ICRAF

INTERNATIONAL COUNCIL FOR RESEARCH IN AGROFORES
CONSEIL INTERNATIONAL POUR LA RECHERCHE EN AGROFORES
CONSEJO INTERNACIONAL PARA INVESTIGACION EN AGROSILVICUL

ICRAF House, off Limuru Road, Gigiri, P.O. Box 30677, Nairobi,
Telephone (254-2) 521450, Telex 22048, Telefax: 521001 Cable:

Nairobi, 27 May 1991

Dr. Cherla B. Sastry,
IDRC Singapore,
Regional Office for Southeast and East Asia,
Tanglin P.O. Box 101,
SINGAPORE.

Dear Dr. Sastry,

Please find enclosed a combined report by the 3 members of the Paulownia evaluation mission. As indicated in the report, we were impressed with the research results and the commitment of the Chinese scientist to the Project. We realize that it was impossible to do a complete review of all Paulownia research, especially since a considerable amount of research had already been completed prior to the start of the IDRC Project, and additional Paulownia research is conducted alongside the IDRC-financed research. Our suggestions should, therefore, be discussed within the context of all past and present research.

To initiate an increased linkage between ICRAF and CAF, I am preparing, with the help of our Dissemination Unit, a package of all ICRAF publications and video films.

Once our new Director-General, Dr. Pedro Sanchez, will take up his post, possibilities of increased linkages with China in light of ICRAF's worldwide mandate in agroforestry under the CGIAR system will be further explored.

On behalf of my two colleagues, I would like to thank you for making this visit to China and the Paulownia Project feasible.

Sincerely yours,

Dirk A. Hoekstra
Regional Coordinator E.A. AFRENA

cc. Prof. Zhu Zhao-Hua, Deputy Director CAF
Dr. Larry Szott, IDRC AF Programme
Dr. Mohammed Sodjoudee, College of Natural Resources

PAULOWNIA PROJECT EVALUATION REPORT
Dates: May 11 - 20, 1991

MEMBERS EVALUATION TEAM

Ir. Dirk A. Hoekstra	-	Regional Coordinator E.A.AFRENA, Agricultural Economist ICRAF (Team leader)
Dr. Larry Szott	-	Technical Advisor IDRC Agroforestry Programme in Latin America, Soil Scientist, based at CATIE
Dr. Mohammed Sodjoudee	-	Faculty member College of Natural Resources, Gorgan, Iran

1. OBJECTIVES

The team's objectives were to establish:

i) Why research is being conducted on Paulownia
ii) What research is being conducted
iii) What is the impact of the research
iv) What is the applicability of the research for other countries.

2. ITINERARY

May 10 - 12 Arrival and sightseeing (Summer Palace, Forbidden City, Great Wall)

- Welcome dinner with Project staff and administrators from the Chinease Academy of Forestry (CAF)

May 13 Visit Yian Zhou County in Shan Dong Province.

- Forestry network (shelter belts) of Poplars, *Robinia pseudoacacia* and Paulownia.
- Yian Zhou Research Station where work on nursery/propagation takes place, (including tissue culture), as well as selection and breeding.
- Visit to Confucius Temple, House and Burial grounds.
- Official dinner with County officials.

May 14 Visit to Chen Wu County in Shan Dong Province.

- Paulownia intercropping in farmers' fields.
- Visit to furniture factory using Paulownia wood.

- Official lunch with County officials.

Visit to Shangqui Prefecture in Henan Province.

- Official dinner with Province, Prefecture and County officials.

May 15 Visit to Minquan County in Henan Province.

- Multistorey linear arrangements of Paulownia with fruits in farmers' fields.
- Hedges of *Fraxinus chinensis* on previously unproductive sandy wasteland.
- Forestry Bureau's experimental land used by the Project for different linear multistoreyed models.
- Ecological farm also used by the Project for developing multistoried linear models.
- Official lunch with Minquan County officials,

Visit to Dang Shan County in An Hui Province.

- Spacing trials, 5 x 10, 5 x 20, 5 x 30 and 5 x 40 at the Dang Shan Paulownia experimental station.

May 16 Visit Research Station of Chemical Processing and Utilization of Forest Products, Nanjing.

Visit Tonglin City in An Hui Province.

- On-station block models, including Paulownia and tea.
- Clonal testing
- Official dinner with Tonglin City officials.

May 17 Visit Nanjing.

May 18 Report writing and discussions.
Official dinner with the President of the Chinese Academy of Forestry.

May 19 Rest and sightseeing.

May 20 Departure.

3. MAJOR FINDINGS/RECOMMENDATIONS

3.1 Why Paulownia research?

The research on Paulownia was initiated as a result of a study on existing Paulownia trees in Henan Province in the seventies, and a diagnosis of problems in the wheat-based land-use system in the flat plains of the Huang-Huai-Hai. The main diagnosed problems at the time were: low income of the rural population, shortage of wood for construction and fuel (straw was frequently used), and environmental/biological problems such as dust storms, hot dry winds just before harvesting and poor soil conditions, especially in the former bed of the Yellow River (alkaline, sandy and salty). The study revealed that Paulownia intercropping had a potential for addressing these problems.

3.2 Paulownia research

3.2.1 Component research

3.2.1.1 Nursery propagation techniques

Over the last eight years, research in nursery management and propagation of Paulownia has led to increased germination, survival and growth of Paulownia and consequently, a reduction in the time plant material spent in the nursery. Techniques developed range from relatively sophisticated tissue culture methods, which have enabled the rapid propagation of improved clones for research and evaluation, to simple, low-cost methods (direct seeding and root cuttings in beds or containers that can be intercropped with wheat) using local material readily available to farmers. As a result, over 60,000 ha of nurseries have been installed, enabling the large-scale dissemination of Paulownia to Chinese farmers. The Project has thus rightly become the international leader in this area.

3.2.1.2 Selection and breeding

The selection and breeding component of the Project has included: the identification and characterization of Paulownia species and provenances, quantification of their growth characteristics, the selection of species and/or provenances for specific ecological zones, and controlled breeding to develop superior trees. Selection and breeding have concentrated mainly on increasing the height, diameter and timber volume and large gains (ranging from 25 - 70%) have been achieved. In the process, 55 ha of plantations for clonal testing have been established and 3.7 million individuals of seven superior clones have been produced.

Despite such notable achievements, further work remains to be done:

i) The objectives of the screening/breeding programme should go beyond its initial focus on timber volume to include specific objectives such as improving witch's broom disease resistance and wood characteristics, and developing trees particularly suited to intercropping with annual crops.

ii) Improved clones should be screened over a wider range of soil/climatic conditions in order to present a greater environmental "challenge" to Paulownia and hence to provide more knowledge on gene X environment interactions and Paulownia's adaptability.

iii) The present protocol for screening Paulownia in which the sites are fertilized, needs to be rethought, especially for situations in which Paulownia may not be normally fertilized. (e.g. woodlots).

iv) At the international level, there is currently an active debate regarding screening procedures and designs for multipurpose tree species. Researchers from the Paulownia Project should try to initiate contact with such researchers in order to interchange ideas and experiences and to improve screening procedures.

3.2.1.3 Wood properties and utilization

Most of the research on wood properties has already been conducted prior to the second phase of the IDRC Project and the results are published in: Paulownia in China. Some measurements were also taken during this phase, however, they were less comprehensive. In the breeding work, the demand for specific characteristics for the Japanese market will be considered. Generally speaking, Paulownia wood is very good as a raw material, except for paper production, since length of the wood fibre is insufficient (<1,400 microns).

It was noted that the furniture factory stocked their logs in the open, resulting in checks and splits. It is suggested that wastage of wood as well as the biological degradation can be prevented by shrinking all logs in water or to end-coat the logs.

The Project did *in vitro* analysis of the leaves of the different *Paulownia* spp. as well as some feeding trials. It was noted that the replacement of wheat bran by Paulownia leaves does not lead to a saving in grains as claimed in the final report.

To evaluate the fodder value of Paulownia leaves it would be useful to relate the nutrient output of different models with the farmers' feed requirements during the year.

3.2.2 Component interaction/prototype research

The Project is conducting component interaction/prototype research for two basic models, i.e. linear arrangement of Paulownia trees with or without an understorey in the crop land and block planting of trees in forest land, wastelands and tea plantations.

3.2.2.1 Linear models

These models have been designed for the wheat-based systems in the flat areas and their main functions are production of wood for home consumption and sale as well as improving the micro-climate. The latter function will be best achieved when multistoreyed linear arrangements are used.

Research on these models under the IDRC-funded Project addressed different spacing arrangements between rows of trees. Their research also included measurements of micro-climate and micro-site parameters. Based on these measurements, the group developed recommendations for between-row spacing as well as a crop yield simulation model for intercropping with Paulownia. This research is of excellent quality and probably the only one on Paulownia in the world.

The team encouraged CAF to increase contact with other scientists who have developed crop simulation models. The team also recommends that the effect on yields of factors other than radiation, are clearly explained and/or examined through experimental manipulation of such factors, e.g. artificial root barriers. In view of the change in land-use from communal to private utilization, the team also recommends that some of the earlier conducted research on the in-row spacing of Paulownia trees is reviewed, since it will be difficult for most farmers to have more than one row of trees on their farms because of the small size of their holdings (< 1 ha) and the layout of their plots (long narrow strips). In particular, spacing with variable harvesting times in-row may be examined.

The second main issue addressed is the multistorey arrangement of trees in linear arrangements. Several understoreys are tested, including apples, pears, grapes (mainly for cash), *Fraxinus chinensis* (tool handles, javelin) and *Amopha fructiosa* (green manure, twigs for weaving). This research has commenced more recently and will be included in the IDRC-funded Integrated Farm Forestry Project.

In evaluating these models, economics is a crucial issue since most models do replace a considerable crop area. Whether or not this trade-off between annual crops and perennial crops is economic, will to a large extent depend on the market potentials of the understorey crops. For some crops such potentials have already proved to be limited (e.g. grapes). Most models aim at increasing production from trees as well as to improve the micro-climate, and only few models address the diagnosed soil fertility issue. The team suggests that the potential of Paulownia as an understorey (continuous coppicing) may be explored for this purpose.

At present, no research is conducted on management of the trees to improve the tree-tree and the tree-crop interactions for the different types of linear arrangements. The team suggests that such research may be considered for the different models.

3.2.2.2 Block models

These models are developed for the rice-based systems in hilly areas. Such hills/wasteland are normally used for village forestry since it is not common to interplant trees with rice.

A special model is Paulownia-tea intercropping; others are Paulownia with bamboo, Paulownia with Magnolia and mushrooms and Paulownia with Chinese fir.

These models are presently not part of the IDRC-funded Project and hence, no data are provided in the final technical report.

Similar as to the multistorey linear models, economic evaluation of the different models will be a key research area for these models. Since funds are limited, the team recommends to concentrate on only those models which have a high potential of being adopted by the farmers.

4. IMPACT OF THE RESEARCH

The final technical report of the Project specifies the number of seedlings distributed and areas effected by the intercropping of Paulownia. What is less clear from the report is the method of disseminating other than the audio-visual and written material. During the field trip, it became abundantly clear that the Project maintains excellent relations with local government officials, especially in the Forestry Bureaus of the counties. Meetings and distribution of improved clones through such officials have greatly contributed to the excellent dissemination of the Project's findings.

As mentioned earlier, two main bottlenecks may influence future dissemination of some of the different models/research findings, i.e. marketability of the different products and changed land-use arrangements. The Project is well aware of these potential dangers.

5. APPLICABILITY TO OTHER COUNTRIES

In most cases, the Project's experience and results in component research (i.e. nursery management and propagation, tree selection and breeding and tree properties) can be readily applied to other developing countries. However, the results of component interaction research and especially the formula for China's success in the extension of these results to farmers, is strongly dependent on the agricultural systems in China: an emphasis on annual crops such as wheat, the intensive use of land, labour, purchased chemical inputs, and a well-developed structure for disseminating information to farmers. This would potentially limit the usefulness of this knowledge in agricultural systems where farmers practice extensive agriculture with little or no use of purchased inputs and where institutional linkages between farmers and researchers are often absent. In any case, the Chinese have shown how, in various ways, trees can be combined with annual and perennial crops, and this may provide a stimulus to other researchers in their work on agroforestry systems.

The team recommends that scientists from the CAF Paulownia Project assist in the development of the research and development of Paulownia in other countries through the establishment of a Paulownia network.

ACKNOWLEDGEMENT

The team would like to thank Prof. Zhu Zhao-Hua and Xiong Yao-Guo for the hospitality and guidance provided during the mission. The team was enormously impressed, not only by the research results but also by their commitment to the Paulownia Project.

We also would like to express our gratitude to all other researchers, county officials and the driver, who made our visit a memorable one.

Special thanks are also offered to Prof. Liu Yuhe, President of the Chinese Academy of Forestry, and Prof. Huang Weiguan, Director of Foreign Affairs CAF.

Last but not least, we would like to thank IDRC, especially Dr. Sastry for enabling us to make this Paulownia mission to China.