

Applied Period in
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What have I done?

- Main work:
 - Prepared a Sino-German cooperation project proposal on innovative sustainable land use together with Mr. Mathias Brix under the supervision of Prof. Heinrich Spiecker
- Others:
 - Listened to the lectures on the module of *Forest and Climate Change*
 - Excursion in the fields
 - Got familiar with the host organization

Overview on Agro-Forestry Systems in China

Outline:

- Background
- History of Agro-forestry in China
- Main Agro-forestry systems currently in practice and its environmental and economic benefits
- The characteristics of existing agro-forestry systems
- The future potential

Agro-forestry

- **Agro-forestry:** A dynamic, ecologically based natural resources management system that, through the integration of trees in farmland and rangeland, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels. (ICRAF, 1997)
- Agro-forestry or farm forestry is a production technique or method that combines agriculture and forestry on same piece of land to fully utilizing the natural resources of sunlight, water and nutrition. (Zhonglun Wu, 1991)
- The modern sense of agro-forestry: a land-use technique aimed at optimizing agricultural and forestry outputs sustainably as well as improving environment.

International Trends

In every corner of the globe, farmers are looking towards agro-forestry:

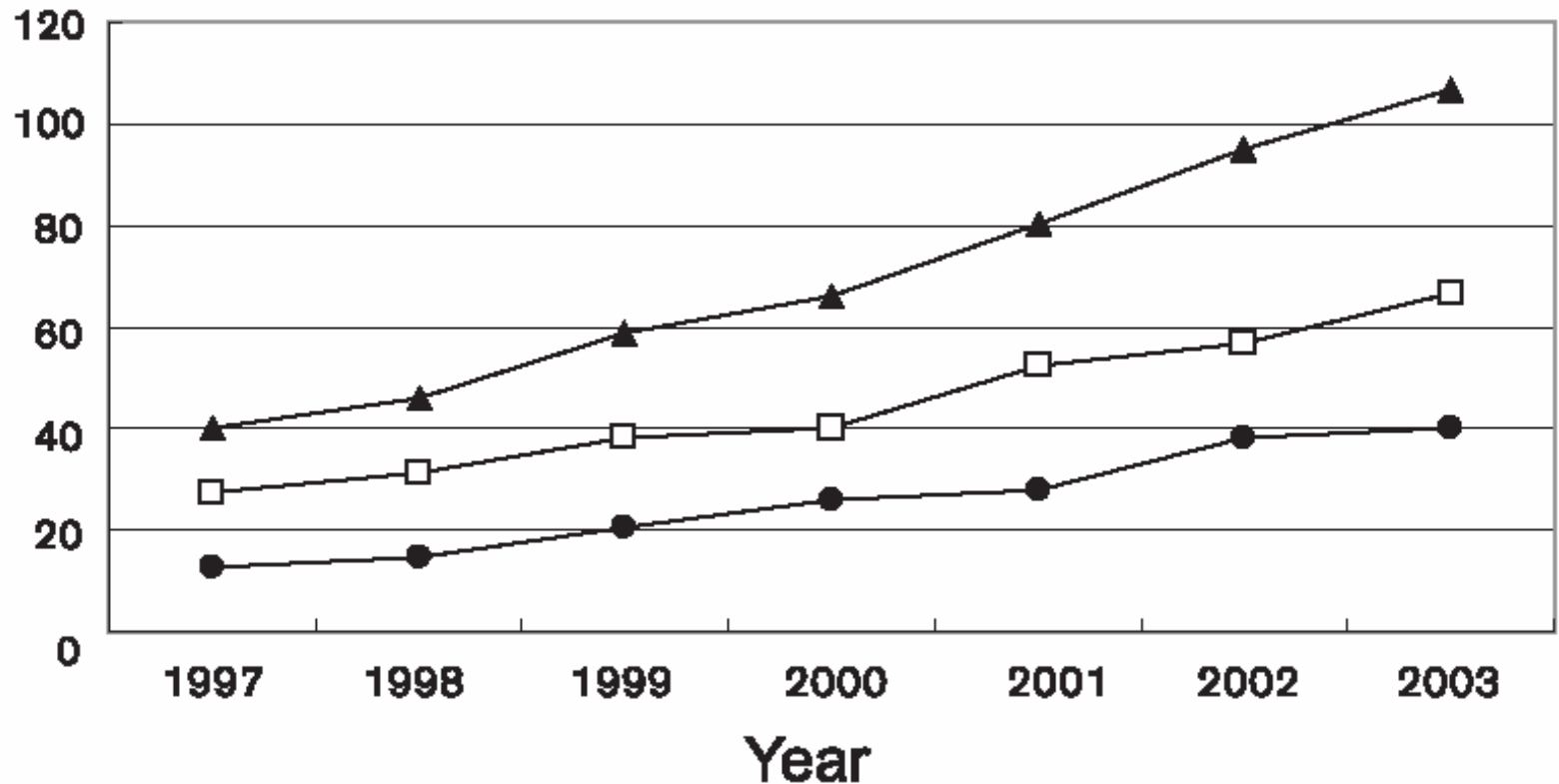
- The Agricultural Research Service in the USA advocates agro-forestry techniques to small farmers in an economic bind (Weaver 1997)
- The International Centre for Research in Agro-forestry (ICRAF) is aiding the African country of Malawi to engage in a major agro-forestry initiative to help rejuvenate soils and battle severe food deficits (Bowers 2002)
- In Brazil, the Projecto Abraco Verde, or Project Green Hug, is underway to provide training and assistance to formerly landless farmers, enabling them to reclaim fragile marginal forest lands that would otherwise be left for ecological death (Fenimore and Cullen 2002)
- In Europe, The SAFE research project sponsored by the European Union from August 2001 to January 2005, exploring how trees could be maintained or re-introduced in agricultural systems of Europe.

Background relevant of China

- Total land area: about 9.6 MKm² (7% of world land), of which 100 Mha are arable, 197Mha are forested (18.21% of land area) (FRA 2005)
- Population:1.36 billion (23% of world population)(2004), of which 61% in rural area
- The average land area available to the Chinese farmer is less than 0.1 ha
- The total amount of forest resources is insufficient (area per capita is 0.15ha, 17% of world average)
- The growing stock in forest is 13.3Bm³, of which the commercial growing stock is 12.2Bm³, about 10m³ per capita (FRA 2005)
- Although an average of 3 Mha of land is afforested annually, the forest product imports keep increasing

China's forest product imports 1997-2003

Imports (million cubic meters RWE)



● Timber Product Imports □ Pulp and Paper Imports ▲ Total Forest Product Imports

Source: X. SUN, E. KATSIGRIS and A. WHITE, 2004

History of Agro-forestry in China

- One form or another of agro-forestry has been practised in China since ancient times.
- During the Han Dynasty (206 B.C. - A.D. 220), administrators recommended the development of forests together with the raising of livestock and crops according to different site conditions.
- Since new China was established many successful agro-forestry systems have developed very fast throughout the country.
- Since the late of 1970s, some government policies such as Forest Responsibility System, the Household Responsibility System and various other government backed, extensive agro-forestry projects have promoted the further development of Agro-forestry in China.
- In 1990s, agro-forestry has been receiving more and more attention in China. Many agro-forestry research projects have been implemented by many categories of scientists from their respective perspectives and more than 500 papers on agro-forestry have been published so far.

The main forms of agro-forestry area

- Farmland shelter belt and forest networks
 - farmland shelter belts are usually built together with roads and channels;
 - widely used in the North and Northeast of China as well as in parts of the southern subtropical areas;
- Intercropping agricultural crops with trees
 - practised in the plains, over an area of more than 2 million ha.
 - the main forms of intercrop are agricultural crops with Paulownia, date, fruit tree, willow, false indigo and white mulberry.
- Planting trees around houses, along roadside and river banks etc
 - another common type of agroforestry in China's plains
 - the tree area amounts to 10 - 15% of the total area of plain land in rural parts
 - the farmer thus manages intensive multiple use of the small area of land around his house

Main Agro-forestry systems currently in practice and its environmental and economic benefits

- Intercropping agricultural crops with Paulownia;
- Intercropping agricultural crops with *Ziziphus jujuba* (Chinese date);
- Artificial agro-forestry multiple ecosystem in Lixiahe flatland;
- Multiple layer artificial population in Yunnan tropical area;
- Forest-grass system in North Western Loessial Plateau and desert area;
- Intercropping models in subtropical forest region;
- Garden type agro-forestry.

(i) Intercropping agricultural crops with *Paulownia*



***Paulownia (Paulownia elongate) -
Wheat Intercropping (Yanzhou,
Shandong)***

- an important cultivation system in North China Plain
- This system has been used and expanded to approximately 1.3 Mha
- About 0.5 in 3 volume of timber can be harvested from a ten-year old individual tree.
- also a strong trend of increased yields in agricultural production. Wheat increased between 6 - 23%, millet by about 20% and maize between 7 - 17% (Anon, 1986)
- the economic benefit of which increased by 15 - 25% when compared to single stand crops



Forest Network and Intercropping in North China Plain (Shandong)

- played a notable role in alleviation of natural calamity caused by early summer's dry-hot wind and drought,
- Experiments showed that wind speed was reduced between 21 - 51%, evaporation rate was about 9.7% during the day and 4.3% during the night, the moisture content of the upper layer of soil increased as much as 19.4% and air temperature went up by about 0.2-1°C in winter and down between 0.2-1.2°C in summer in the day time

(ii) Intercropping agricultural crops with *Ziziphus jujuba* (Chinese date)



***Chinese Date (Ziziphus jujuba) -
Peanut Intercropping***

- This 'date' is a nut tree species popular in China, thriving from temperate to subtropical areas
- It is reported that 1,500 kg of honey can be collected from one ha of intercropped land
- Intercropping space between two sprouts can be 3-6 in x 6-12 in
- mixed planting of the date with wheat results in the increased yield of both
- Intercropping with the date has now exceeded 7,000 ha of land area

(iii) Artificial Agroforestry Multiple Ecosystem in Lixiahe Flatland



Agroforestry System (Forestry-Fishery-Agronomy) with water canal (Lixiahe, Jiangsu)

- The Lixiahe flatland lying in the coastal belt receive deposit silt from Yangtze River and Huai River
- Models such as forestry plus agriculture, forestry plus agriculture plus fishery, and forestry plus animal husbandry have been demonstrated to be the most appropriate ways to utilize land resource in this region
- the ecosystem gets improved and the economic benefit derived increases by as much as five-fold at some sites when compared with monocrop farming
- A tenfold increase in the yield of firewood, has been observed when compared to unexploited wasteland.

(iv) Multiple Layer Artificial Population in Yunnan Tropical Area



Rubber tree (Hevea brasiliensis) - Tea (Camellia sinensis) Interplanting

- At Yunnan Xishuangbanna Center for Tropical Forest Research, the stereo-population models have been developed with consideration of the ecological and economical profiles of various trees and crops
- The rubber tree and tea combination, or the rubber tree and camphor tree plus tea tree combination are the best patterns.
- In forest land, the yield of tea increases by an average of 412.5 kg/ha, with the quality being much better.
- In multiple layer population, the yield from the rubber tree is also found to be higher than that from the pure rubber stand.

(v) The Forest-grass System in North Western Loessial Plateau and Desert Area



Protective Forest System in Grassland

- Serious damage occurs to the vegetation cover in this area.
- There is a shortage of fuelwood, forage and timber.
- The policy now is to develop a forest-grass structure combining high forest and shrubbery with grass, so that soil can be conserved, thus maintaining soil fertility, and attenuating the problems of lack of fuelwood, timber and fodder.
- The forest-grass species are also successful both in terms of ecology and economic benefit.

(vi) An Intercropping Model in the Subtropical and Tropical Forest Region

- The subtropical area is vast in China. There are many types of timber forest and economic forest as well as varied and interesting forms of agroforestry.



***Bamboo (Phyllostachys pubescens)
- Paulownia (Paulownia fortunei)
Mixed Plantations (Tongling, Anhui)***



An Ebielle Fungus (Auricularia auricula-judae) cultured under Paulownia



***Pecan (Carya illinoensis) - Tea (Camellia sinensis)
Interplanting***



***Forest and the traditional Chinese medicinal herbs
intercropping***



***Pineapple Intercropped
in Eucalyptus Plantation
(Eucalyptus Leizhou No.
1) (Hainan)***



***Forest, Network of Farmland
in Zhujiang River Delta
(Guangdong)***

(vii) Garden Type Agroforestry

- Various models of garden agroforestry exist in the country according to the ecological, social and economic conditions of different districts.
- For instance, in Hunan Province (Longsan County) that is located in a subtropical zone, a farmer has planted 2,200 timber trees and fruit trees both in front and at the back of his house. Also 2,050 economic trees, as well as many undergrowth such as pistacho tree and beans are grown.
- In Anhui Province's Dangshan County located in a warm temperate zone, a farmer has planted 60 *Paulownia* trees around his house; these *Paulownia* trees are twelve years old, and their worth has exceeded 10,000 Chinese Yuan (RMB). Under *Paulownia* trees, many grapevines are cultivated, and under the grapevine-rack multi-storey rabbit-sheds were established.

The characteristics of existing agro-forestry systems

- Due to the distinctive climates, soils, topographies and vegetation, the agro-forests of China are variegated. Some species and techniques are better suited to different regions
- The most commonly used method in China is agro-silviculture or the silvarable practice, which combines the growth of crops and trees into one harmonious system
- The environmental and economical benefits of agro-forestry are diverse, vast and numerous. Generally, by bettering the microclimate of the cultivated land and immediate environment, an increase in total agricultural productivity is the bottom line.

The characteristics of existing agro-forestry systems (cont.)

- Due to time preference and short-term economic interest incentives, the existing agro-forestry systems pay more attention on short rotation tree species and agricultural crops, with little consideration on long-rotation valuable timber production.
- The major constraint on agro-forestry is that most of the systems are on a low level of management, primarily resulting from a shortage of technical support.

The Future Potential

- In China, major agro-forestry systems are estimated to cover 45 M ha. Agro-forestry systems, combining the principles of forestry with agriculture, play an integral and vital role for more than one billion subsistence farmers in China.
- As the forests are being destroyed and the ecological environment is getting worse, the practice of forest-agriculture and tree-crop mixed cropping become an urgent task.
- With increasing support from the Government for improving farmers' incomes, forest development and environmental protection, agro-forestry in China will develop further in the future.

Thanks for your attention!

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Thanks for the valuable supports
of the host organization