

Status of forest genetic resources conservation and management in the People's Republic of China

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Introduction

The conservation and management of forest genetic resources (FGR) is essential for the existence and development of modern societies. Burley (2002) stressed that forest biological diversity represents a fundamental resource since it includes the world's species and their constituent genes upon which humanity depends for health, prosperity and environmental welfare. The loss of ecosystems, species and genes is a major threat to the survival of humans and other organisms.

China is one of the largest nations in area in the world with a rich biological diversity but relatively poor forest resources. With regard to the number of species per country, China is only behind Brazil and Malaysia. Over 30 000 species of vascular plants are found in China, comprising perhaps more than 10% of the world total. Many species represent archaic and distinctive evolutionary lines, for example, *Ginkgo biloba* and *Metasequoia glyptostroboides*.

An estimated 30 560 species of plants have been documented in China, belonging to 343 families and 3150 genera. All families of Gymnospermae, apart from Araucariaceae, are naturally distributed in China. Of the total number of woody plants, over 2000 species are trees and 6000 are shrub species, belonging to more than 1200 genera and 187 families. The Chinese flora is also characterized by a great number of species that are endemic or only shared with eastern Asia. About 17 300 species are endemic accounting for more than 60% of the total in the country. On the other hand, the Chinese flora contains, in terms of origin, a great deal of floristic elements of the old world, Mediterranean and, especially, Indo-Malayan flora (Wu Zhengyi 1980; Anon 1997; Chen Linzhi and Ma Keping 2001; Liu *et al.* 2003).

There is an ecological gradient in rainfall from the east to the west of China. In general western China, being in the isocline of 400 mm rainfall, is phytogeographically characterized by arid or semi-arid desert vegetation, grassland, tundra or alpine forests, while eastern China is sub-humid or humid, covering a range of forest vegetation zones from boreal forest, cold-temperate and temperate broadleaved forest, subtropical evergreen broadleaved forest to seasonally tropical rain forests. To facilitate sustainable forest management, forest types of China are grouped into the following categories: Coniferous forests, Broadleaved forests, Bamboo forests, Bush communities and Cash tree crops (Anon 1997).

According to the forest statistics of China published by the Department of Forest Resources Management, State Forestry Administration (SFA), forest coverage reached 16.65% of the nation's area in 1998¹ (SFA 2000). The total area of forests in China is 158.94 million ha, of which 107 million ha or 69.62% can be classified as natural forests and 46.67 million ha (30.38%) are plantations, including tree crops.

Only a few native species and exotics are used in plantation programmes even though the native forest flora is very rich. For example, industrial plantations established in 2002 in the whole China covered 110 010 ha, of which 35 622 ha were of eucalypts and acacias, 24 626 ha of *Pinus elliottii*, *P. taeda* and *P. caribaea* and 26 473 ha of poplars and paulownias, the rest being mostly indigenous hardwoods and bamboos (see the web page of the Department of Afforestation, SFA at <http://www.forestry.gov.cn/lytj/index.asp>). The national forestry authorities have noted that more indigenous species should be used in

¹ Projected foliage coverage of canopy was changed to 0.2 from 0.3 in the 5th national forest inventory, which was carried out during 1994–1998.

planting programmes in order to maintain the biological diversity. In general, the forest resources of China can be summarised as follows:

- Forest resources are unevenly distributed in the geographic regions since 41.27% of forest area is located in only a few provinces: Heilongjiang, Jilin, Inner Mongolia, Sichuan and Yunnan.
- Age-structure of stands is far from reasonable with over 70% of immature forests, which implies that the forest resources have been cut excessively.
- The average standing volume for commercial forests is around 72.5 m³ ha⁻¹ and for plantation forests even much less; only 35 m³ ha⁻¹. Only 8% of the total wood production is contributed by plantation forestry even though planted forests make up 20% of the total forest area.
- Most of the forest stands are dominated by *Pinus massoniana*, *Cunninghamia lanceolata* and species of *Larix*, *Picea* and hardwoods such as *Quercus*, *Betula* and *Populus*, etc. In total, *P. massoniana* and *C. lanceolata* contribute 23.5% of the total forest area. *Abies*, *Picea*, *Tsuga*, *Tilia* and some pines, for example *Pinus densata*, are not accessible for forest management activities in the remote alpine areas.

The economy of China is booming and the demand for a range of wood and wood products is on the increase. To meet the domestic demand for timber, China has to import a great deal of timber and timber products. For instance, according to the Forestry Information Institute (FII), the Chinese Academy of Forestry (CAF) the quantity of round timber imported in 2002 reached a record 24.3 million m³ with the import value of US\$ 2138 million (see <http://www.lknet.forestry.ac.cn/my/ymbg.htm>).

Conservation of forest genetic resources

General status

Forest biodiversity in China also suffers from the explosive increase in the intensity and extent of human activities. Poaching of timber, medicinal materials and other non-timber forest products (NTFPs) is still a serious problem for the conservation of FGR. For example, the genetic resources of *Taxus yunnanensis* have been exhaustively exploited and the species is on the verge of extinction in the forests (Chen Shaoyu *et al.* 2001). Fragmentation and degradation of natural forests are commonly seen in China. Valuable timber species are disappearing and becoming extinct.

It was highlighted in the Forestry Action Plan for China's Agenda 21, published in 1995, that great efforts must be made and scientific research must be enhanced in the conservation and sustainable utilization of FGR (MOF 1995). The Chinese government has been aware of the significance of developing socioeconomic priorities, initiatives, regulations, policies, and legislation to intensify the support for biodiversity conservation.

Since 1998, the Chinese government has launched six major forestry programmes with emphasis on the conservation of the native resources and the environment. FGR conservation activities are included as major components of these programmes. The six programmes included (a) conservation of natural forest resources, (b) land use conversion from marginal agriculture to forestry or grassland, (c) combating desertification in the vicinity of the capital Beijing, (d) networks of shelterbelts in 3N regions (Northern, Northeastern and Northwestern China) and the middle and lower reaches of Yangtze river, (e) conservation of the genetic resources of wildlife and plants and (e) the development of nature reserves and development of commercial forest plantations.

In situ conservation

FGR can be conserved with two different approaches, *in situ* and *ex situ*. The former is a dynamic and evolutionary approach. *In situ* genetic conservation is an essential component of sustainable forest management (Koski 1998; Palmberg-Lerche 1998; Sigaud *et al.* 2000; FAO, DFSC, IPGRI 2001). Unfortunately, it is often overlooked in the practice of forest management in certain circumstances.

In China, the strategy of FGR conservation has, to a certain extent, been adopted from that of agricultural crops, making much effort to establish facilities, such as *ex situ* conservation stands and genebanks with great investments. *In situ* conservation programmes are still not well designed as integrated elements in sustainable management of forest resources or seed production. Human activities are, of course, not necessarily always negative to forest ecosystems if forest management is properly carried out (Palmberg-Lerche 2002). As yet in China, *in situ* conservation has not received enough attention, even though superior populations have been identified for a number of economically important tree species. The utilization and conservation of FGR can be integrated through planning and implementing in all of the major forestry programmes mentioned above.

Nature reserves and national parks play a significant role in conservation of FGR. However, they never replace the establishment of *in situ* conservation stands in managed forests. Conservation activities in nature reserves focus dominantly on the diversity of ecosystems and endangered or threatened species, while genetic conservation programmes should give more priority to the genetic diversity among wild populations within species that are, presently or potentially in the future, important for forestry production or breeding programmes. This has been addressed during the last decade in successive sessions of the FAO Panel of Experts on FGR.

For protecting biodiversity, China has established 1757 national and local nature reserves. The total protected area is 1330 million ha, accounting for 13.2% of the country's area (see <http://www.lknet.ac.cn>). Out of these, 171 are national reserves, 21 have been designated as Biosphere Reserves of the UNESCO's Man and the Biosphere Programme, and seven have been designated as globally significant wetlands. China has set an ambitious goal of increasing the number of reserves to 1800 (covering 15% of the area) by 2010 and 2500 by 2050 (Liu *et al.* 2003).

***Ex situ* conservation**

Species or provenance trials, progeny tests, seed orchards and plantations are all components of the category of *ex situ* gene conservation (Palmberg-Lerche 1998). Over 400 *ex situ* conservation areas, including about 100 botanical gardens and arboreta, have been established in the country to collect tree germplasm. Since exotic species play an increasingly important role in plantation forestry (in China about 25% of planted forests are established with introduced species), all commercial and experimental plantings of exotics can be regarded as *ex situ* conservation. However, the functioning of genetic conservation in commercial plantations is doubtful as these plantations are established with fast-growing species with short rotation, for example eucalypts, and many species do not become reproductively mature before being cut down. Indigenous and exotic species, for which some form of *ex situ* conservation stands have been established, include:

- a) **Indigenous:** *Cunninghamia lanceolata*, *Pinus armandii*, *P. koraiensis*, *P. massoniana*, *P. sylvestris* var. *mongolica*, *P. tabulaeformis*, *P. yunnanensis*, *Populus simonii*, *P. tomentosa* and *Hippophae rhamnoides* (All of these are in the form of seed orchards, clone banks or plantations)
- b) **Introduced:** *Pinus elliottii* and *P. taeda* (seed orchard), *P. caribaea* var. *caribaea* (progeny tests with 220 families), *P. caribaea* var. *bahamensis* (progeny test with 121 families), *Larix kaempferi* (seed orchard), *Eucalyptus globulus* ssp. *globulus* (progeny test with 300 families), *E. grandis*, *E. smithii* and *E. urophylla* (progeny test and seed orchard), *Acacia auriculiformis*, *A. crassicarpa* and *A. mangium* (provenance/progeny tests), *Populus euamericana* (clone bank), *Robinia pseudoacacia* (seed orchard) and other species

Research activities in tree improvement and breeding

Traditional breeding

Traditional tree breeding and improvement programmes in China have been conducted mostly in the last two decades. Much of the research in forest genetics, tree improvement and breeding has focused on creating a better understanding of patterns of genetic variation at both inter- and intraspecific levels in major commercial plantation species, which are currently used or potentially valuable in future. Understanding of the genetic structure and identifying outstanding provenances create a scientifically sound basis for *in situ* conservation programmes in sustainable forest management. Major research activities have been undertaken with the following species to understand patterns of genetic variation:

a) Conifers:

- *Cunninghamia lanceolata* (Hong and Wu 1990; Hong and Chen 1994)
- *Larix gmelinii*
- *L. olgensis*
- *L. principis-rupprechtii* (Ma 1992a)
- *Pinus armandii* (Ma 1992b)
- *P. koraiensis* (Niu 1992)
- *P. massoniana* (Wang and Chen 1992; Zhou 2001)
- *P. sylvestris* var. *mongolica* (Chen 1992)
- *P. tabuliformis* (Shen 1992; Xu 1992)
- *P. yunnanensis*
- *Platycladus orientalis* (Wu and Shen 1987; Liang and Chen 1989)

b) Hardwoods:

- *Betula platyphylla*
- *Paulownia* spp. (Xiong *et al.* 1991)
- *Populus cathayana*
- *P. simonii* (Lu *et al.* 2001; Lu and Fu 2002)
- *P. tomentosa* (Zhu Zhiti 1991)
- *Quercus mongolica* (Xia *et al.* 2001)
- *Salix* spp. (Tu *et al.* 1991)
- *Ulmus pumila* (Ma 1993; Anon 2002)

c) Economic trees

- *Eucommia ulmoides*
- *Camellia oleifera*
- *Aleurites fordii*
- *Rhus sylvestris*
- *Castanea mollissima*
- *Juglans regia*
- *Ziziphus jujuba*

d) Rattan and bamboo:

- Rattan (Xu *et al.* 2002)
- *Phyllostachys pubescens*

e) Shrubs: *Hippophae rhamnoides* (Zhao *et al.* 1992)

Biotechnology and GM trees

In recent years, a large proportion of research funding has been allocated to research in molecular genetics and biotechnology to detect genetic diversity and produce genetically modified (GM) trees, for instance, with *Larix* spp., *Pinus massoniana*, *Populus* section *Tacamahaca*, introduced poplars (Li *et al.* 2000), *Quercus mongolica* and *Q. mongolica* var. *liaodongensis* as well as *Paulownia* spp.

GM trees of poplars have been released and used in commercial plantations. Eighty hectares of plantations of GM *Populus nigra*, resistant to leaf-eating insects, were established in 2002. More transgenic research is actively ongoing with species of *Populus*, *Betula* and *Larix* (Su Xiaohua, personal communication 2003).

Resource allocation

There is an imbalance in resource allocation for research in traditional breeding and research in biotechnology; only a few research projects on traditional tree breeding with seed orchards and provenance trials are surviving today as most of the governmental funding is directed to the development of new technologies.

It is noted that GM research and applied tree breeding are separated from each other; instead, they should be closely linked by project planning. Studies on GM trees should be aimed at species that are of important economic value for commercial forestry, other than at species that are biologically easier to work with by genetic engineering. Genetic materials selected by traditional breeding programmes should be made use of in genetic engineering.

Education, training, and research

Education and training on FGR conservation in Chinese universities is normally included in relevant subjects such as forest ecology, forest genetics and tree breeding, while most research projects on natural conservation, e.g. on endangered or threatened species, are assigned to ecological studies and nature reserve management. Short-term training courses and research activities are conducted or coordinated by national research organizations in close cooperation with local forestry authorities and research units. It is possible to operate activities in cooperation with international institutions; in fact, currently there are a number of international programmes going on. For example, FAO, GEF, UNDP and the World Bank, WWF and other foundations have programmes involving biodiversity and management of natural resources.

Identification of national priorities

The criteria and justification for selecting priority species have been discussed at different sessions of the FAO panel of experts on FGR and among many scientists. "Priorities in the sustainable management of forests, including the conservation of forest biological diversity at the levels of ecosystems, species and genetic resources, will depend on value judgments and the relative emphasis on the various roles and functions of forests", as Palmberg-Lerche (2002) pointed out.

It is rather difficult to set up priorities for FGR conservation in China since the Chinese forest flora is very sophisticated and diverse across the country, from the cold temperate to the tropical zone. The essential principles (FAO 1993; FAO, DFSC, IPGRI 2001; Namkoong 1998; Palmberg-Lerche 1998, 2002; Sigaud *et al.* 2000) for setting priority species include:

- Species with important economic value at present for wood production
- Species with important economic value for NTFP
- Species with important economic value in agroforestry systems, i.e. multi-purpose tree species (MPTS)
- Species with important ecological value for land reclamation and other environmental improvement
- Keystone species in forest ecosystems
- Species with obvious potential value or economical importance in the future
- Species whose economic value remains unknown under the present human knowledge

Priority species for FGR conservation programmes in China are listed in Appendix 1. Priority species that are shared with southeastern Asia in their natural range are listed in Appendix 2.

Institutional framework

The National Forestry Administration (formerly the Ministry of Forestry) has the mandate to coordinate national and international programmes on FGR conservation; in addition, the national Bureau of Environment Protection is also involved. Projects are normally approved by the Ministry of Science and Technology with governmental funds. As a research organization, the CAF is responsible for implementing conservation programmes in cooperation with the provincial forestry agencies. Currently, several conservation programmes, both national and international, are being carried out by the academy.

As for legislation on biodiversity and conservation, the Chinese government has issued the following laws or regulations:

- 1) The Forest Law of the People's Republic of China, issued in 1984 and revised in 1998 by the National People's Congress (NPC)
- 2) The Law on Seed of the People's Republic of China (NPC 2000)
- 3) The implementing regulation of the Forest Law (SFA 2000)
- 4) The Law on Combating Desertification (NPC 2002)
- 5) The Regulation on Preventing Forest Fires (State Council 1988)
- 6) Managerial Regulation on Nature Reserves (1994)
- 7) The Regulation on protecting wild plants (State Council 1997)
- 8) The Protection Regulation on New Plant Varieties (State Council 1997)
- 9) Managerial certificate on producing and marketing tree seed (SFA 2003)
- 10) Regulation on land use conversion from marginal agriculture to forestry (State Council 2002)
- 11) Regulation on land use conversion from forested land for other uses
- 12) Biosafety regulation on agricultural GMOs (State Council 2001)
- 13) Regulation on plant quarantine and monitoring of introduced seed, stocks and other genetic materials
- 14) Biosafety regulations on the application of GM trees (in progress)

All these documents reflect, to a certain extent, the essence of international instruments, for example, the CBD and other international conventions and treaties. The detailed information on each law or act can be found at the web page of the NAF, China at http://www.forestry.gov.cn/DB/zcfg/index_bmgz.asp.

Conclusions

This report can be concluded with the following points:

- Indigenous species are identified as priority species for *in situ* FGR conservation programmes that should be integrated into sustainable forest management.
- There are a few introduced species whose *ex situ* conservation should be enhanced in combination with tree breeding programmes.
- Research projects must be carried out with potentially important native species for creating an understanding of genetic variation patterns.
- Conceptual differences between gene conservation of forest trees and of agricultural crops should be better understood and distinguished; with trees more emphasis should be placed on *in situ* conservation.
- Research and development of GM trees needs to be closely linked with traditional breeding programmes.
- For the time being, there are a number of both national and international forestry and environment projects that are related to FGR conservation. It is challenging to find out how to coordinate these programmes in the aspects of gene conservation.
- Table 2 lists species that are naturally distributed in not only China, but also in some other countries in Southeast Asia. Efforts for genetic conservation of these species need to be made through international cooperation between China and neighbouring countries with the coordination of FAO or IPGRI.

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Appendix 1

Priority species for FGR conservation with emphasis on species that are naturally distributed in or introduced to subtropical and tropical China

SPECIES	Presently important for wood production	Presently important for NWFP	Presently important as MPTS	Site reclamation and landscaping	Keystone species	Potential economic value	Presently unknown	Remarks and references
<i>Abies chensiensis</i>					+			Subtropical alpine species
<i>A. delavayi</i>					+			Subtropical alpine species
<i>A. ernestii</i>					+			Subtropical alpine species
<i>A. fabri</i>					+			Subtropical alpine species
<i>A. georgei</i>					+			Subtropical alpine species
<i>Acacia auriculiformis</i>	+							International PVT, exotic
<i>A. catechu</i>		+						Native to China and India
<i>A. confusa</i>				+				Native to China
<i>A. crassicarpa</i>	+							Exotic, PVT, SO
<i>A. mangium</i>	+							International PVT, SO, exotic
<i>Acer buergerianum</i>	+							
<i>A. palmatum</i>	+							
<i>A. truncatum</i>	+							
<i>Albizia chinensis</i>	+			+				
<i>Alnus cremastogyne</i>	+							
<i>A. japonica</i>	+							Pioneer, fast-growing Native to China, Japan, Korea
<i>Alnus nepalensis</i>								
<i>Amentotaxus yunnanensis</i>	+			+				Pioneer, fast-growing Rare, China
<i>Anthocephalus chinensis</i>				+				
<i>Aquilaria</i> spp.		+						Overexploited, poor regeneration, recalcitrant
<i>Artocarpus heterophyllus</i>		+						Tropical fruit
<i>Azadirachta indica</i>		+	+					International PVT initiated
Bamboos	+	+	+	+				(<i>Bambusa</i> spp., <i>Dendrocalamus</i> spp.) PVT, SW China
<i>Betula alnoides</i>	+							
<i>B. luminifera</i>	+							
<i>B. pendula</i>	+							

SPECIES	Presently important for wood production	Presently important for NWFP	Presently important as MPTS	Site reclamation and landscaping	Keystone species	Potential economic value	Presently unknown	Remarks and references
<i>B. platyphylla</i>	+							PVT, China
<i>Camellia oleifera</i>		+	+					Valuable oil, China and Japan
<i>Canarium album</i>				+				Fruit, China
<i>C. pimela</i>	+							Timber
<i>Carya cathayensis</i>	+	+	+					Nut and timber
<i>Castanea henryi</i>	+	+						Timber and nut
<i>C. mollissima</i>		+	+					Nut, many varieties
<i>Castanopsis hystrix</i>		+						Timber and nut
<i>Casuarina equisetifolia</i>				+				Exotic, breeding in China
<i>Cercidiphyllum japonicum</i>					+			(E) China, protected
<i>Chamaecyparis formosensis</i>	+							China
<i>Choerospondias axillaris</i>		+	+					MPTS
<i>Chosenia arbutifolia</i>	+							Monogenus*
<i>Chukrasia tabularis</i>								(E) some provenances
<i>Cinnamomum camphora</i>	+	+	+	+				Overexploited
<i>C. cassia</i>		+						Bark and essential oil
<i>Cryptomeria fortunei</i>	+							Valuable timber, dry site
<i>Cupressus chengiana</i>	+							Valuable timber, dry site
<i>C. duclouxiana</i>	+							Valuable timber
<i>C. funebris</i>	+							China
<i>C. gigantea</i>				+				Timber species for dry exposed sites.
<i>C. torulosa</i>	+							PVT, seed orchard, vegetative propagation
<i>Cunninghamia lanceolata</i>	+							China (E)
<i>Cycas panzhihuaensis</i>				+				China (E)
<i>Dacrydium pierrei</i>	+							Valuable timber
<i>Dalbergia hupeana</i>	+	+						China, valuable timber, becoming rare
<i>D. odorifera</i>	+	+						Valuable timber
<i>D. obtusifolia</i>	+							Yunnan, China
<i>Duabanga grandiflora</i>	+							Dry area and sandy land in temperate country
<i>Elaeagnus angustifolia</i>	+			+				

SPECIES	Presently important for wood production	Presently important for NWFP	Presently important as MPTS	Site reclamation and landscaping	Keystone species	Potential economic value	Presently unknown	Remarks and references
<i>Erythrophleum fordii</i>	+							Valuable timber
<i>Eucalyptus camaldulensis</i>	+							Exotic to China
<i>E. globulus</i>	+							Exotic to China
<i>E. grandis</i>	+							Exotic to China
<i>E. smithii</i>	+							Exotic to China
<i>E. urophylla</i>	+							Exotic to China
<i>Eucommia ulmoides</i>		+	+					Monogenus, endemic to China. (E). Chinese herbal medicine
<i>Firmiana major</i>	+							China
<i>Fokienia hodginsii</i>					+			Monogenus and endemic to China.
<i>Fraxinus mandshurica</i>	+							PVT
<i>Ginkgo biloba</i>		+	+	+				Seed used for human food and for medicine
<i>Gleditsia sinensis</i>			+					MPTS
<i>Glyptostrobus pensilis</i>			+			+		(E)
<i>Gmelina arborea</i>			+					International PVT
<i>G. hainanensis</i>			+					
<i>Haloxylon ammodendron</i>				+				Central Asia. Cold and dry areas
<i>H. persicum</i>								
<i>Hopea hainanensis</i>	+			+				Central Asia. Cold areas
<i>Hovenia dulcis</i>	+	+						Tropical China
<i>Illicium verum</i>		+						China, Japan
<i>Juglans mandshurica</i>	+							China. Medicine and spice
<i>J. regia</i>		+	+					Himalayas. Nuts
<i>J. sigillata</i>		+						Many cultivars in China
<i>Keteleeria davidiana</i>								China
<i>K. pubescens</i>								PVT. Fast-growing, good timber species
<i>Larix griffithiana</i>								Rare. Restricted to Tibet
<i>L. gmelinii</i>	+							PVT, SO
<i>L. leptolepis</i>	+							PVT, SO
<i>L. olgensis (Larix gmelinii var. olgensis)</i>	+							Important for hybridization

SPECIES	Presently important for wood production	Presently important for NWFP	Presently important as MPTS	Site reclamation and landscaping	Keystone species	Potential economic value	Presently unknown	Remarks and references
<i>P. densata</i>	+							Tibet, restricted to two dry valleys
<i>P. Gerardiana</i>	+							
<i>P. fenzliana</i>	+							China, India. (E) some provenances
<i>P. kesiya</i>	+							(E) in parts of the range. Protected in China.
<i>P. koraiensis</i>	+							China, PVT, PGT, SO
<i>P. massoniana</i>	+							China. PVT, PGT, SO
<i>P. sylvestris</i> var. <i>mongolica</i>	+							China. PVT, PGT, SO
<i>P. tabuliformis</i>	+							China. PVT, PGT, SO
<i>P. taiwanensis</i>	+							
<i>P. wallichiana</i> (syn. <i>Pinus griffithii</i>)								Tibet. Vigorous regeneration
<i>P. yunnanensis</i>	+							PVT, PGT, SO
<i>Pistacia chinensis</i>			+					Adapted to calcium soil
<i>P. vera</i>		+						Edible nuts
<i>Platycladus orientalis</i>	+			+				Species for semi-arid areas
<i>Populus deltoides</i>	+							Introduced to China
<i>P. euphratica</i>					+			(E) China. Dry areas
<i>P. simonii</i>	+				+			PVT in China
<i>P. tomentosa</i>	+			+				Endemic to China
<i>Prunus amygdalus</i>		+		+				Nut for arid areas
<i>Pseudolarix amabilis</i>	+							Monogenus, protected in China
<i>Pseudotsaxus chienii</i>								Overexploited
<i>Pterocarpus indicus</i>	+						+	S. China
<i>Pteroceltis tatarinowii</i>		+						Bark fibrous for Chinese painting paper and adapted to calcium soil
<i>Quercus acutissima</i>	+			+				
<i>Q. mongolica</i>	+			+				
<i>Q. variabilis</i>	+			+				
<i>Salix babylonica</i>	+			+				
<i>S. matsudana</i>	+			+				Ornamental

SPECIES	Presently important for wood production	Presently important for NWFP	Presently important as MPTS	Site reclamation and landscaping	Keystone species	Potential economic value	Presently unknown	Remarks and references
<i>S. mongolica</i>	+			+				China, MPTS
<i>Sapium sebiferum</i>		+	+					
<i>Sassafra tzumu</i>	+							
<i>Schima superba</i>	+							
<i>Sinowilsonia xylocarpa</i>							+	Fire protection Monogenus, endemic to China
<i>Syzygium jambos</i>								
<i>Taiwania cryptomerioides</i>				+				Fruit tree in S. China (E), Taiwan, China
<i>T. flousiana</i>						+		(E), China, PVT
<i>Taxus cuspidata</i>		+				+		Overexploited for medical extracts
<i>T. yunnanensis</i>		+						Overexploited for medical extracts
<i>Tectona grandis</i>	+							Exotic to China
<i>Thuja sutchuenensis</i>	+			+				China
<i>Tilia amurensis</i>	+							
<i>Toona microcarpa</i>	+	+	+					MPTS
<i>T. sinensis</i>	+	+	+					MPTS
<i>Torreya grandis</i>				+				Nut, S. China
<i>Tsuga chinensis</i>								
<i>Ulmus parviflora</i>				+				China, Ornamental
<i>U. pumila</i>	+			+				
<i>Vatica guangxiensis</i>								
<i>V. hainanensis</i>								China, Tropical rain forest
<i>Xanthoceras sorbifolia</i>	+			+				China, Tropical rain forest
<i>Zanthoxylum simulans</i>	+			+				For oil in arid area
<i>Zelkova schneideriana</i>								
<i>Zenia insignis</i>				+				Breeding in Japan In karst mountainous area**
<i>Ziziphus jujuba</i>								

PVT = Provenance trial; PGT = Progeny trial; SO = Seed orchard; E = Endemic to China; MPTS = Multi-purpose tree species

* Monogenus = a genus that includes one species only

** Karst mountainous areas are typical particularly in southern China; the topography is featured with limestone mountains or outcrops and shallow soils that make agriculture or tree growing very difficult. Only a small number of tree species are adapted to the environment.

Appendix 2

Priority species for FGR conservation, which are shared in common distribution among China and some other countries in SE Asia

SPECIES	Presently important for wood production	Presently important for NWFP	Presently important as MPTS	Site reclamation and landscaping	Keystone species	Potential economic value	Presently unknown	Remarks and references
<i>Acacia auriculiformis</i>	+							International PVT, exotic
<i>A. catechu</i>		+						China and India
<i>A. crassicaarpa</i>	+							Exotic, PVT, SO
<i>A. mangium</i>	+							International PVT, SO, exotic
<i>Albizia chinensis</i>	+			+				
<i>Alnus cremastogyne</i>	+							Pioneer, fast growing
<i>A. nepalensis</i>	+							Pioneer, fast growing
<i>Amentotaxus yunnanensis</i>				+				Rare, China
<i>Anthocephalus chinensis</i>				+				
<i>Aquilaria</i> spp.		+						Overexploited, poor regeneration, recalcitrant
<i>Artocarpus heterophyllus</i>		+						Tropical fruit
<i>Azadirachta indica</i>		+	+					International PVT initiated
Bamboo	+	+		+				(<i>Bambusa</i> , <i>Dendrocalamus</i> spp.)
<i>Betula alnoides</i>	+							PVT, SW China
<i>Canarium album</i>		+						Fruit, China
<i>C. pimela</i>	+			+				Timber
<i>Casuarina equisetifolia</i>				+				Exotic, breeding in China
<i>Choerospondias axillaris</i>		+						MPTS, China and India
<i>Chukrasia tabularis</i>								(E) some provenances
<i>Dacrydium pierrei</i>	+							China (E)
<i>Dalbergia hupeana</i>	+	+						Valuable timber
<i>D. odorifera</i>	+	+						China, valuable timber, becoming rare
<i>Duabanga grandiflora</i>				+				Yunnan in China and India, Malaysia

SPECIES	Presently important for wood production	Presently important for NWFP	Presently important as MPTS	Site reclamation and landscaping	Keystone species	Potential economic value	Presently unknown	Remarks and references
<i>Erythrophleum fordii</i>	+							Valuable timber
<i>Eucalyptus camaldulensis</i>	+							Exotic to China, important plantation species
<i>E. grandis</i>	+							Exotic to China, important plantation species
<i>E. urophylla</i>	+							Exotic to China, important plantation species
<i>Gmelina arborea</i>			+					Int. PVT
<i>G. hainanensis</i>			+					Tropical China
<i>Hopea hainanensis</i>	+							Widely distributed in China
<i>Melia azedarach</i>	+		+					Rare, very valuable timber, Yunnan
<i>Mesua ferrea</i>	+							Oversampled
<i>Ormosia henryi</i>	+							China
<i>Ormosia macrophylla</i>	+							
<i>Parashorea chinensis</i>	+							
var. <i>kwangsiensis</i>								
<i>Paulownia elongata</i>	+		+					Work in progress. China
<i>Pinus caribaea</i> var. <i>bahamensis</i>	+							PVT, PGT in China
<i>P. caribaea</i> var. <i>caribaea</i>	+							PVT, PGT in China
<i>P. wallichiana</i> (syn. <i>Pinus griffithii</i>)								Tibet. Vigorous regeneration
<i>Pinus yunnanensis</i>	+							PVT, PGT, SO
<i>Pterocarpus indicus</i>	+							S China
<i>Schima superba</i>	+							Fire resistant
<i>Syzygium jambos</i>		+	+	+				Fruit tree in S. China
<i>Tectona grandis</i>	+							Exotic to China
<i>Toona microcarpa</i>	+	+	+					MPTS
<i>Toona sinensis</i>	+	+	+					MPTS
<i>Vatica astrotricha</i>	+	+	+					China, Tropical rain forest
<i>Zenia insignis</i>			+	+				In karst mountainous area

PVT = Provenance trial; PGT = Progeny trial; SO = Seed orchard; E = Endemic to China; MPTS = Multi-purpose tree species