Introduction on Forestry in China

Prof. LIU Yong

(Beijing Forestry University, Beijing, China)

OUTLINE

1. Natural condition for the development of forestry in China
2. Development of China’s forestry
3. Forest resources in China
4. Forest researches
5. Higher forest education

1. Natural condition for the development of forestry in China

Area of 9.6 million km^2
North to south 5500km
East to west 5200km

Temperate cool zones

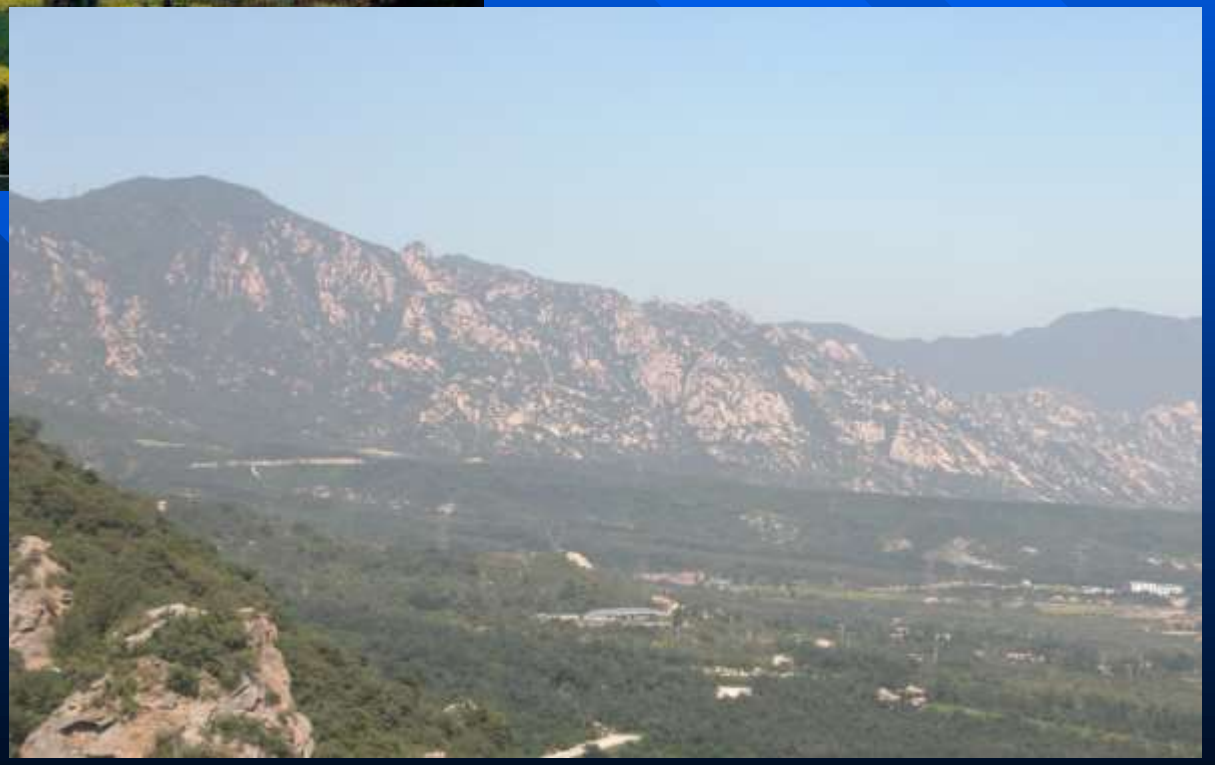
Temperate warm zones

Sub-tropic zones

Tropic zones

Mt. Everest Mountains Plain Pacific Ocean

Geographic conditions



Forest types

coniferous forests

coniferous and deciduous mixed forests

subtropical moist evergreen forests

tropical monsoon rain forests

tropical rain forests

8000 tree species, arbor species 2000

Some native species to China:

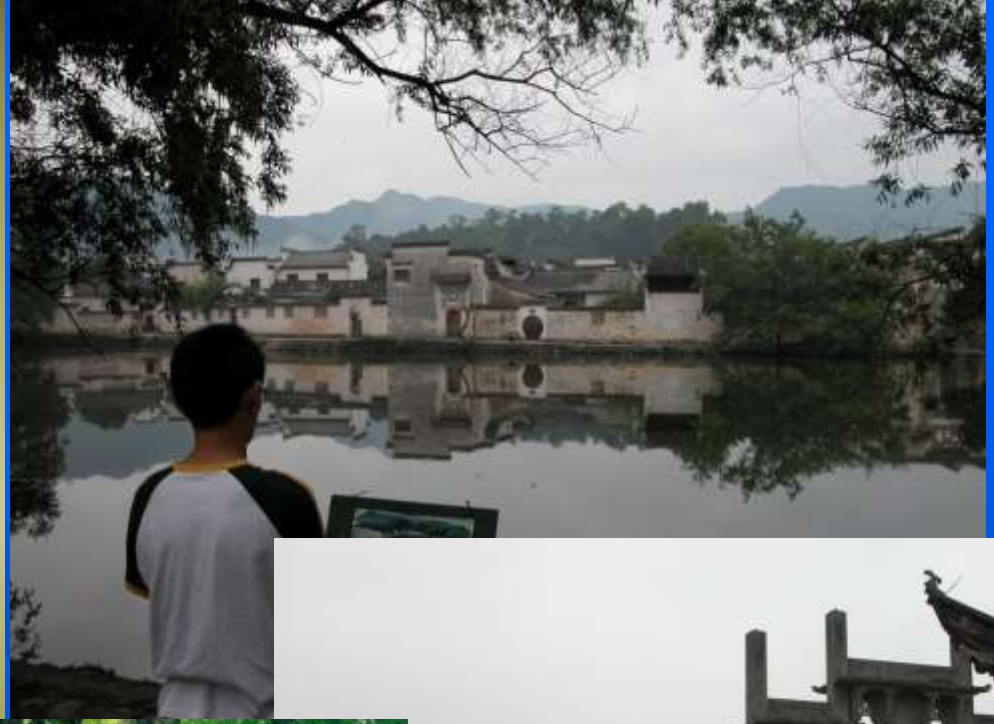
- *Metasequoia glyptostrobiodes* 水杉
- *Cathaya argyrophylla* 银杉
- *Pseudolarix amabilis* 金钱松
- *Glyptostrobus pensilis* 水松
- *Taiwania cryptomerioides* 台湾杉
- *Fokienia hodginsii* 福建柏
- *Keteleeria fortunei* 油杉
- *Cuninghamia lanceolata* 杉木

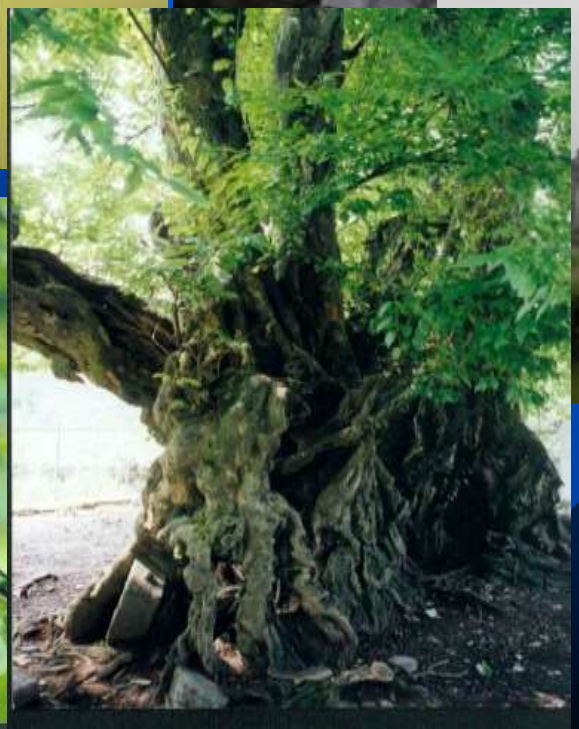
Precious wood species:

- *Cinnamomum camphora*
- *Pinus koraiensis*
- *Phoebe zhennan*
- *Fraxinus mandshurica*
- *Tilia* spp.

Important economic (non-timber) tree species:

Castanea mollissima
Juglans regia
Camellia oleifera
Vernicia fordii
Sapium sebiferum
Eucommia ulmoides etc.





Pteroceltis tatarinowii

构树（*Broussonetia papyrifera*）

However, because of long history of deforestation, China's forest resources suffered severed damage.

1949, forest are 83million ha, coverage 8.6%.

2. Development of China's Forestry

After founding of the P.R. of China in 1949

Forest administrative organizations

- National level (State Forestry Administrative, SFA)
- Province level (Department of Forestry)
- Prefecture level (Forestry Bureau)
- County level (Forestry Bureau)
- Township level (Forestry Station)

“Forest Law of the People’s Republic of China” was promulgated in 1979.

Forest types in forest law of China (按森林功能或培育目的分类)

1) Protection forest 防护林
2) Timber forest 用材林
3) Economic (non-timber) forest 经济林, 油料林，特种经济林，果树林,其他经济林
4) Firewood forest 薪碳林
5) Special forest 特种用途林：国防林，实验林，母树林，环境保护林，风景林，名胜古迹和革命圣地林，自然保护区林
6) Four side planting 四旁植树 路、水、村、宅

Protection forest

Timber forest

Eucalyptus

Poplars

Apple

Eucommia ulmoides

Economic forest
(non-timber forest)

经济林, 油料林， 特种经济林， 果树林,其他经济林

Lycium chinense

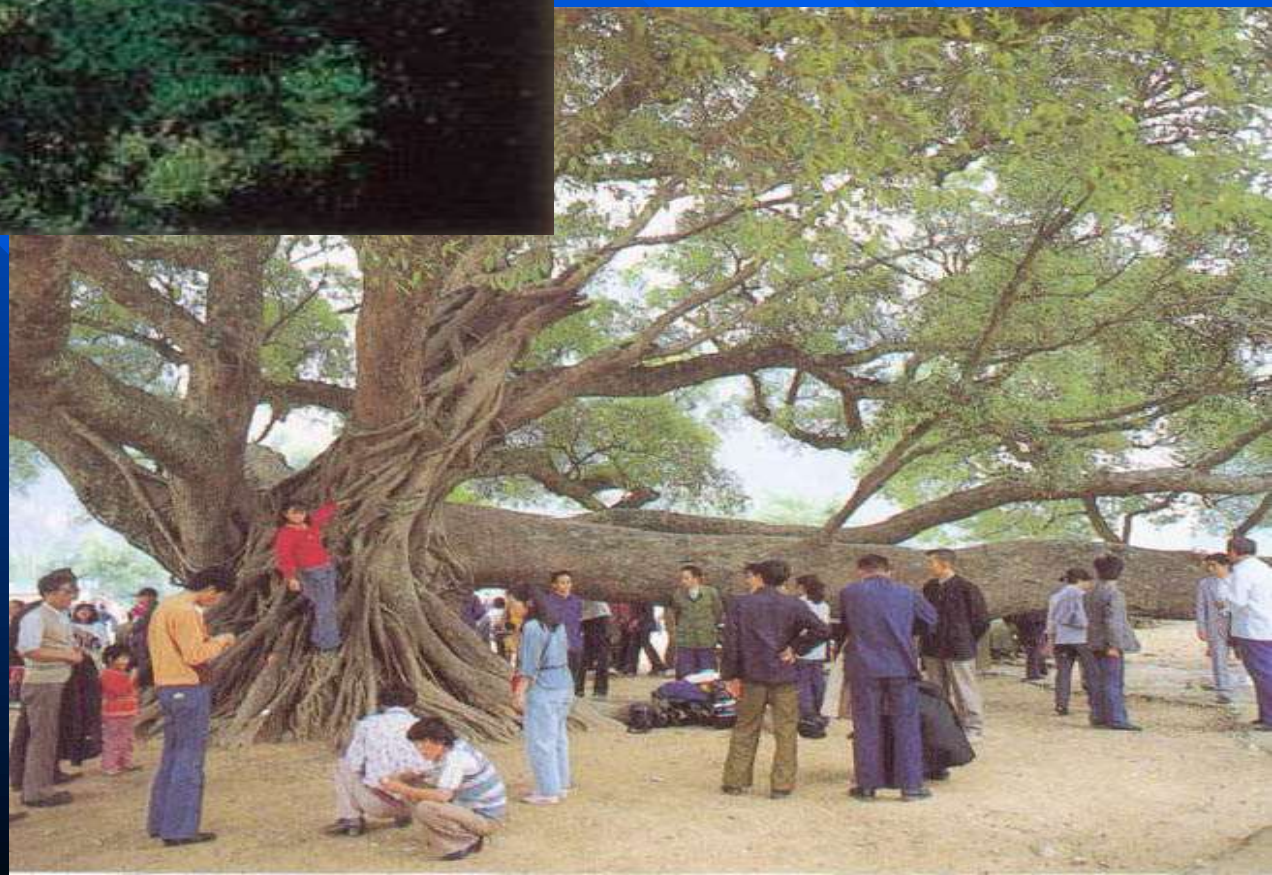
Firewood forest

Millettia spp.

Jatropha curcas

Special forest

Pinus bungeana



国防林，实验林，母树林，环境保护林，风景林，名胜古迹和革命圣地林，自然保护区林。

Four side planting

路、水、村、宅

"Arbor Day", March 12th (since 1979).
Large scale afforestation activities

- **Voluntary Afforestation Campaign** 1981, planted 25 billion trees (1981-1996)

Airplane seeding: *Pinus tabulaeformis* in northern China
Pinus massoniana in Southern China
Pinus yunnanensis in Southwest of China.

- **Three-North Protection Forest Program**

1978-present, shelterbelt in the northeast, north and northwest China.

China's Green Great Wall, stretches across 13 provinces

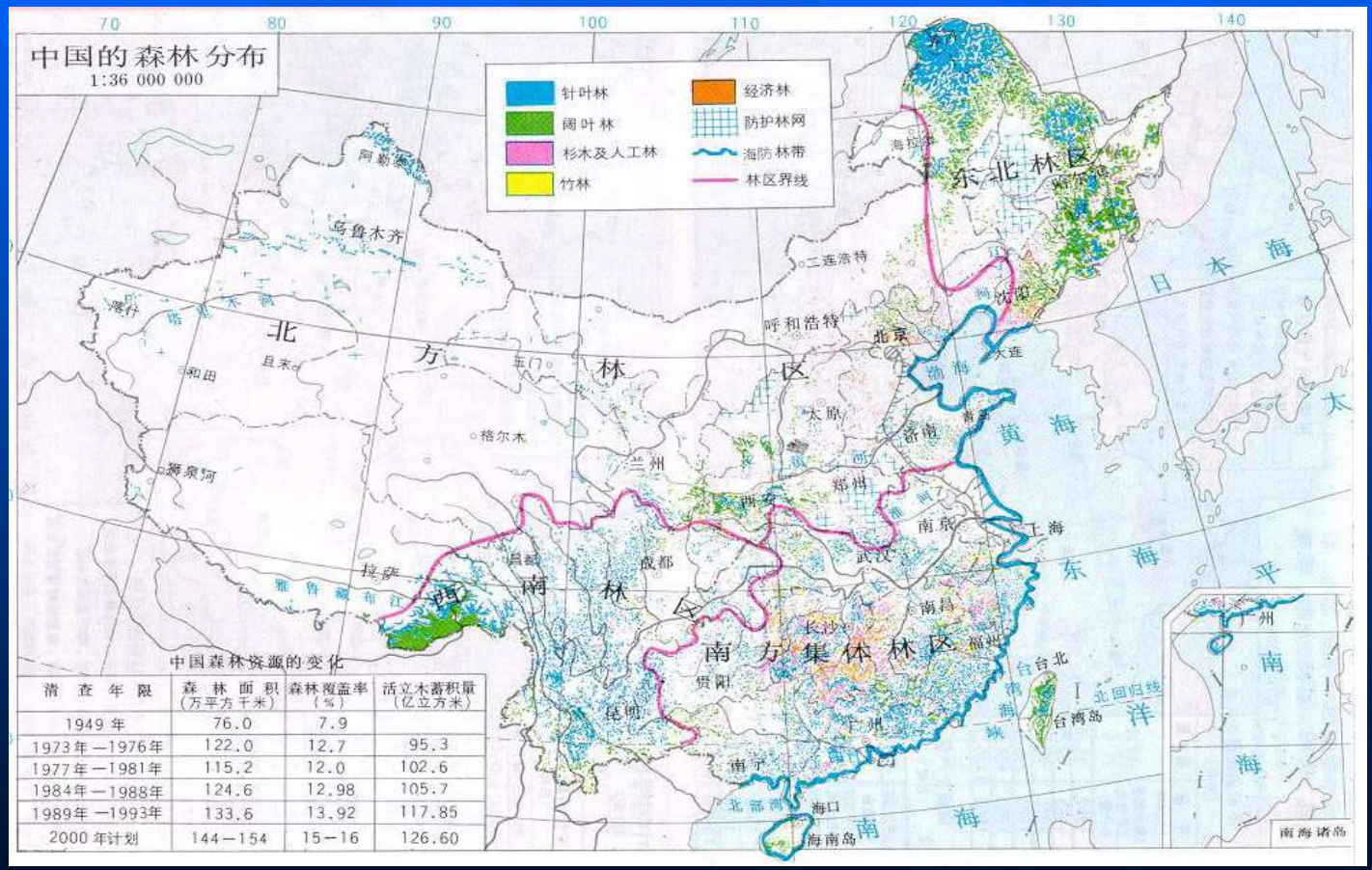
- **The Coastal Windbreak Project**

Total 18,000 km

- **The shelterbelt network on the middle and upper reaches of the Yangtze River**

  By 1997, a total investment of 600 million Yuan

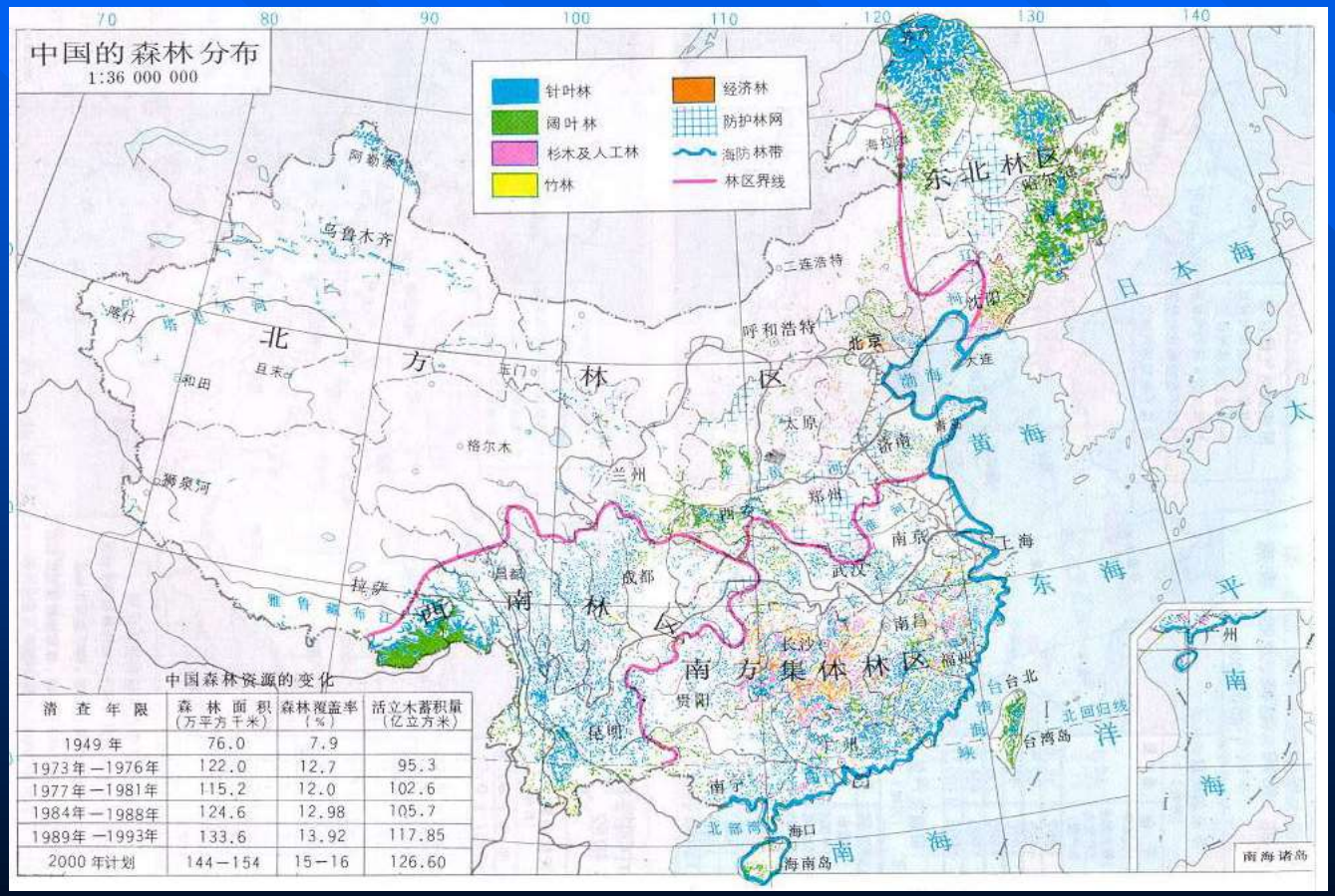
  4.7 million hectares of forest had been built.



中国森林资源的变化

清查年限	森林面积（万平方千米）	森林覆盖率（%）	活立木蓄积量（亿立方米）
1949年	76.0	7.9	
1973年—1976年	122.0	12.7	95.3
1977年—1981年	115.2	12.0	102.6
1984年—1988年	124.6	12.98	105.7
1989年—1993年	133.6	13.92	117.85
2000年计划	144—154	15—16	126.60

In 1996, the Yellow River Middle Reaches Shelterbelt, the Huaihe River and Taihu Lake Valley Shelterbelt, the Pearl River Valley Shelterbelt and the Liaohe River Valley Shelterbelt.



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At the end of 1996, these 10 key forest ecological projects in the areas frequently hit by flood, drought, wind and sand were under full wing of construction.

They cover more than 60 percent of China's total land and the framework of China's forest ecological system had been formed.

12 provinces eliminate barren mountains;
Artificial afforestation areas 33.3 million hectares

Catastrophic floods in Yangtze River in south and Songhua River in north of China in 1998.

Therefore more great projects were implemented since 1998.

Natural Forest Protection Program (NFPP):

1998-present

724 counties of 17 provinces, in the upper reaches of the Yangtze River, upper and middle reaches of the Yellow River, Northeast China, Inner Mongolia, Hainan, Xinjiang, and other key state-owned forest zones.

Prohibiting and alleviating commercial cutting to help the forests with rehabilitation and sustained growth.

Up to 2009, the project has protected forests as much as 12.08 million hectares and added 5.85 million hectares forests. More than 680,000 workers have been allocated to other jobs.

Converting Crop Land to Forests Project:

1999-present.
1,897 county-level agencies in 25 provinces, is designed to address water loss and soil erosion.

By 2009, a total area of 21.53 million hectares of forest had been built, that comprises 9.06 million hectares of farm land have been converted to forests, 14.14 million hectares of barren hills and wasted lands have been planted with trees and 1.93 million hectares of forests have been well protected by mountain closure. By the end of 2010, the central government had invested in this project with 169 billion Yuan

Fast-growing and High-yielding Forest Project:

2002-present

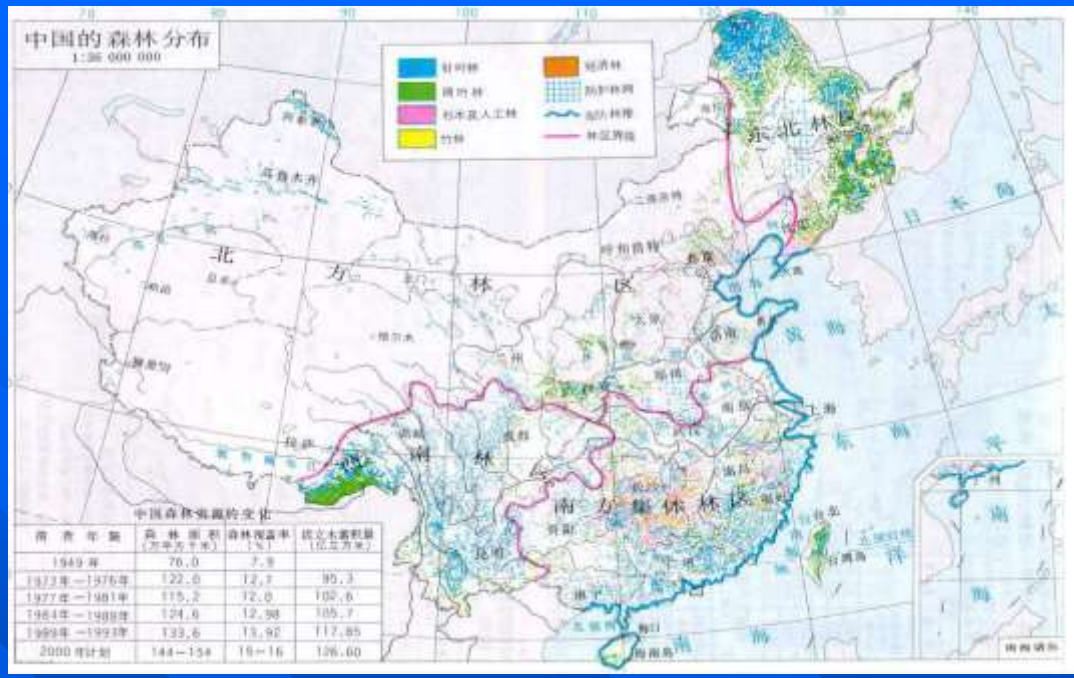
Covers 1000 counties in 18 provinces

It is focused on addressing imbalance between supply and demand of timber in domestic market.

Up to 2009, 2 million hectares of fast-growing & high-yielding forests have been planted

The shelterbelt projects:

Since 1978



Three-North Shelterbelt Program
Yangtze River Conservation Forest Program
Zhujiang River Conservation Forest Program
Coast Protection Forest Program
Plain Afforestation Program
Taihang Mountaion Afforestation Program
Beijing-Tianjin Sandstorm-control Program.

3. China's Forest Resources

3.1 National Forest Resource State

According to the recently released Eighth National Forest Resource Inventory (2009-2013) result:

China's forests cover 208 million hectares
21.63% of the total land area.

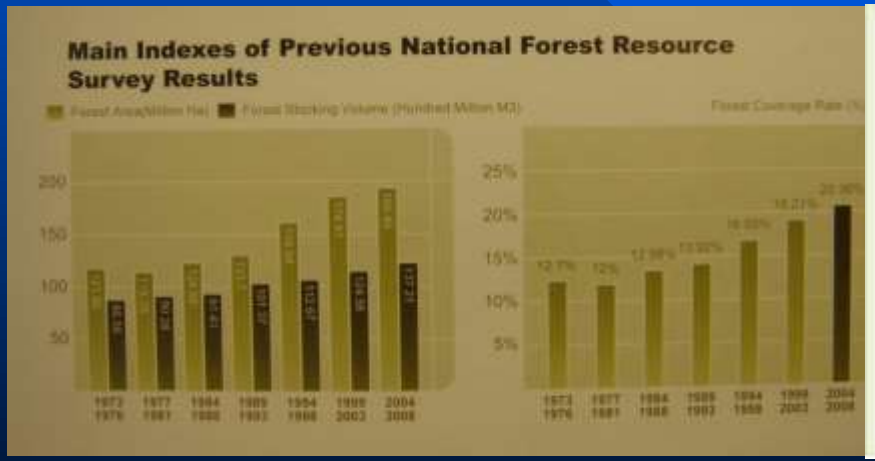
Growing stock is 15.24 billion m^3

Natural forest 121.84 million hectares,

Forest plantation 69.33 million hectares

3.2 The dynamic changes of Chinese Forest Resource

- Continued increase of forest area and growing stock.
  The forest area increased by 12.23 million hectares.
  The forest cover increased from 20.36 % to 21.63%.
  The total forest volume has risen from 13.72 billion m^3 to 15.14 billion m^3, increased 1.42 billion m^3.



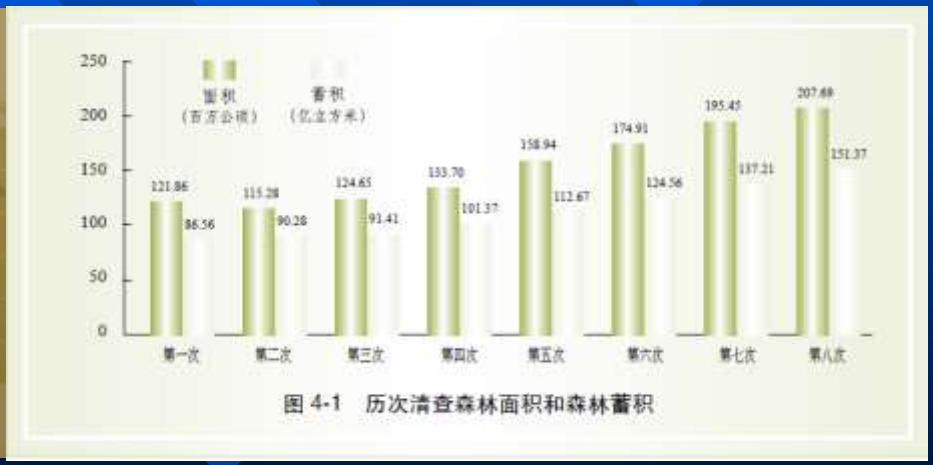


图 4-1 历次清查森林面积和森林蓄积

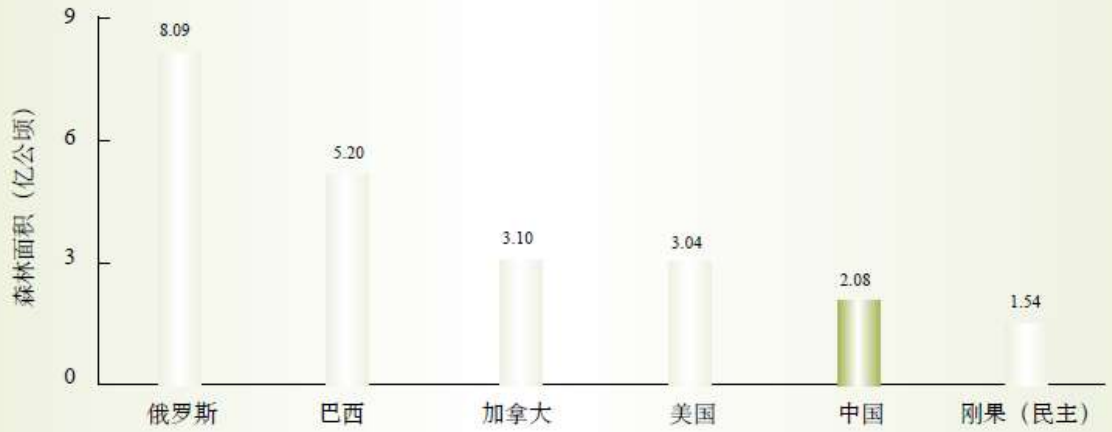


图 4-2　森林面积排名前 6 位的国家

图 4-3　森林蓄积排名前 6 位的国家

- Natural forest resource increased significantly

The area of natural forest increased from 119.69 million ha to 121.84 million ha，increased 2.15 million ha. The standing volume increased from 11.4 billion m^3 to 12.3 billion m^3，increased 894 million m^3.

- Plantation resources are increasing.

  The plantation area increased from 61.69 million ha to 69.33 million ha. There has been a net increase of 7.64 million hectares in plantation area and the growing stock increased by 522 million m^3.

• Harvests from plantation increased.

The volume of annual net growth has continually exceeded cuttings. The Harvest from natural forest was decreasing, while plantation harvest increased, which accounted for 46% of the total harvest and rose 26%.

• Improvement of forest quality and enhancement of forest ecosystem function.

The average arbor growing stock per hectare was 89.79 m^3, has increased by 3.91 m^3, The proportion of mixed forest rose by 2%. The structure of forest age distribution and the tree species mix has improved.

Carbon storage of China's forest vegetation is 8.4 billion tons, the forest ecosystems conserve 580.7 billion m^3 of water, stabilizes the soil 8.2 billion tons, keeps 430 million tons of fertilizer in place annually, absorbs 38 million tones of air pollutant, holds down 5.8 billion tons dust.

• Proportion of forest managed by individuals significant rose. The non-public forest was 32.08% of the total plantation area increasing by 11.39%. Among the existing plantation and immature planted forests, 59.21% and 68.51% belong to the non-public.

4. Overview of Forestry Research Development

The forest research institutes in China include:
The Chinese Academy of Forest Science
Forest research institute in province and prefecture level
Forestry universities and agriculture universities.

4.1 Tree genetic breeding, species introduction and acclimation.

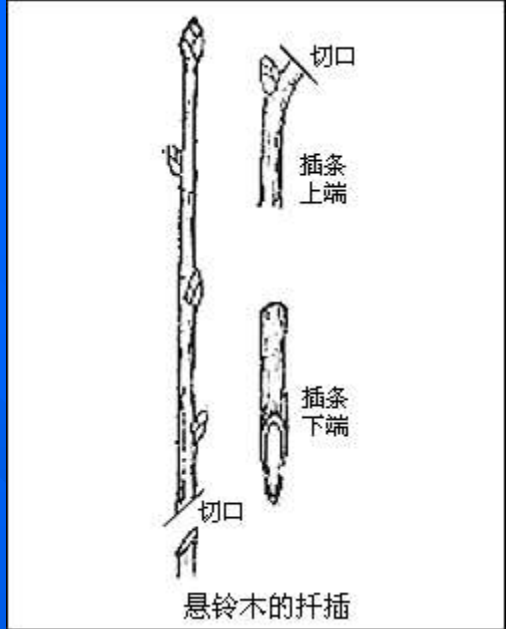
First generation seed orchards for several main timber species such as *Cunninghamia lanceolata*, *Pinus massoniana*, *P. elliottii*, *P. taeda*, *Taxoduim ascendens*, *P. armandii*, *P. yunnanensis*, *P. koraiensis*, *P. sylvestris L. var. mongolica Litv.*, *Picea asperata*, *and* 5 species of *Larix* spp.

Second and third generation seed orchards

Cutting orchard 采穗圃：

Clone of superior trees

Products: cuttings



New breeding techniques of hybridization and chromosome double have made great progress. New varieties such as *Populus simonii* Carr. × P. *nigra* L.

Triploid *Populus tomentosa*


三倍体毛白杨叶片 Leaf of 6-month-old 3X Chinese white poplar

Introduced species:

Robinia pseudoacacia

Pinus elliottii, *P. taeda*

4.2 Studies on afforestation techniques

Site index

A given species, at certain age, average tree height of several superior trees

$$SI = f(x_1, x_2, \ldots\ldots x_n, z_1, z_2 \ldots\ldots z_n)$$

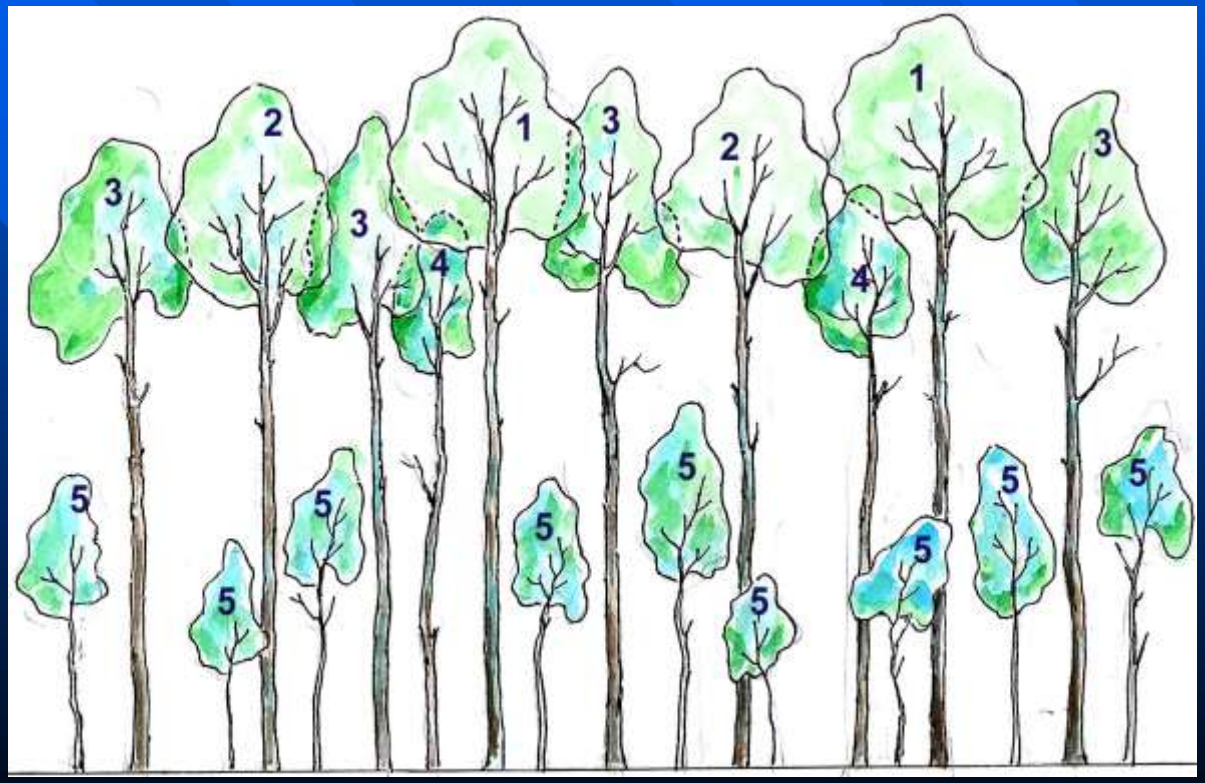
SI: Tree height

x_1: elevation

x_2: slope direction

x_3: soil depth

……



25 year old Chinese pine forest (25年生油松人工林)

$Ht = 2.109+0.6773SF+0.3917EL+0.4040ASP$

复相关系数 $R=0.8495$

偏相关系数 $R'_{SP}=0.6567$ $R'_{EL}=0.4378$

$R'_{ASP}=0.3354$

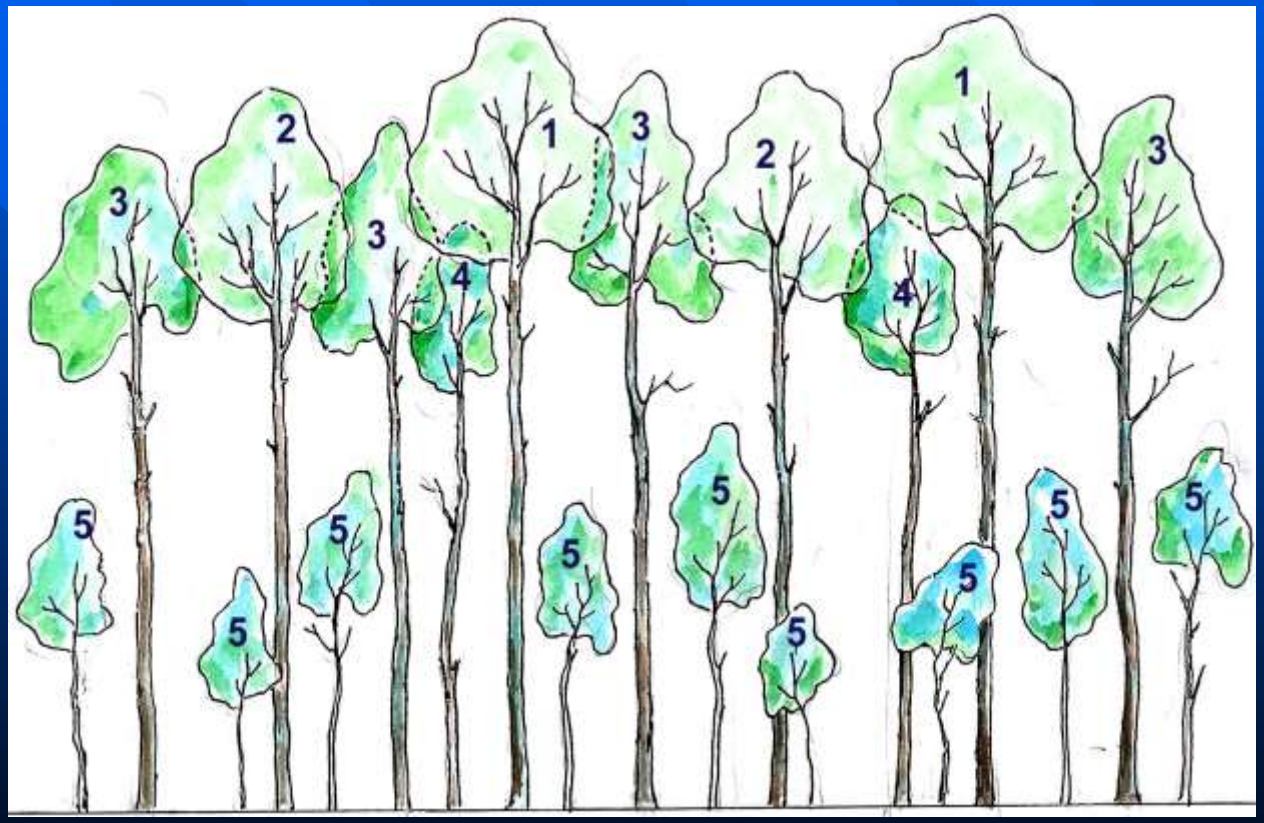
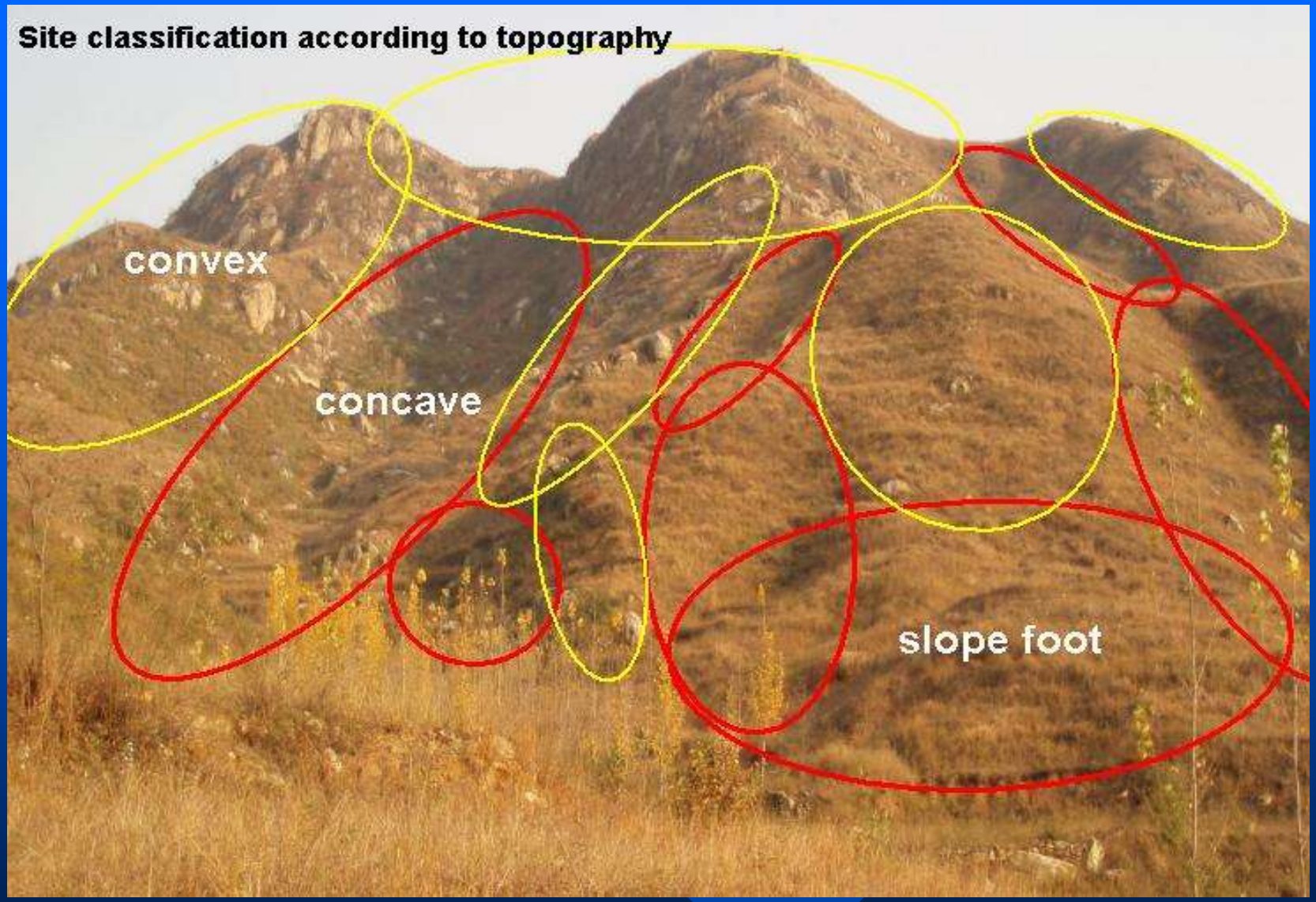


表 1-2　京西山区油松上层高的生长预测表　　m

海拔 (m)	<400			400~800			800~1 200			1 200~1 600		
	坡向											
土肥级	SW	E	N	SW	E	N	SW	E	N	SW	E	N
Ⅰ (>81cm)	5.61	6.01	6.42	6.00	6.41	6.81	6.39	6.80	7.20	6.78	7.19	7.59
Ⅱ (51~80cm)	4.93	5.34	5.74	5.32	5.73	6.13	5.72	6.12	6.52	6.11	6.51	6.92
Ⅲ (31~50cm)	4.26	4.66	5.06	4.65	5.05	5.45	5.04	5.44	5.85	5.43	5.83	6.42
Ⅳ (<30cm)	3.58	3.98	4.39	3.99	4.37	4.78	4.36	4.77	5.17	4.75	5.16	5.56



Site conditions are different even in a small place!

How do we do in practice when facing a large area?

Site classification

Site type area　　Site types　　Slope　　Soil depth

表 1-8　长白山北部立地区立地分类表

立地类型区	坡度类型	坡向	土层
低山丘陵立地类型区	谷地类型组		厚层土
	缓坡类型组		厚层土
			中层土
			薄层土
	斜坡类型组	阴坡	厚层土
		阴坡	中层土
		阴坡	薄层土
		阳坡	厚层土
		阳坡	中层土
		阳坡	薄层土
	陡坡类型组		薄层土

Elevation Slope Soil type and depth

例 2：冀北山地立地条件类型的划分（表 1-9）

表 1-9 冀北山地立地条件类型表

编号	海拔高度（m）	坡向	土壤种类及土层厚度（m）	备注
1	>800	阴坡半阴坡	褐色土，棕色森林土，>50	
2	>800	阴坡半阴坡	褐色土，棕色森林土，25~50	
3	>800	阳坡半阳坡	褐色土，棕色森林土，>50	
4	>800	阳坡半阳坡	褐色土，棕色森林土，25~50	
5	>800	不分	褐色土，棕色森林土，>25	土层下为疏松母质
6	<800	阴坡半阴坡	褐色土，棕色森林土，>50	或含 70% 以上石砾
7	<800	阴坡半阴坡	褐色土，棕色森林土，25~50	
8	<800	阳坡半阳坡	褐色土，棕色森林土，>50	
9	<800	阳坡半阳坡	褐色土，棕色森林土，25~50	
10	<800	不分	褐色土，棕色森林土，>25	土层下为疏松母质 或含 70% 以上石砾
11	不分	不分	<25 及裸岩地	土层下为大块岩石

Site Classification System in China
森林立地分类系统

1.《中国森林立地分类系统》詹昭宁等人

Forest Site Classification System in China, Zhan Zhaoning, et al.

2.《中国森林立地》张万儒，蒋有绪等人

Forest Site in China, Zhang Wanru, Jiang Youxu, et al.

Seed storage methods

干藏(dry storage)

Dry condition, low temperature

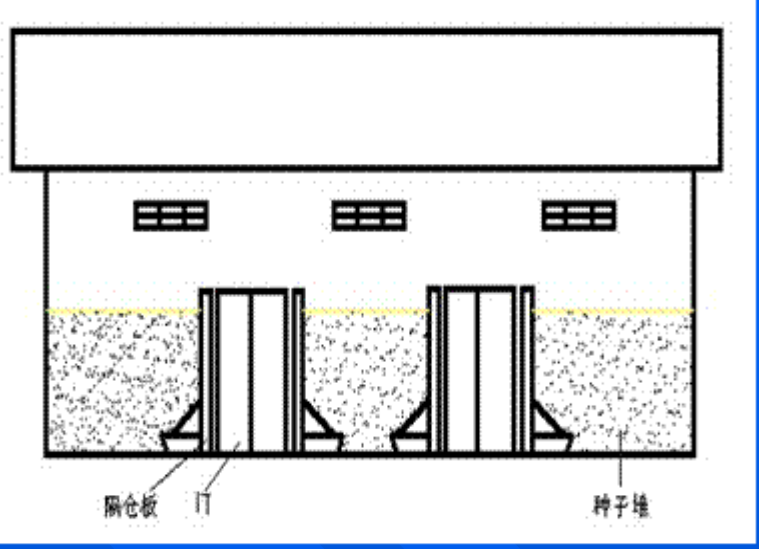
普通干藏（conventional dry storage）

short time storage

密封干藏（sealed dry storage）

long time storage

cold storage



超干燥贮藏法
Ultra-dry storage

Optimal water content

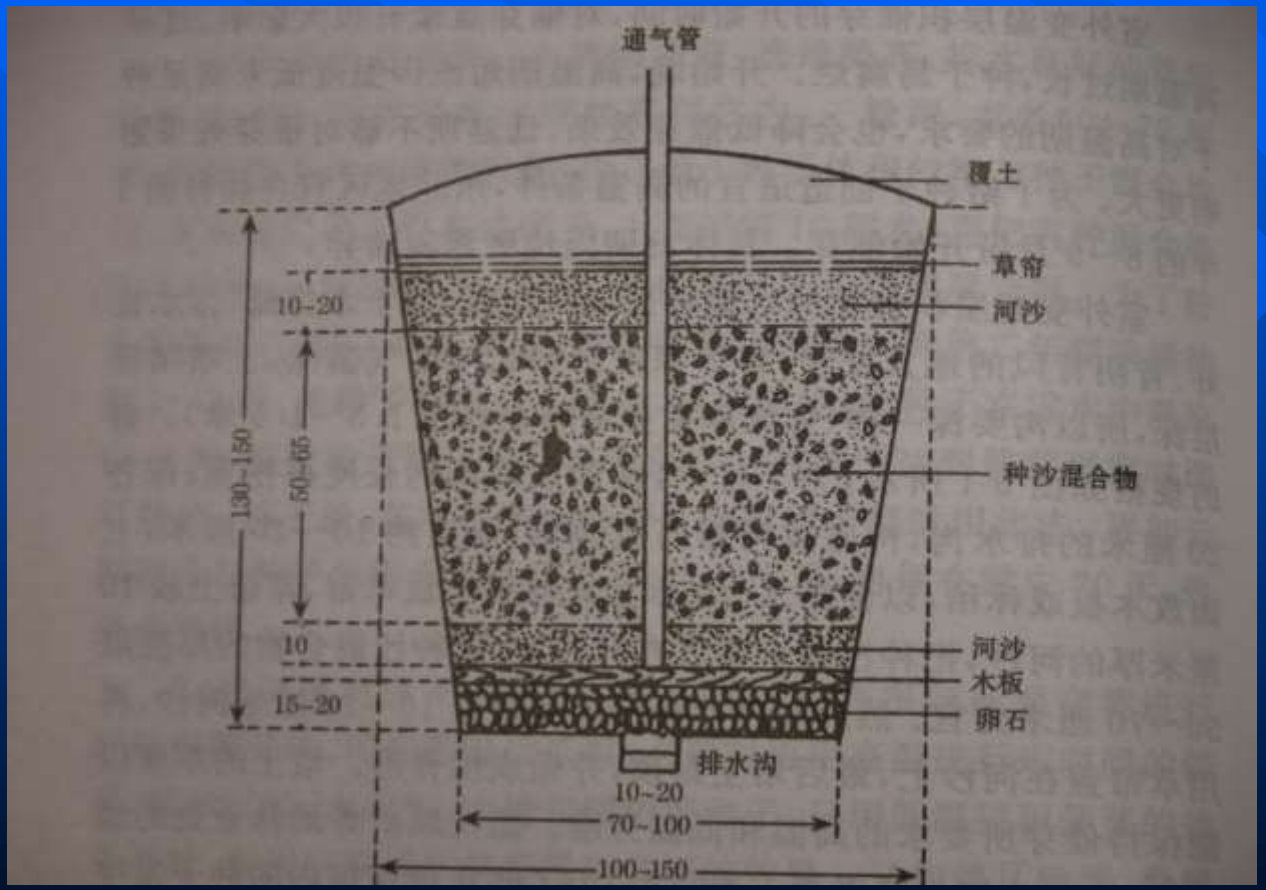
红松(*Pinus koraiensis*), 4%
柳杉（*Crytomeria fortunei*）, 4%
福建柏（*Fokienia nodginsii*）, 5%
杉木*(Cunninghamia lanceolata)*, 4%-5%
马尾松*(P. massoniana)*, 5%
木麻黄（*Casuarina equisetifolia*）, 1%
刺槐（*Robinia pseudoacacia*）, 4.3%-4.8%
小叶锦鸡儿（*Caragana microphylla*）, 4.6%
银合欢（*Leucaena leucocephala*）, 3.95%
华山松（*P. armandii*) 4.39%
白皮松（*P. bungeana*) 3.5%

Silica gel

湿藏（wet storage）

Condition: humid, low temperature, ventilation. Suit for seeds with high safety moisture content

坑藏法(pit storage)



Seed dormancy and seed stratification

种子休眠及催芽

浅休眠(light dormancy)

如杨(*Populus spp*)、榆(*Ulmus pumila*)
桑(*Morus alba*)、栎类(*Qucus spp*)
油松(*Pinus tafulaeformis*)、落叶松(*Larix spp*)
樟子松(*P. sylvestris L. var. mongolica Litv*)
马尾松(*P. massoniana*)、湿地松(*P. elliottii*)
云杉(*Picea asperata (Spruce)*)、
杉木(*Cunninghamia lanceolata*)

深休眠(deep dormancy)

红松(*Pinus koraiensis*)、白皮松(*P. bungeana*)
杜松(*Juniperus rigida*)、椴树(Tilia *spp*.)
山桃(Prunus davidiana)、黄栌(*Cotinus coggygria*)
水曲柳、黄菠萝、槭树、漆树、皂荚、山楂、山丁子

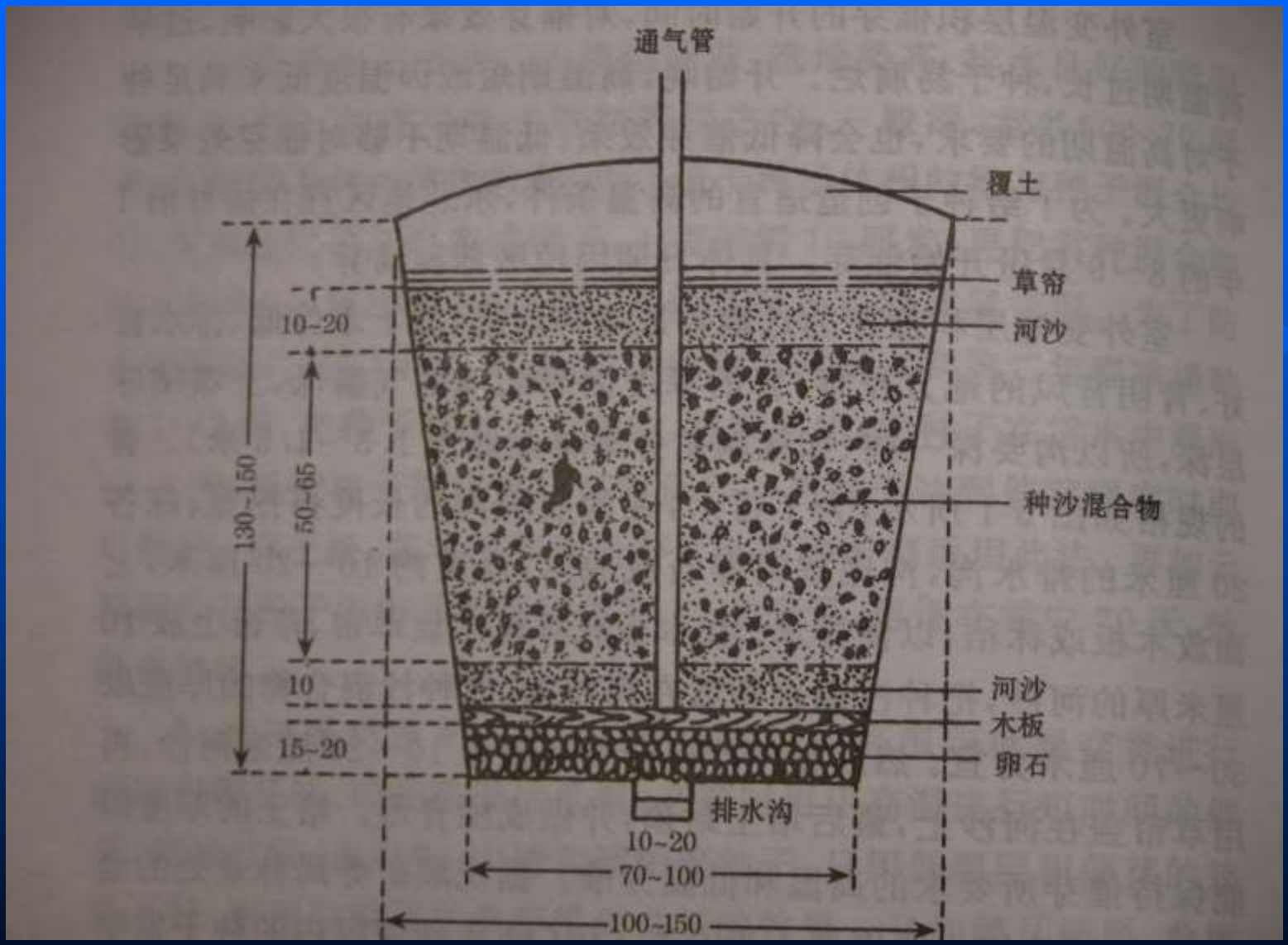
种子休眠的原因大体上可分为两类：
Reasons for deep dormancy

（1）胚以外的原因造成(reason out of embryo)
Seed coat hard and impermeable

（2）胚本身的原因造成的(embryo problem)
胚未发育完全
* Embryo do not fully developed
胚已成熟，代谢存在某些障碍而不得萌发
* Inhibitors: ABA
Promoters: GA_S

（3）综合原因（Integrated reason）

层积催芽（seed stratification）



红松 (*Pinus koraiensis*)	180-300 D
白皮松 (*P. bungeana*)	120-130
落叶松 (*Larix spp*)	50-90
樟子松 (*P. sylvestris L. var. mongolica*)	40-60
油松 (*P. tafulaeformis*), 马尾松(*P. massoniana*)	
湿地松 (*P. elliottii*), 火炬松（*P. taeda*）	30-60
白蜡 (*Fraxinus rhynchophylla)*	80
栾树 (*Koelreuteria paniculata)*	100-120
黄栌 (*Cotinus Coggygria)*	80-120
杜仲 (*Eucommia ulmoides*)	40-60

种子综合处理技术(integrated method)

红松 ***Pinus koraiensis***

Sulphiuric acid 90 min 浓硫酸腐蚀种皮;
200ppm CTK+500ppm GA 4 days 浸泡;
15% PEG 2 days 浸泡;
300ppm Rare-earth nitric acid 1 day 硝酸稀土浸泡;
Cold stratification 2 month 低温沙藏;
Germination rate 60～80% 发芽率

白皮松 ***Pinus bungeana***

200ppm GA_3 ＋20% PEG, 48 hours 浸泡;
Soaking in water 48 hours 常温水中浸泡48小时;
35%PEG, 48 hours 浸泡

播种苗培育 (1-0 seedling production)

播种苗的年生长规律 (Growth pattern)

1、出苗期 (emergence period)
seed ---- cotyledon
2、幼苗期 (young seedling period）
true needle ---- fast growing
3、速生期 (fast growing period)
fast growing ---- H growth slow
4、木质化期 (hardiness period)
slow growth ---- dormancy

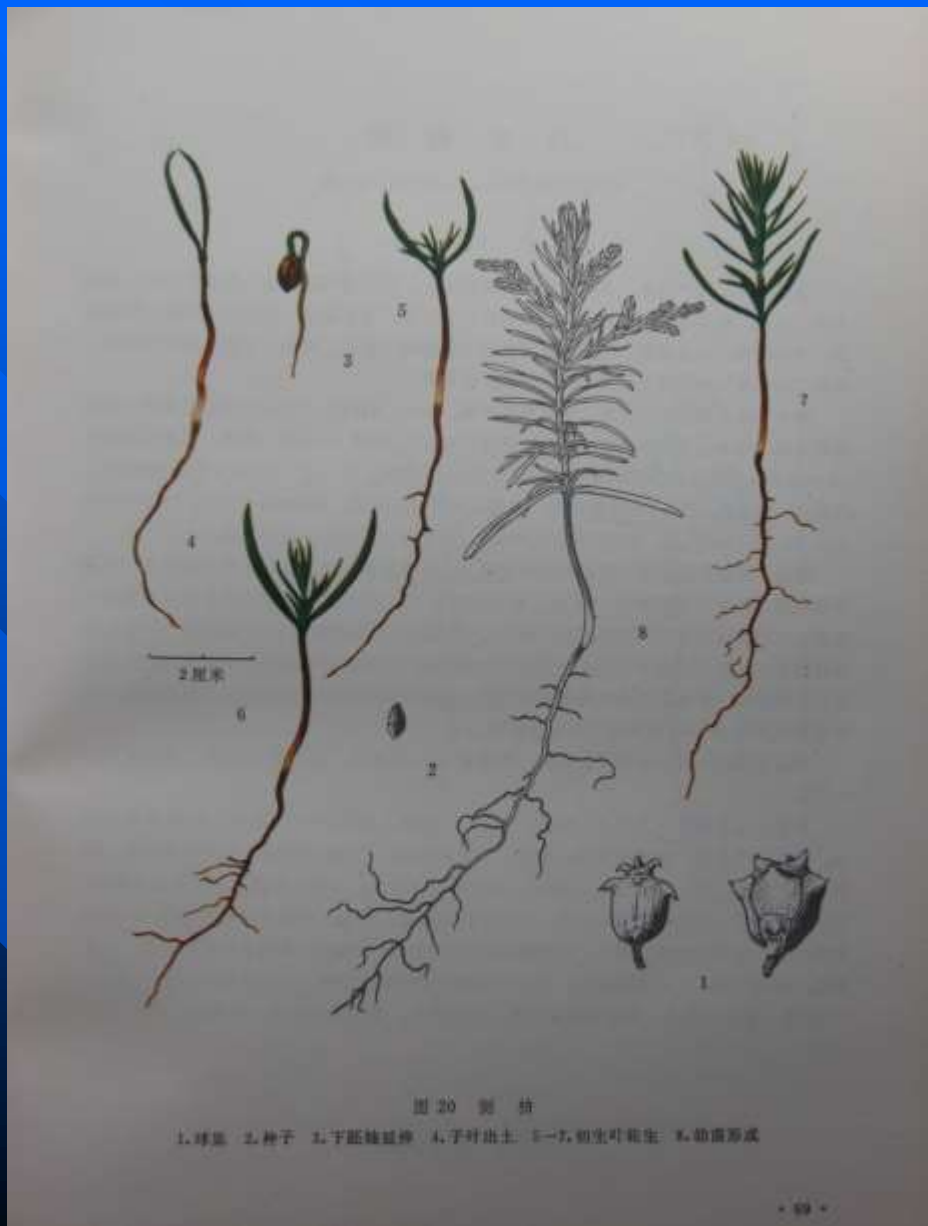


图 9　华山松

1. 球果　2. 种子　3. 幼根初露　4. 下胚轴延伸　5. 子叶乘载　6. 初生叶初露
7. 幼苗形成

播种期(Sowing date)

*春播(Spring-sowing)

*秋播(Fall-sowing)

oaks

*夏播(Summer sowing)

杨(popular)、柳(willow)、榆(ulmus)、桑(mulberry tree)

*冬播(Winter sowing)

杉木(*Cunninghamia lanceolata*)

播种前的准备工作 (preparation before sowing)

(1)种子准备(seed preparation)

(2)播种前整地 (soil preparation before sowing)

平地(leveling)、浅耕(shallow plough)、耕地(plough)和耙地(harrow)

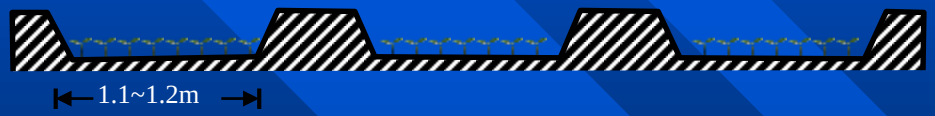
苗床准备（seedbed preparation）

高床（high seedbed）

低床 (low seedbed)

高垄 (high ridge)和低垄 (low ridge)

高床（high seedbed）



低床 (low seedbed)

播种(sowing)

$$X = \frac{N \times W \times 10}{P \times G} \times C$$

其中：X——播种量（the amount of sowing seeds, g）；

N——单位面积计划产苗量(target seedling yield)（株数 / 平方米或米, seedlings / m^2）

W——种子千粒重(weight of 1000 seeds)（g）；

P——种子净度 (seed purity, %)；

G——种子发芽率 (seed germination rate, %)；

10——常数 (Constant)；

C——损耗系数 (Consuming constant)。

C values：

Big seeds（1000 seeds weight >700 g）C＞1；

Tiny seeds （<3 g）C＞3（杨树种子C=10～20）；

Middle and small seeds（seed weight between above ）
1＜C＜5（油松种子为1＜C＜2，
落叶松 C=1.60～1.70）

播种方法(sowing methods)

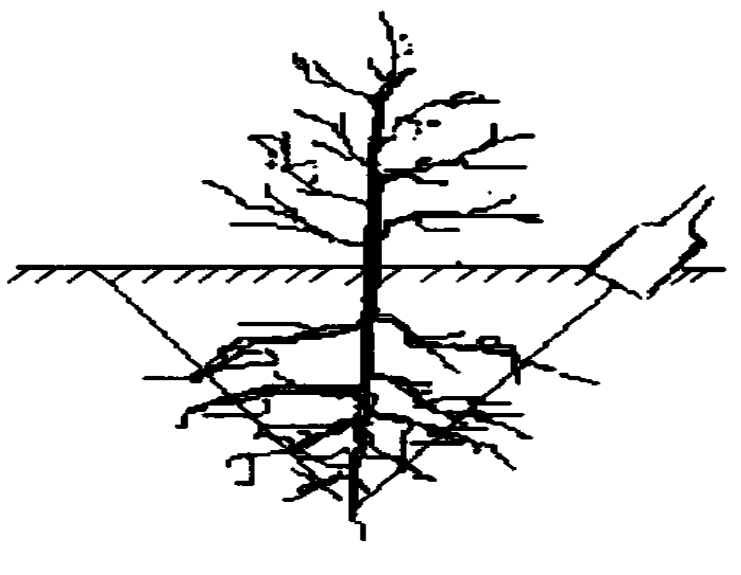
撒播 (broadcast sowing)

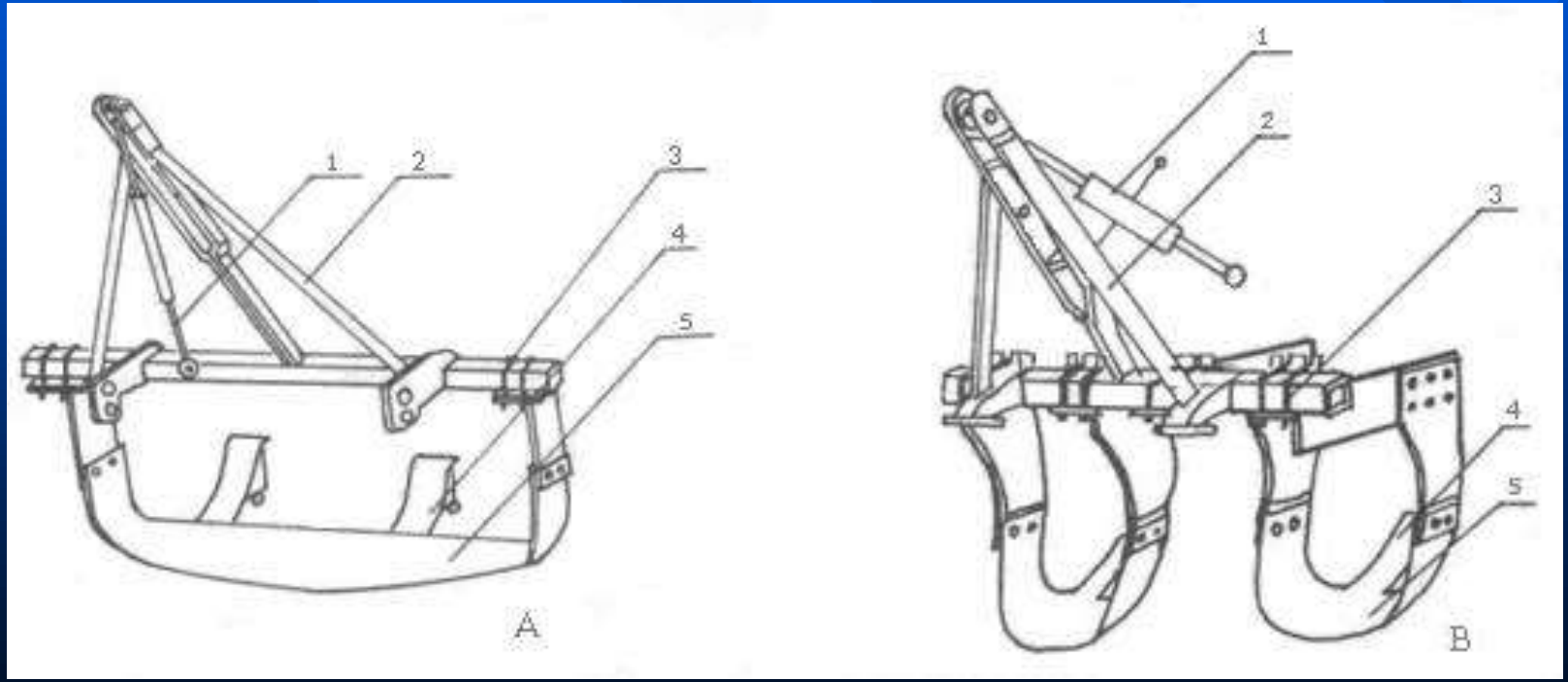
条播 (drill sowing)

点播 (point sowing)


0
1
2
3
cm

(4) 密度控制
(density control)
(5) 切根
(undercutting)





(6) 病虫害防治 (disease and pest control)

(7) 苗木越冬防寒 (cold prevent during winter)

生理干旱 (physiological drought)

霜冻 (frost)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移植苗培育
Transplanting production

- Bareroot to bareroot
- Container to bareroot
- Container to container
- Bareroot to container

营养繁殖苗培育
(vegetative stock production)

扦插（Stock produced from cutting）

1）选条(cutting selection)

2）制穗(making cutting)

3）贮藏(storage)

4）催根(pretreatment of cutting)

催根方法(pretreatment of cutting)

（1）浸水催根(water soaking)

（2）激素催根(treated by plant regulators)

萘乙酸〔NAA, naphthalene acetic acid〕

吲哚丁酸（IBA, indolebutyrie acid）

50-100 PPM，浸泡 12—24小时；or

500—1500PPM的溶液，浸蘸5秒钟

生根粉（ABT, rooting powder）

（3）温床催根(warm bed treatment)

5) 扦插(transplanting cutting)

杨、柳树以垄插(high ridge)为宜。

干旱地区和花灌木多用低床(low bed)扦插。

组织培养育苗
(Tissue culturing)


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Seedling Viability Protection
裸根苗活力保护

起苗 (lifting)

起苗季节 (lifting date)

（1）春季起苗 (spring lifting)

（2）秋季起苗 (autumn lifting)

（3）雨季起苗 (raining season lifting)

苗木包装 (seedling packing)

4.3 The studies on farm shelterbelts

In the 1950s, the chief research objective was to improve the farm land micro climate

In the 1970s, the objective was to transform the old agricultural ecosystem and to establish the system of comprehensive protective forests.

Some achievements have been obtained in the designing and planning of forest belts, in the disposition of tree species, and in the afforestation techniques and protective benefits.

Experiments show that forest belts can reduce wind velocity by 30%, and the maximum protective distance is 23 times the height of the trees, with an optimum degree of wind penetration of 25%.

4.4 Studies on sand fixation and afforestation.

A biogenic sand fixation system

Herbs: *Artimisia filidia*, *Astragulus adsurgenspan*.

Shrubs: *Calligonum mongolicum*, *Hedysarum scoparium*, *Haloxylon ammodendron* and *Acacia mearnsii*.

Arbors: *Elaeagnus angustifolia* and *salix* spp.

4.5 The forest resource survey and the study of forest remote sensing

1970s, fixed sample plots were set up

The fixed sample plots were more than 250,000.

We conduct forest inventory for the whole country every five years. The latest one was in 2009-2013, which was the eighth time.

Remote sensing techniques

4.6 The studies of forest diseases and insect pests

In respect of the forest pathology, we mainly studied the fungi in trees. Emphasis was placed on studying the technique of disease prevention and control.

Forest insect species in the country amount to 3000

destructive ones account for about 2400

beneficial one for about 600

the most important destructive ones are about over 20.

We have studied the life cycles, habits and characteristics of over 450 species of the destructive insects, 7 species of the resource insects and over 200 species of natural enemies.

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5. Higher Forest education

Higher forest education of China started in 1914 in Beijing Technical Agricultural School as well as in Jinling University in 1915. Till the founding of the new China, there were no independent forest colleges and schools. Only in the agricultural colleges of 21 universities were there forest departments with a total number of 540 students.

In 1952
Beijing Forestry College (now Beijing Forestry University)
Northeast Forestry College (Northeast Forestry University)
Nanjing Forestry College (Nanjing Forestry University)

Several forestry departments in 12 agricultural colleges reserved.

After 60 years of development,

48 universities and colleges with higher forest education, among which there are 6 independent forestry universities

The number of students graduated in 2014:

- Graduate students 7,379 (Msc, PhD)
- Undergraduate students 40,739
- Higher Forestry vocational and technical college 37,702
- Secondary forestry vocational school 67,712

The offered diplomas include PhD, Master, and Bachelor.

Table 1. Some of the main specialties in China.

Categories	**Specialties**
Foundation of Silvicultrue	Forest biology Wood science
Silvicultural science	Silviculture Forest protection Non-timber forest
Natural resources and environment science	Soil and water conservation Sand desert management Landscape architecture Wildlife management Natural resources management
Forest engineering	Logging and transportation Forest road and bridge engineering Forest machinery
Forest products and processing	Wood processing Forest chemical engineering Wood preservation and modification Furniture Design and technology
Economics and management	Economic management of forestry Wood trade Forestry information management


Thank you !