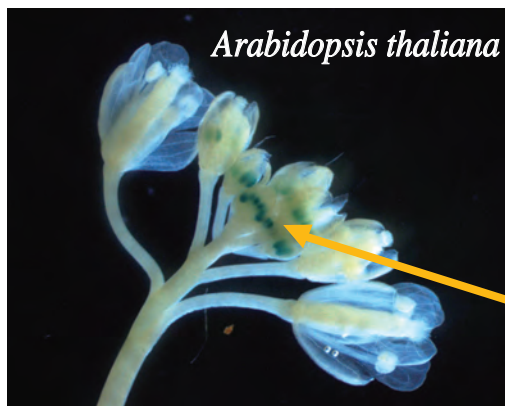
FBRC will produce male sterile (pollen free) *C. japonica* plus trees by genetic engineering

⑤ Current status of genetic engineering research for pollen free varieties development



Pollen development of *C. japonica* starts around September, and the pollen matures around November. Left figure shows that the gene 1009-C47 is expressed only in male flower from September to October. (White bands indicate the genes expressed)

Promoter of this gene is specifically expressed in anther*



Promoter is regulating gene expression. The promoter of this gene was fused to *GUS* reporter gene (it dyes cells blue where expressed), and was transformed into *A. thaliana*. Transformed *A. thaliana* showed blue color in anther, indicating that this promoter is specifically expressed in anther. From this result, it is expected that this promoter is also anther-specific in *C. japonica*.

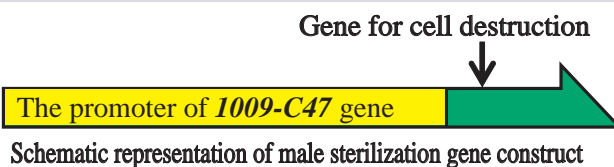
Organ where the promoter of 1009-C47 gene is expressing (blue colored parts are anthers)

The promoter of 1009-C47 gene

GUS

*Anther: Anther contains pollen. There are about 3,300 pollen grains in one anther of *C. japonica*.

Construction of male sterilization gene, which produces pollen free *C. japonica*



FBRC produced male sterilization gene construct by fusing the 1009-C47 promoter to the gene for cell destruction. This male sterilization gene will express in anther during pollen development, resulting destruction of *C. japonica* pollen.

FBRC is conducting genetic transformation of male sterilization gene to *C. japonica*

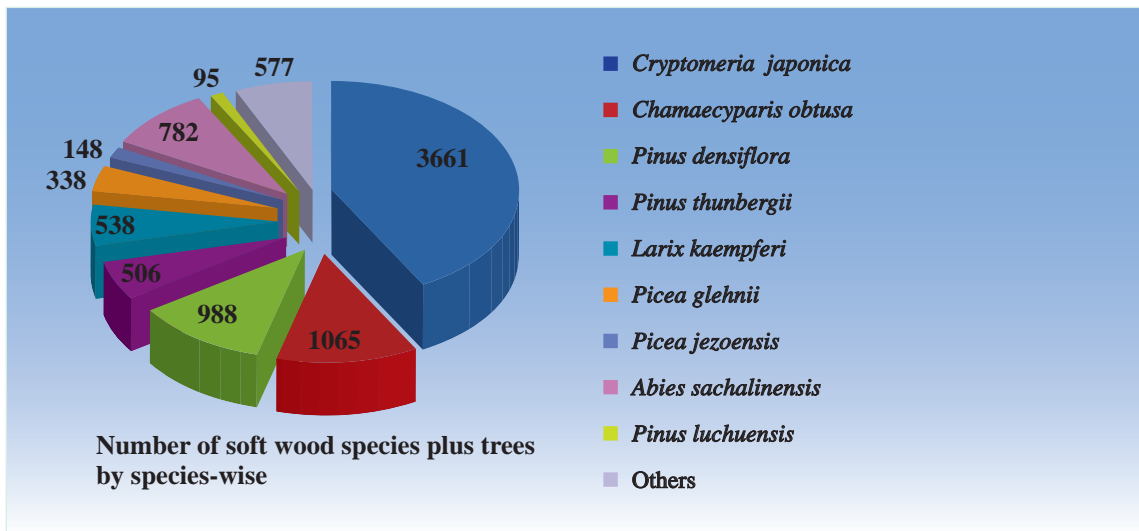
Development of varieties superior to growth and wood quality

① Selection of plus trees

About 9,000 trees have been surveyed and selected as plus trees which are superior to the adjacent three large trees by more than 30 % in volume.

Various superior traits, e.g. fast growth, good wood quality, and trunk straightness, gifted trees are found in the stock of plus trees which are sources of tree improvement.

Number of plus trees by species-wise is as follows.



Number of soft wood species plus trees by five tree breeding regions

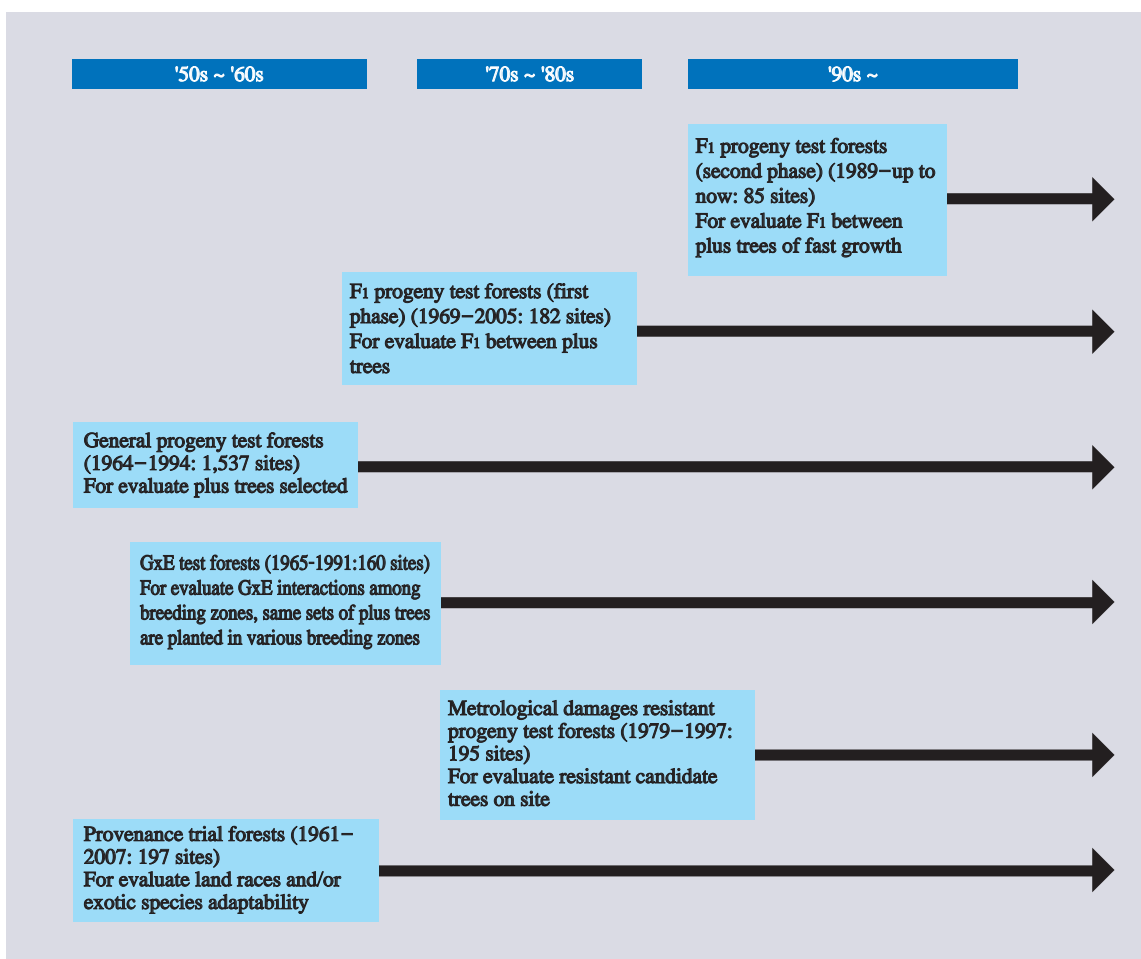
Tree species Breeding region	<i>Cryptomeria japonica</i>	<i>Chamaecyparis obtusa</i>	<i>Pinus densiflora</i>	<i>Pinus thunbergii</i>	<i>Larix kaempferi</i>	<i>Picea glehnii</i>	<i>Picea jezoensis</i>	<i>Abies sachalinensis</i>	<i>Pinus luchuensis</i>	Others	Total
Hokkaido	78		3		278	338	148	782		183	1,810
Tohoku	714	15	201	60	28					162	1,180
Kanto	938	409	306	79	232					160	2,124
Kansai	1,298	453	388	159						25	2,323
Kyusyu	633	188	90	208					95	47	1,261
Total	3,661	1,065	988	506	538	338	148	782	95	577	8,698

② Progeny test forests

Progeny test forests are the backward selection type field trial of plus trees. Saplings clonally propagated and/or seedlings from plus tree ortets are planted. Currently, 2,400 progeny test forests (3,200 ha in total) are maintained and monitored around the nation.



General progeny test site of cedar



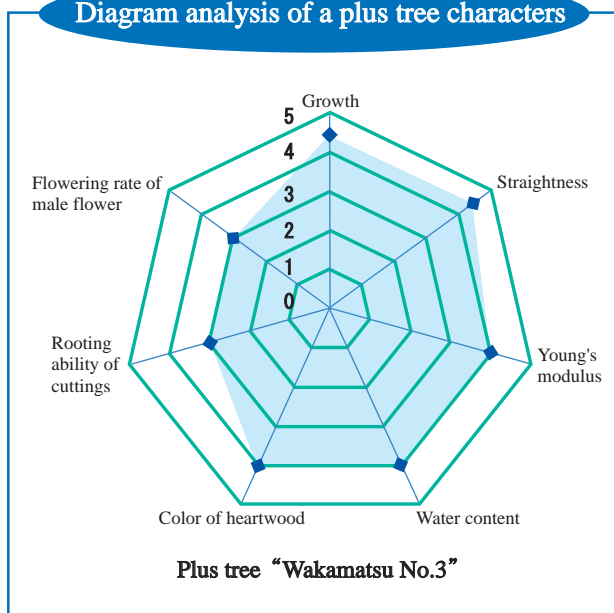
③ Evaluation of traits of plus trees

FTBC is conducting periodical (10 years, 20 years and 30 years old) monitoring of progeny test forests. Collected data such as stem growth, trunk straightness and wood quality-mechanical strength are compiled and evaluated, then published as “Plus trees trait tables”. The plus trees evaluated as superior trait are placed as the recommended varieties.

In Plus trees trait tables, the trait-wise standard score is calculated from the measured data. Such standard score is converted into five degree index. Degree 5 will include 7 % of the total.

Recently, selection will be focused on fast growth trait among the F₁s between superior plus trees. Some of the selected F₁s indicate 7 m height growth in the fifth year, and further selection will be conducted in line with shade tolerance among the selected F₁s.

Diagram analysis of a plus tree characters



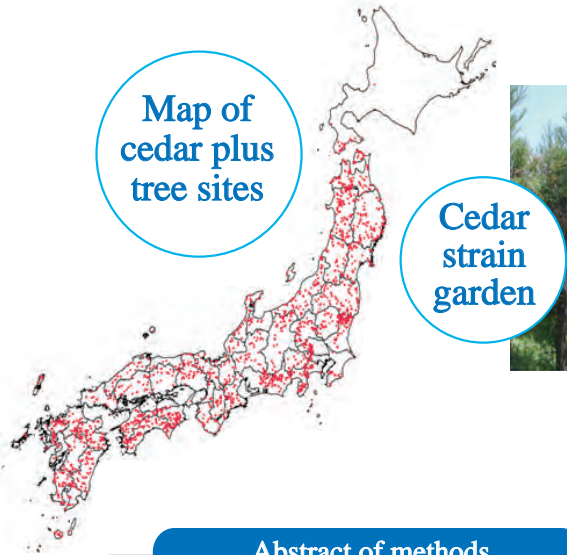
【Harvest is half dependent on seedlings/saplings quality】

Harvest is dependent on the quality of seedlings/saplings by half. Genetically superior seedlings/saplings are essential for good forest management.



F₁ trees of 7 m height in the fifth year
(F₁ progeny test site)

DNA based traceability system of plus trees



More than 3,600 phenotypically superior trees have been selected as plus trees in *Cryptomeria japonica*. Those plus trees have been clonally propagated, and planted in progeny test forests as well as seed/scion orchards. In order to maintain traceable clone management and to avoid contamination induced by human errors, FTBC is developing a new DNA based traceability system of plus trees.

Abstract of methods



Collecting DNA sample (fresh shoot)



Processing by liquid nitrogen



DNA extraction



Amplification of the target DNA segments using PCR (Polymerase chain reactions)

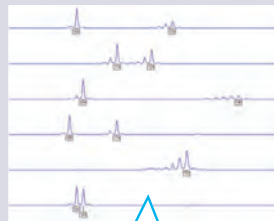


A part of DNA extracted will be stored in freezer



DNA fingerprinting by capillary electrophoresis using sequencer

Results

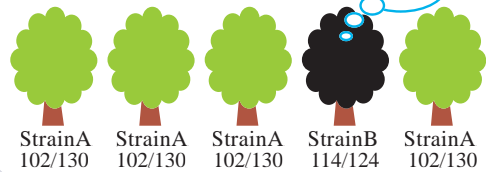


- StrainA 102/130
- StrainB 114/124
- StrainC 104/148
- StrainD 100/114
- StrainE 134/134
- StrainF 102/104

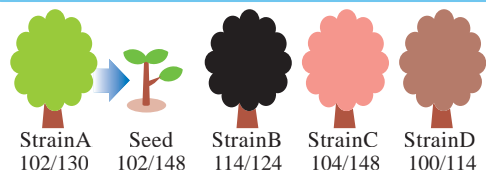
As amplified DNA markers possess abundant polymorphism, fragment lengths vary strain by strain. We can genotype the marker DNA of targeted strains, and discriminate those strains based on the variation of DNA markers.

Usage 1 Strain management in case of Strain A

Wrong!



Usage 2 Seed orchard management in case of seeds from Strain A



When seedling from strain A has a genotype of 102/148, the candidate pollen donor of this seedling will be strain C

DNA analysis enables us to not only high accuracy clone management but also parental analysis of breeding materials

The only forest tree gene bank in Japan

Necessity of forest tree genetic resources conservation

Forest tree genetic resources have been providing various forest products on which human beings depend since ancient times. These genetic resources will be expected to provide various services in future with science and technology development. If such these genetic resources were lost, same genetic resources cannot be reproduced. It is therefore, these genetic resources have to be conserved and inherited to the next generations.

In addition to the increased concern about biodiversity conservation in forest, expectation toward forest genetic resources is expanding with science and technology development. It is going to be more important for FTBC to collect and conserve/preserve forest tree genetic resources.

Outline of forest tree gene bank program

FTBC is the sole implementation agency for forest tree gene bank program in Japan, and has a largest stock in woody plants. 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, pollens or propagated individuals. FTBC is also conducting trait analysis of collected genetic resources for identification of potential use as well as distributing such resources for research purposes.

Chronological history

- 1964 Gene conservation forests (*in-situ* conservation) started
- 1985 National gene bank program under Min. of Agriculture, Forestry and Fisheries started
- 1995 Forest tree genetic resources distribution program started
- 2001 As a part of structural reform of the central government, forest tree gene bank program has become under an incorporated administrative agency FTBC
- 2007 FTBC has merged into FFPRI

Status of plant related gene bank in major institutions

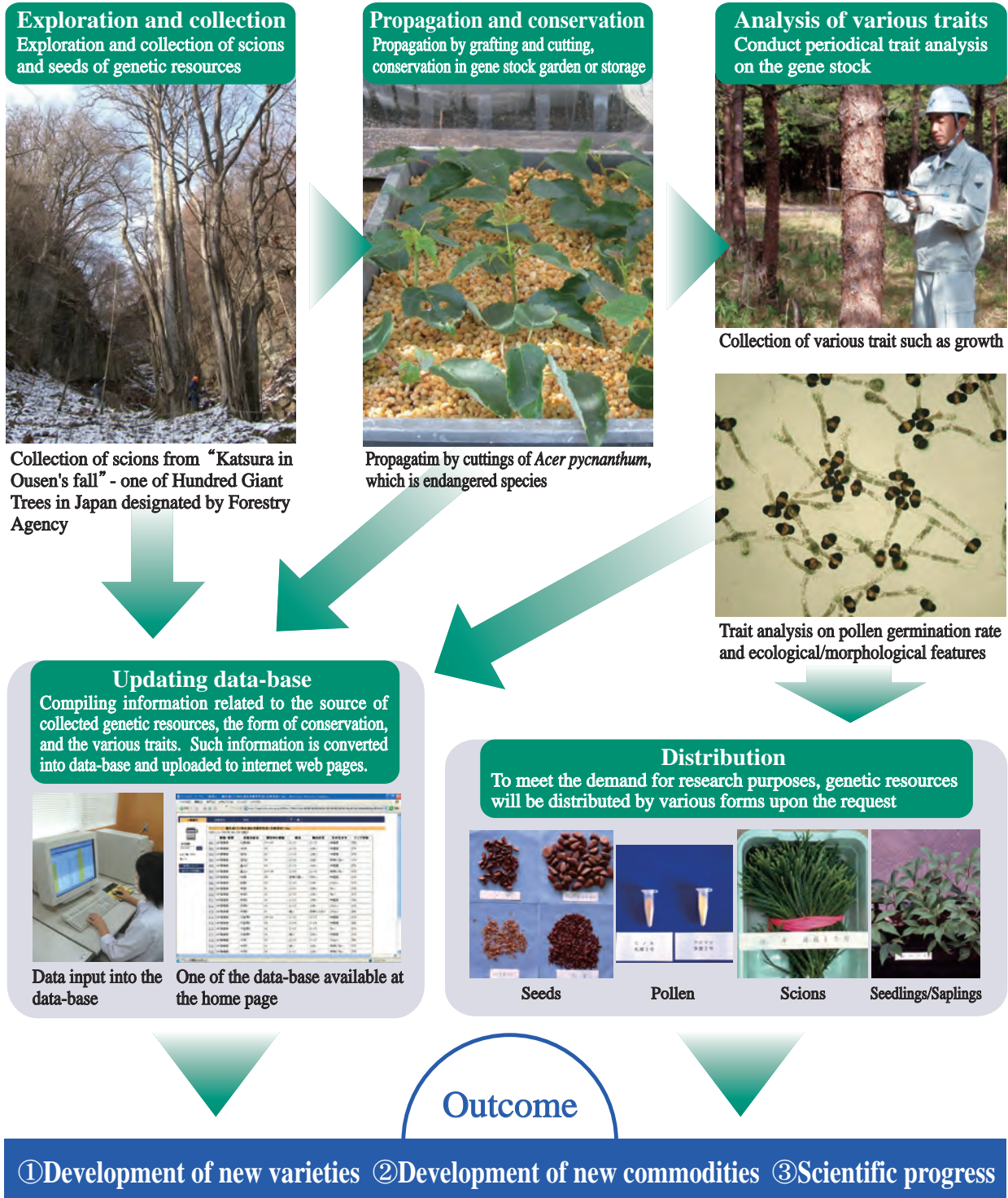
Institution	Number of strains conserved	Remarks
FTBC(See footnote 1)	33,881	Individual:23,040, Seed/pollen:10,841
NIAS(See footnote 2)	241,507	rice, wheat, bean, potato, grain and cereal, fodder, fruit tree, vegetable, flower and horticultural plant, tea, mulberry, tropical and sub-tropical plant
Woody plants	19,447	out of the above, fruits tree, tea and mulberry
USDA NCGRP(See footnote 3)	380,727	Plant seed

1) As of 31 March 2009

2) From the annual report of NIAS for 2008

3) From the home page of NCGRP

Outline of forest tree gene bank program



Status of conservation/preservation of forest tree genetic resources

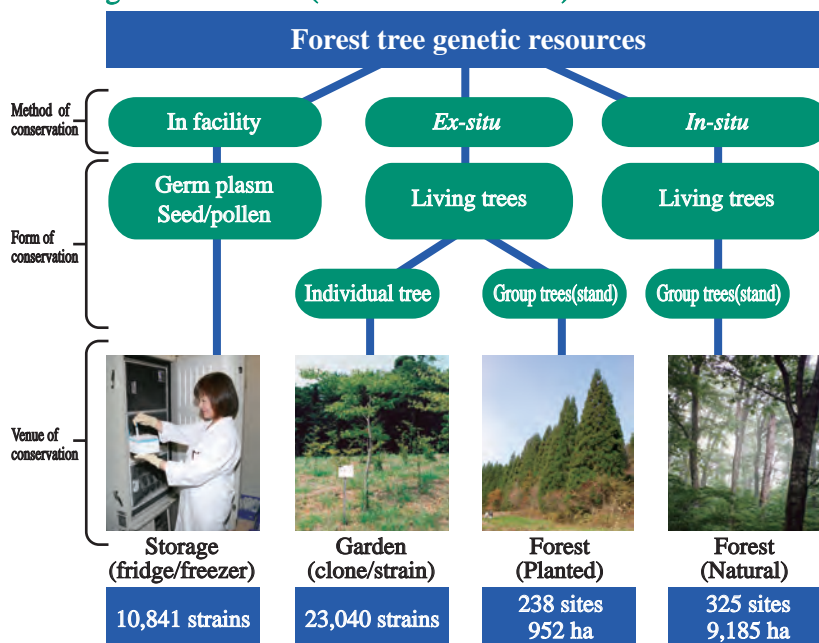
Method and form of conservation

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 31, 2009, 10,841 strains of germ plasm (seed or pollen) and 23,040 living individual strains are under conservation/preservation.

In-situ conservation is applied to 330 sites of gene conservation natural forest (9,000 ha) and *ex-situ* conservation is applied to 240 sites of gene conservation planted forest (1,000 ha).

Flow chart of method and form of conservation of forest tree genetic resources(as of 31 March 2009)



Status of conservation/preservation

Through forest tree gene bank program, ①23,040 strains of living individuals (750 species), ②8,164 strains of seeds (486 species), and ③2,667 strains of pollens (65 species) are under conservation/preservation. Out of which, the number of the endangered species are ①612 strains of living individuals (36 species), ②147 strains of seeds (21 species), and ③33 strains of pollens (5 species).

It is highly expected that such wide range of forest tree genetic resources stock will be used for the various applications such as medicinal and environmental remediation use.

Status of forest tree genetic resources conservation/preservation (as of 31 March 2009)

Form of conservation	Classification	Species	Strains	Endangered species	
				Species	Strains
Individual	Domestic softwood	96	17,181	4	393
	Domestic hardwood	396	4,443	32	219
	Foreign softwood	131	913		
	Foreign hardwood	127	503		
	Sub-total	750	23,040	36	612
Seed	Domestic softwood	54	5,983	4	13
	Domestic hardwood	382	1,794	17	134
	Foreign softwood	33	330		
	Foreign hardwood	17	57		
	Sub-total	486	8,164	21	147
Pollen	Domestic softwood	23	2,440	3	29
	Domestic hardwood	18	156	2	4
	Foreign softwood	19	70		
	Foreign hardwood	5	11		
	Sub-total	65	2,677	5	33

Trials for conservation/preservation of the endangered tree species

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

Morus boninensis

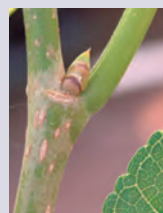


Morus boninensis in Haha-jima island

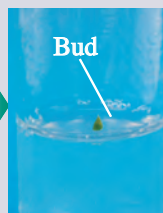
Morus boninensis, which is native in three islands of the Ogasawara Islands, is under the category of "Endangered" of the red list of the Min. of the Environment. Due to high quality of wood for furniture use, large stock of *Morus boninensis* in those area have been intensively harvested. Only around 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 boninensis* will be clonal propagated and clonal saplings will be transhipped to those islands.



Planting



Collecting winter buds



Bud

Cultured in agar medium



Shoot formation



Propagation and rooting in beaker

Transshipment to Ogasawara Islands



Acclimatization process in pot

Pinus amamiana



Pollen



Artificial crossing

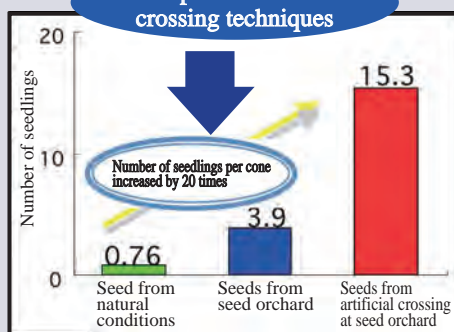


Cone

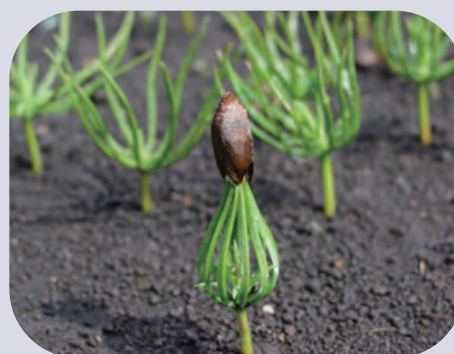
Pinus amamiana, which is native in Yakushima and Tanegashima islands, is under the category of "Endangered" of the red list of the Min. of the Environment.

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

Development of artificial crossing techniques



Number of seedlings per cone



Germination of *Pinus amamiana*

Clonal propagation services of natural heritage trees

Emergency call of natural heritage trees' bank services

Natural heritage trees and trees with long and distinguished history are the asset of local community or objects of faith as well as biological resources. Upon the request for clonal propagation of such trees, FTBC will propagate clonal successor saplings by cutting or grafting. These successor saplings will be returned to the original site while conserving in FTBC as research materials.

As of 31 March, 2009, 70 ortets have been propagated and these successor saplings have been returned. Some of the ortets have died or been cut due to the damage of typhoons or diseases.

"Pine tree beautiful root system exposed" of Kanazawa, Ishikawa

"En-Katsura" of Otobe, Hokkaido - one of Hundred Giant Trees in Japan designated by Forestry Agency

"Cherry tree-The Emperor turned back to see" of Kyoto (cited from Kyoto city, 2005)

"Five heads dragon wisteria" of Takizawa, Iwate

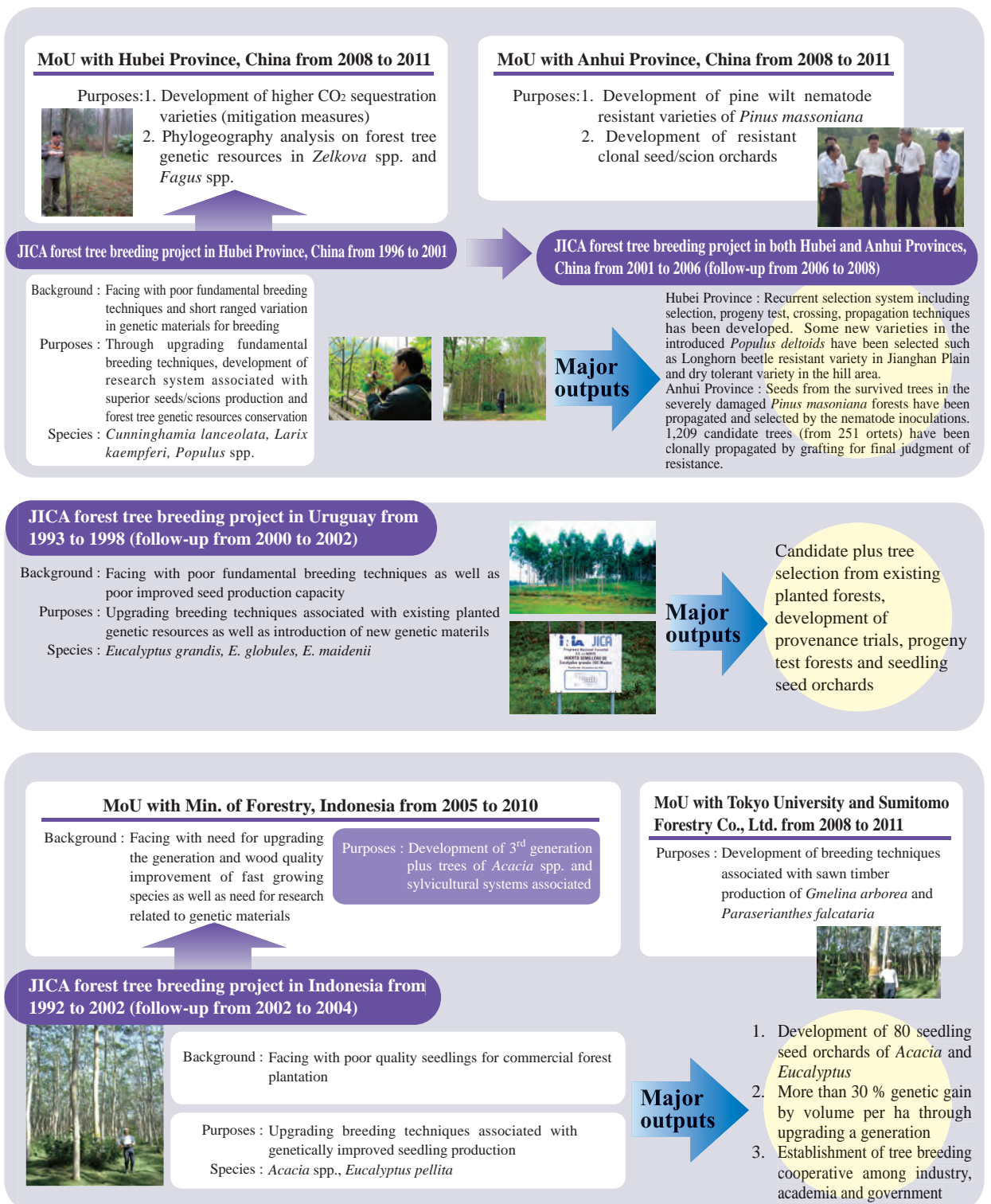
"Red pine in Jisso-in" of Kawagoe, Saitama

"Cedar in Ubu-jinja" of Aso, Kumamoto

"Grant cypress" of Taito-ku, Tokyo

Development of forest tree breeding techniques associated with international cooperation

International collaborative research



Tropical and sub-tropical forest tree species breeding R/D center

Iriomote Tropical Forest Tree Breeding Technical Garden

Purposes and mandates

To have an open field based R/D facilities for tropical forest tree species in Japan, this technical garden has been established in 1996 at Iriomote island where sub-tropical climate is provided.



Main building



Exhibit hall



Exhibit forest

R/D activities

1 R/D of tropical forest tree species' breeding

Clonal propagation



Cutting



Grafting



Layering

Control of tree shape



Chemical application

No chemical application

Artificial crossing technique



Pollen collection method



Formulation of shells

Artificial crossing

2 Technical training of forest tree breeding abroad

Acceptance of trainees abroad

Acceptance of domestic trainees: college students as a part of internship



Training of trainees abroad



Internship training of domestic college students

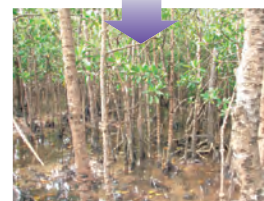
3 Tropical forest tree genetic resources conservation/preservation

Ex-situ conservation

In-situ conservation



Gene bank of *Paraserianthes falcataria*



Gene conservation forest of mangrove

Outputs

Breeding manuals related to tropical fast growing tree species

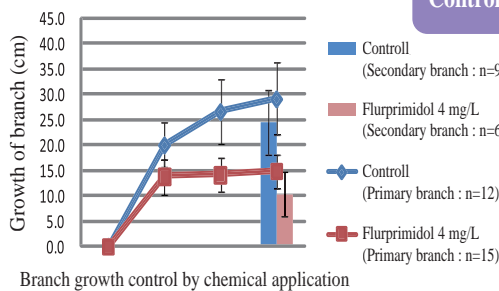


For effective tree breeding technical transfer

Development of clonal propagation techniques of *Acacia mangium*, *A. auriculiformis*, *Eucalyptus urophylla*, *E. grandis*

Tree species	Cutting		Grafting		Layering	
	success rate(%)	appropriate season	success rate(%)	appropriate season	success rate(%)	appropriate season
<i>Acacia mangium</i>	17	Spring	64	Spring	38	Spring/Fall
<i>A.auriculiformis</i>	77	Spring/Fall	42	—	75	Spring
<i>Eucalyptus urophylla</i>	3	—	37	Spring	12	—
<i>E.grandis</i>	7	Fall	22	Spring	10	—

Control of tree shape for seed/scion orchard



Branch growth control by chemical application



Comparison of nodal growth

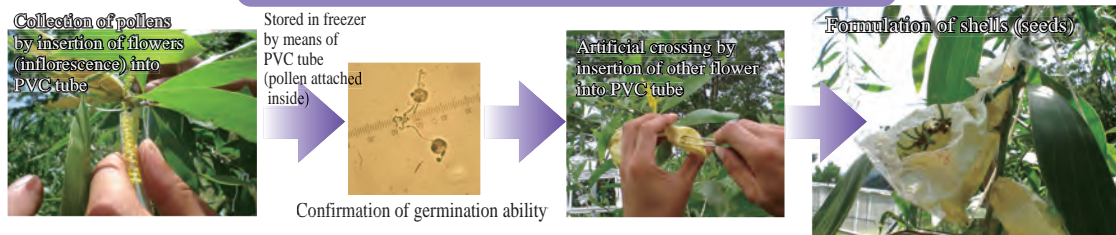
Growth of branch and its nodal growth are controlled



Flowering survey on trees with chemical application

Success in leading compact shape with sound flowering

Development of effective artificial crossing technique between *Acacia* spp.



Succeed in effective, efficient and easy crossing between flowers with different flowering seasons

From these outputs

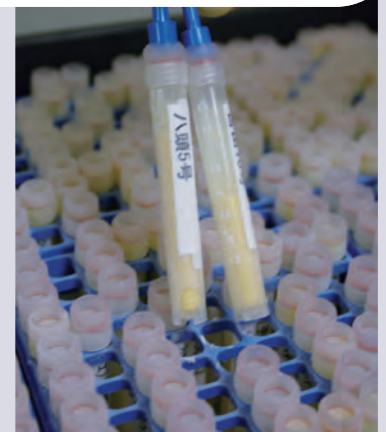


Acclimatization green house
 fully equipped with artificial lighting and closed nursery system



A large scale acclimatization house is equipped with artificial lighting and closed nursery system including higher CO₂ application similar to tissue culture room. After propagation in tissue culture room, saplings will be grown in this acclimatization green house before planting the field.

The only forest tree gene bank in Japan -
Forest tree genetic resources conservation facility



Seeds (-20 °C)

Pollen (-80 °C)

As the only forest tree gene bank in Japan, FTBC is conducting exploration, collection and conservation of forest tree genetic resources for maintain genetic diversity of species and inside of a particular species. This facility will conserve seeds by -20 degrees and pollens by -80 degrees in specific freezers.

Genetic engineering research facilities with due consideration of safety



The facilities are both for research laboratory of tree species genetic engineering and for analysis of such research impact on the environment. The facilities are composed with laboratory of genetic engineering and closed green house for GMO isolated cultivation from the outer environment.

The first and the largest tissue culture laboratory for forest tree species in Japan



This laboratory has four tissue culture rooms with higher CO₂ application system. FTBC is now conducting a mass production of pollen free variety of *Cryptomeria japonica* under a contracted basis as well as technical improvement associated.

The largest **specific net house** in Japan



9 m height and
390 m² in space

This net house is designated for GMO cultivation similar to the outer environment after the closed green house. The specific net house is named because fine meshed nets are fully equipped to avoid invasion of insects carrying pollens.

The largest **GMO isolation field** for forest tree species in Japan



This isolation field is for GMO cultivation and evaluation field after specific net house. This open field is isolated by 60 m × 54 m in space with 8 m height fences and 1 m depth sealed concrete fences. To avoid alien invasion, infrared sensors/cameras are also equipped. FTBC is now conducting a cultivation test of high cellulose contained GMO *Populus* upon the approval from both Ministers of Agriculture, Forestry and Fisheries and the Environment.

Location & Address of
Forest Tree Breeding
Center and its regional office

map



Hokkaido Regional Breeding Office

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Kyushu Regional Breeding Office

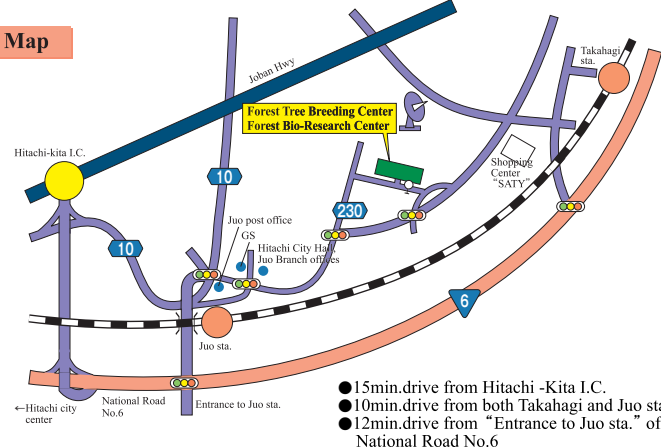
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Iriomote Tropical Forest Tree Breeding Technical Garden

Map



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