Bamboo Value Chain in China and the Importance of Research for Value chain Development

Yue Yongde

International Center for Bamboo and Rattan, SFA China

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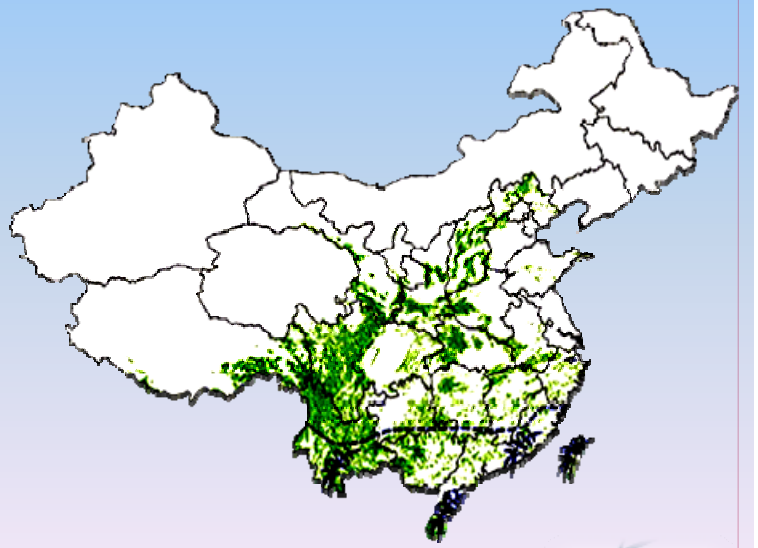
Overview of Bamboo Utilization in China

Bamboo Resources in China

- China is one of the bamboo distribution centers in the world, with the largest area, the most abundant species and biomass.
- There are about 39 genera, more than 590 species in China with 5.38 million hectares of pure bamboo forest, which accounts for 25% of the bamboo area in the world.



Bamboo forest
Area: 5.38 million hectares
Genera: 39
Species: 598

Monopodial	Sympodial	Amphipodial	Others
Genus: 7	Genus: 15	Genus: 9	Genus: 8
Species: 103	Species: 192	Species: 107	Species: 196

Moso bamboo
Area: 3.71 million hectares
Proportion: 69.4%

Other bamboo
Area: 1.67 million hectares
Proportion: 30.6%

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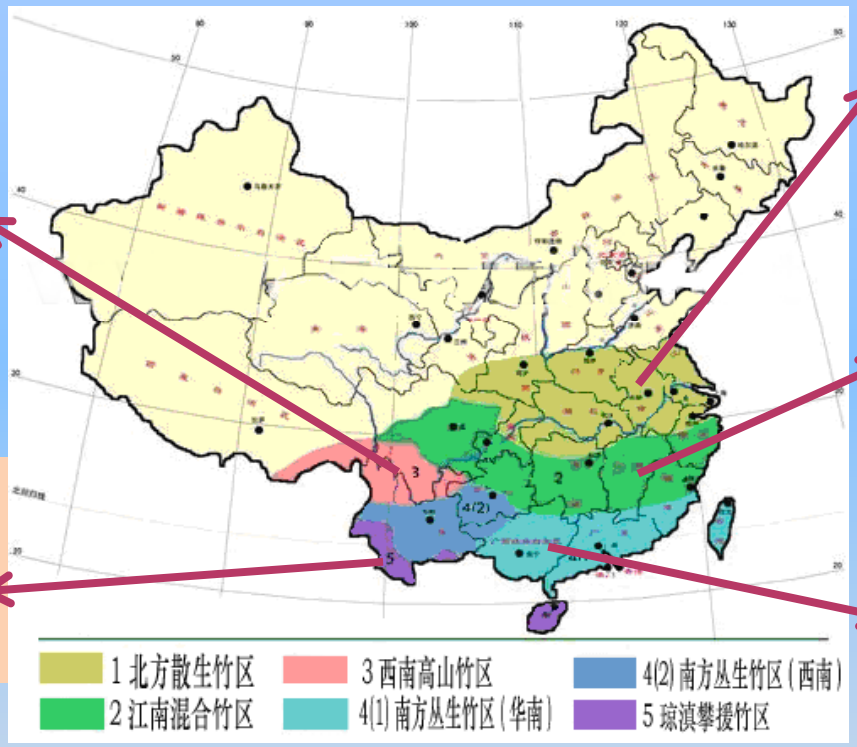
High mountainous bamboo region in southwest part

Climbing bamboo region in Hainan, Yunnan and Sichuan Provinces

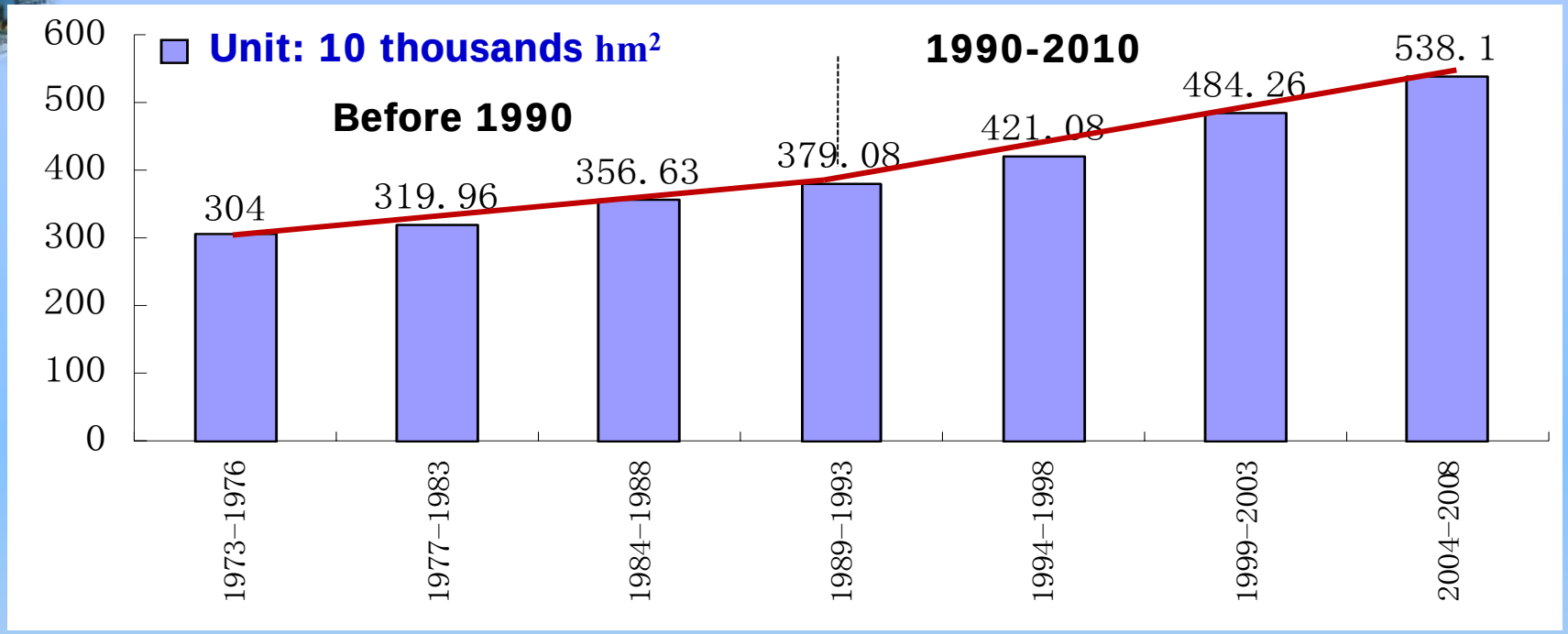


Monopodial bamboo region in north of Yangtze River

Mixed monopodial and sympodial bamboo region in south of Yangtze River

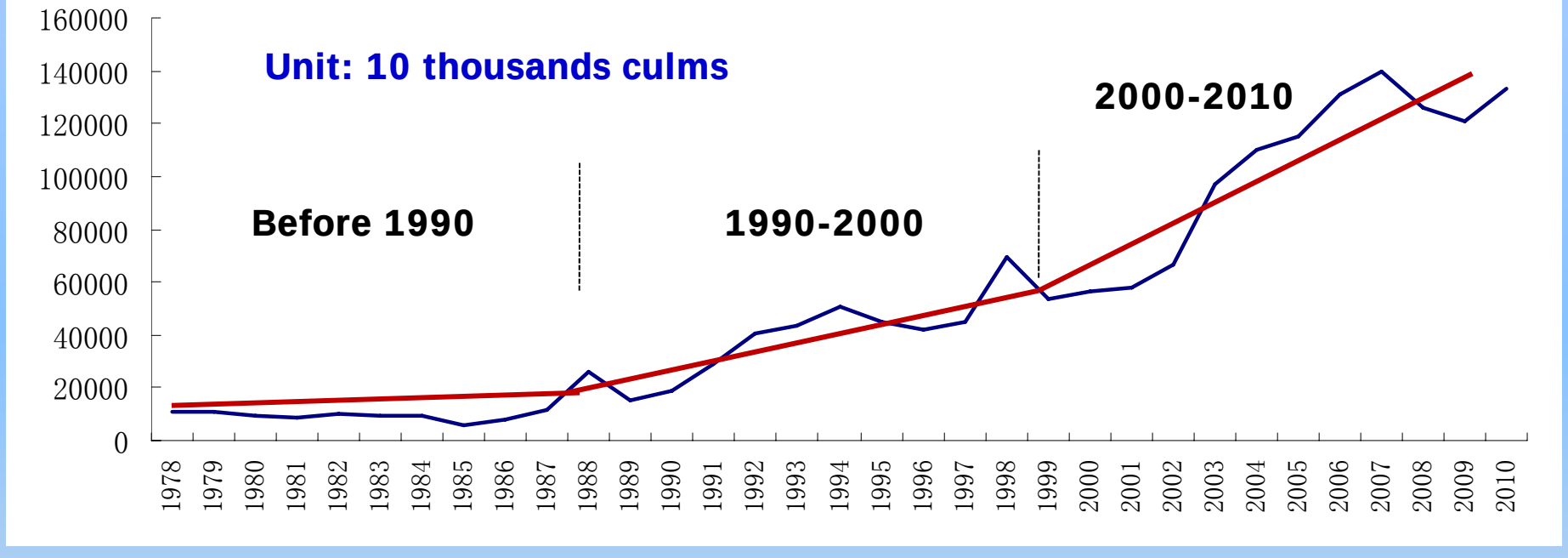
Sympodial bamboo region in southern part

- Bamboo is distributed in the 27 provinces of China.
- Five bamboo distribution regions could be partitioned in China.



The change of pure bamboo forest area in China from 1976-2008

- The area of pure bamboo forest in China increased from 3.04 million to 5.38 million hm^2 from 1976-2008;
- The area of bamboo forest area increased by about 100 thousands hm^2 /year since 1990, almost two times of the annual increase in the 1980's.



The production of bamboo culms from 1978-2010 in China

- **The production of bamboo culms in China changed little from 1978 to 1990, but significantly speeded up during the next 20 years due to the industrial utilization of bamboo, especially from 2000.**

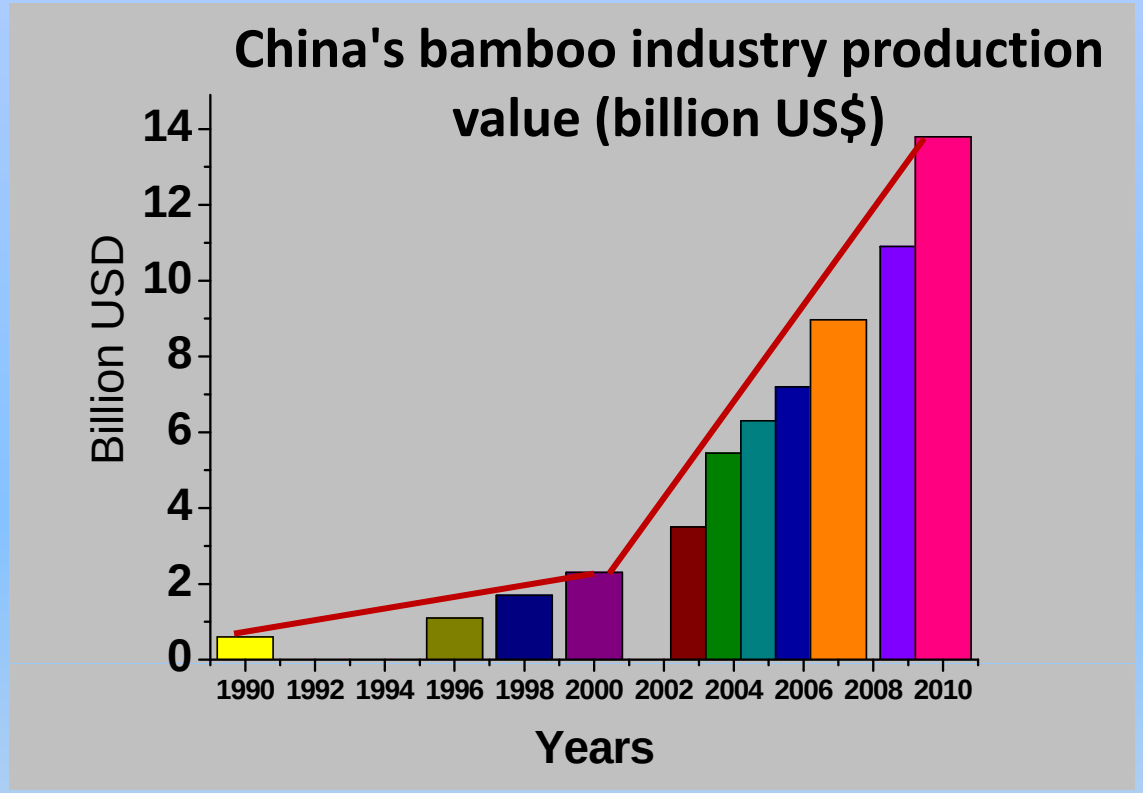
Bamboo Industry

◆ **The development of China bamboo industry can be divided into three stages:**

- **Traditional utilization (before 1990)**
- **handicrafts, woven articles, Scaffoldings**

- **Industrial utilization1990-2000 ()**
- **bamboo plywood, bamboo floorings et al**

- **Comprehensive and value-added utilization (2000-)**
- **bamboo scrimber, bamboo structural lumber, bamboo textiles, bamboo carbon et al**



- **In China, bamboo industry has reached a annual production value of 13.8 billion USD;**
- **Bamboo industry provides many employment opportunities for the society. There are over 5.6 million people directly engaged in the bamboo industry in China.**

Bamboo Value Chain in China

Value chain of bamboo utilization in China

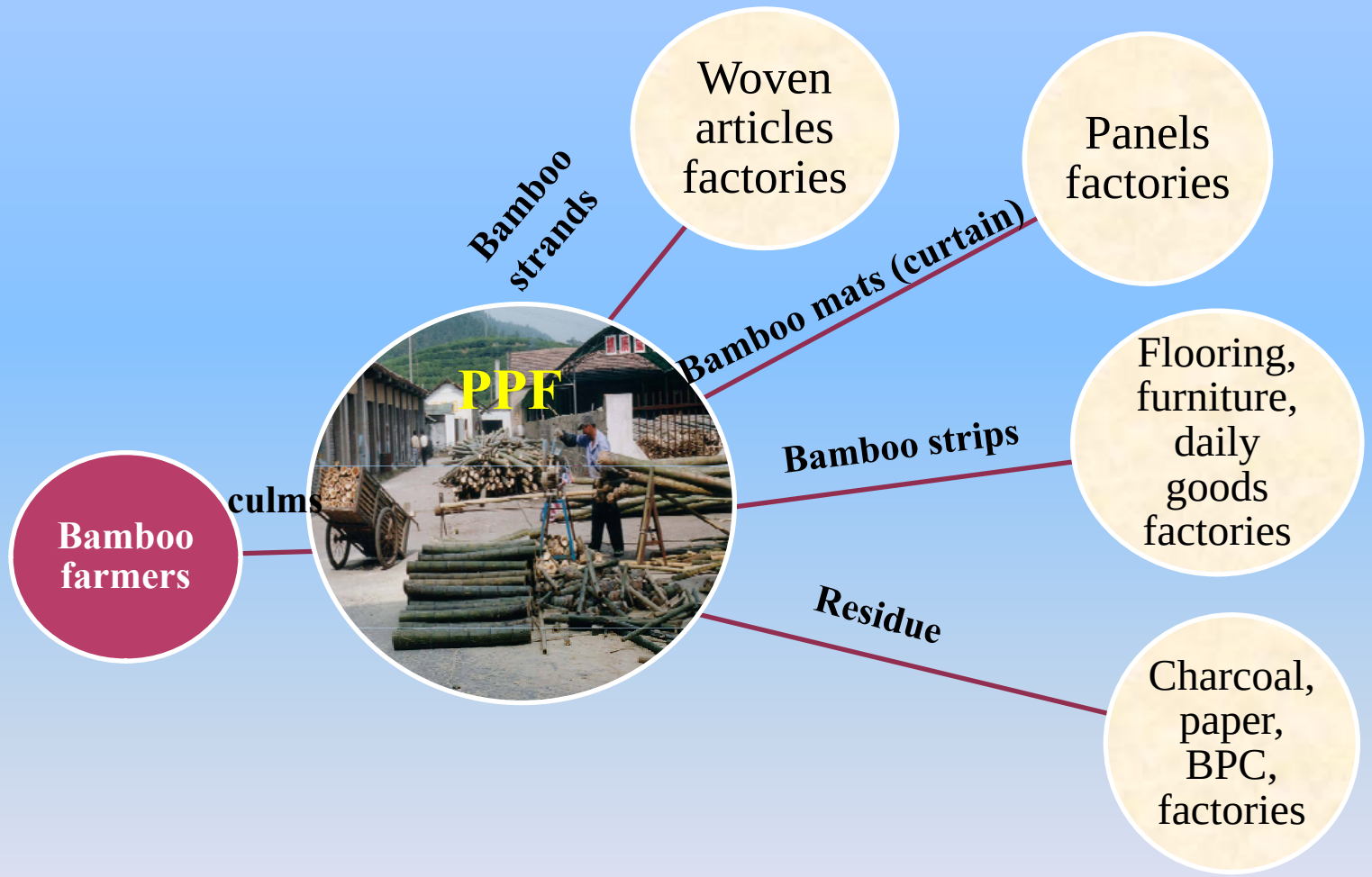
bamboo

- culms
  - Top parts → toothpicks, skewers et al
  - Middle upper parts → Curtain, mat, woven articles, handicrafts, bamboo mat (curtain) laminated panels
  - Middle lower parts → laminated furniture, floorings
  - Base parts → charcoal, bamboo vinegar
- leaves → Fodder, Pigments, medicine, beverage et al
- twigs → Brooms
- Rhizome → Handicrafts

Processing residue

Energy, bamboo powder polymer composites; bamboo particleboard; bamboo viscose fibers textiles

Primary processing factory(PPF) – key of the value chain of the bamboo industry



PPF act as the linkage between farmers and factories and maximizes the values of bamboo culms by providing semi-products from different parts of bamboo for the downstream factories.

From bamboo culms to bamboo floorings

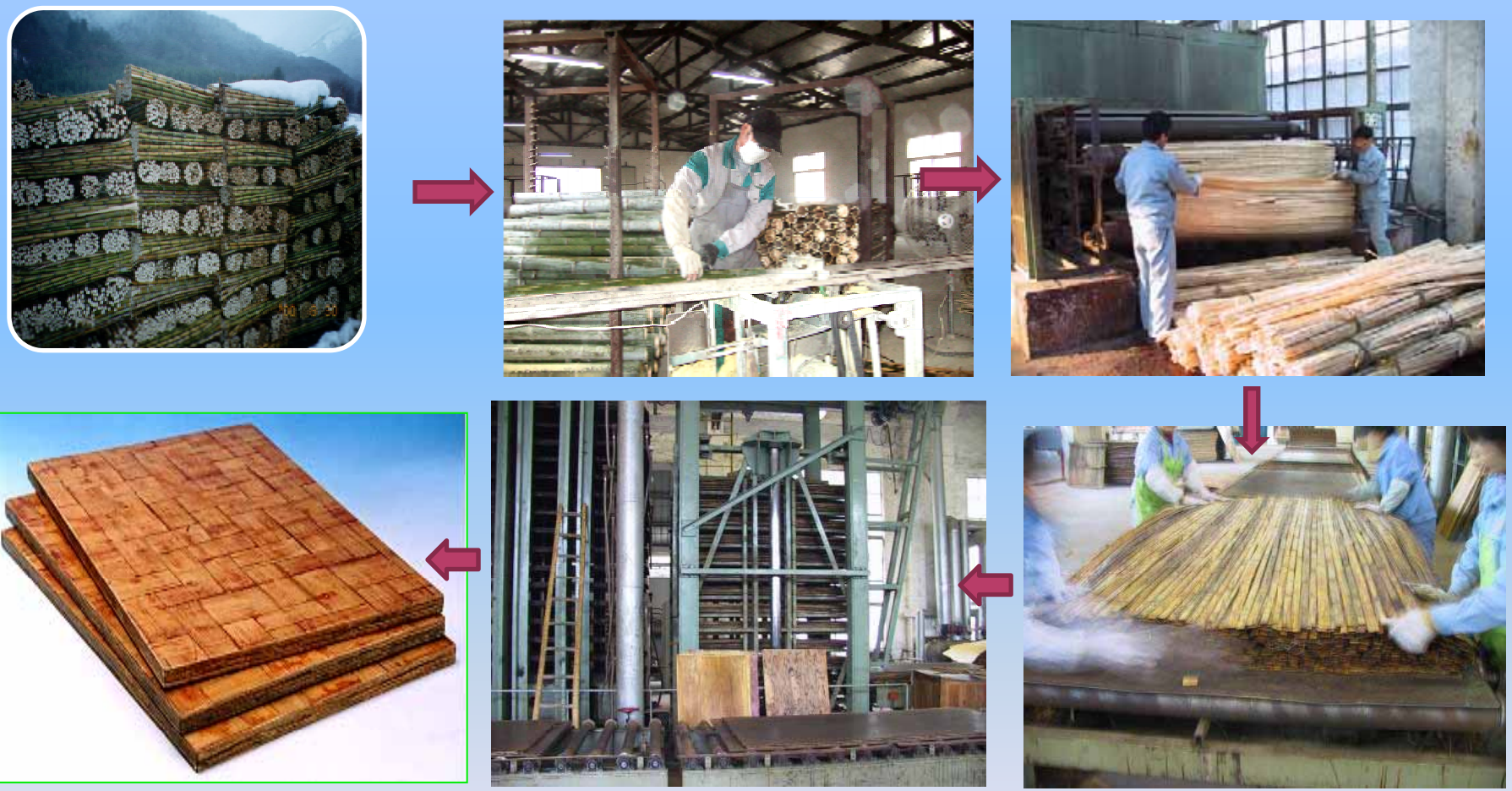




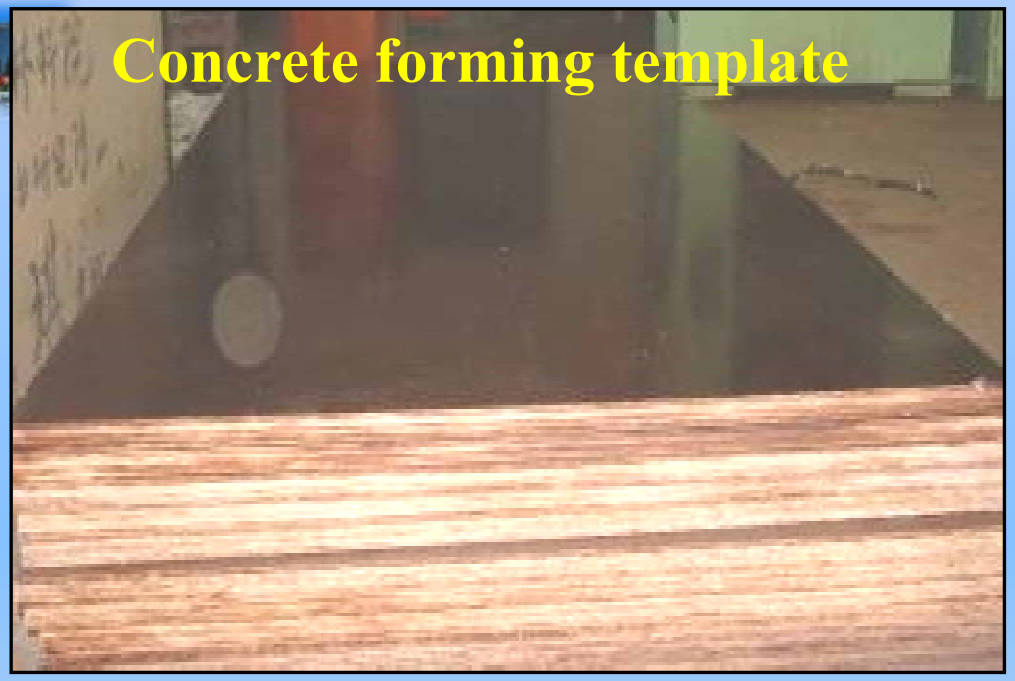
The production of bamboo floorings in China reached 39.4 million m^2 in 2010

Presidential Clinton's Library

From bamboo culms to bamboo laminated panels



The production of bamboo based panels in China reached 3.59 million tons in 2010



The bamboo mat panels find its value-added applications fields, such as concrete forming templates and decking for trucks and containers.

From bamboo culms to bamboo woven articles

Value-added utilization of processing residues

Bamboo powder polymer composites

Bamboo pellet for energy

From processing waste to bamboo charcoals and bamboo vinegar

The production of bamboo charcoals in China reached 0.14 million tons in 2010

Value added utilization of bamboo charcoal

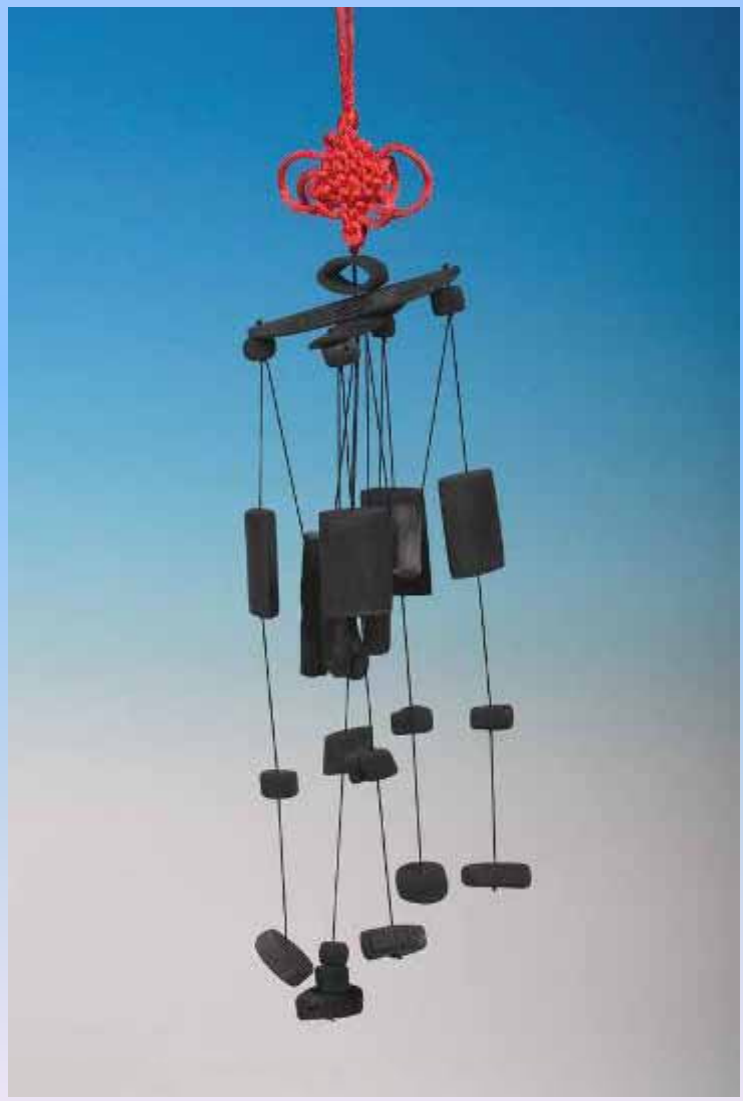
The value of bamboo charcoal is further added by secondary processing.

Bamboo charcoal for adsorption and purification

Bamboo charcoal for improving sleep

Bamboo charcoal fibers for textiles

Bamboo charcoal for handicrafts



Value added utilization of bamboo vinegar

The value of bamboo vinegar is further added by secondary processing.

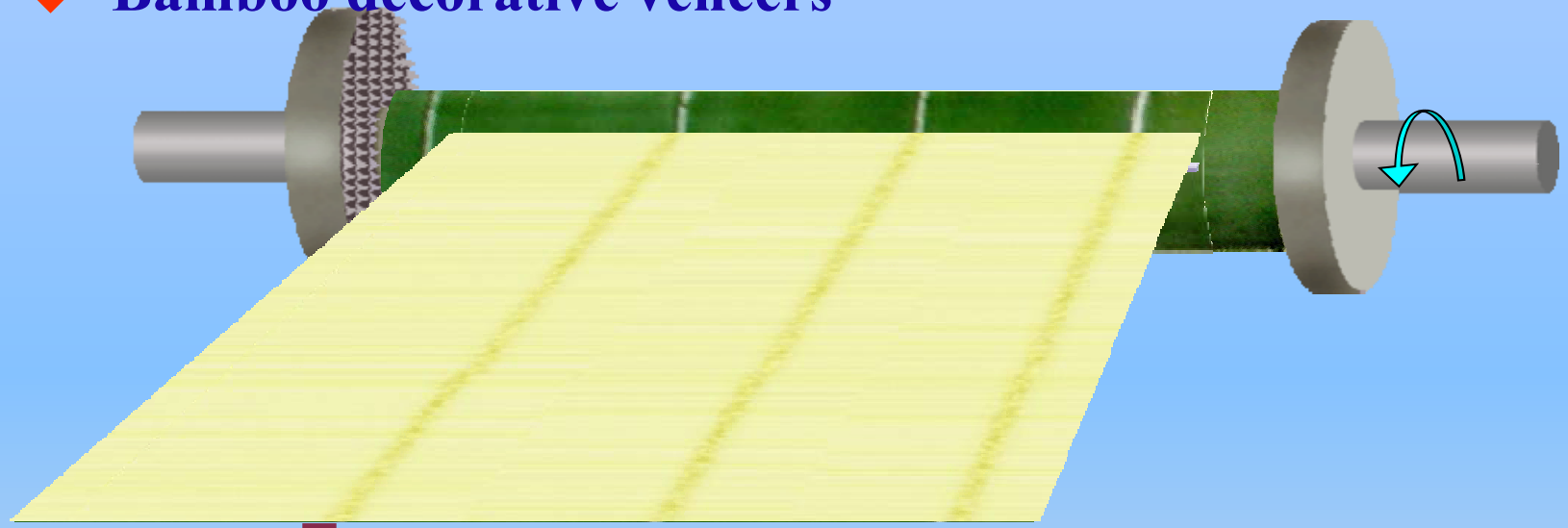
Bamboo vinegar for bathing

Bamboo vinegar for horticulture and agriculture

Several Researches for Value chain Development in China

Develop new high value-added bamboo products

- Bamboo decorative veneers



Bamboo decorative veneers are developed for various decorative purposes.

◆ Advanced bamboo engineered materials

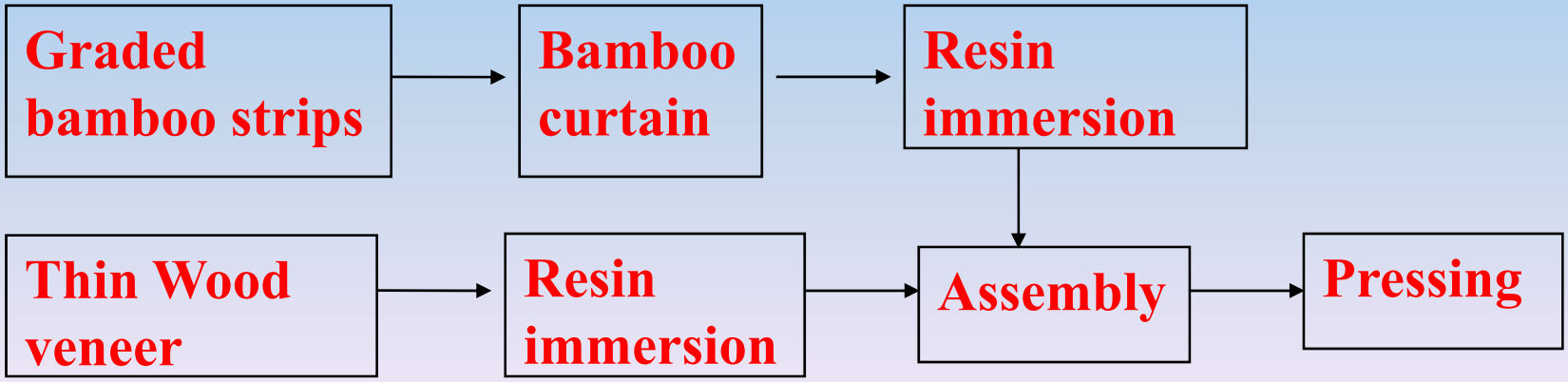
Advanced bamboo engineered materials are significantly different from the existing various bamboo composites with the following characteristics:

- **High stiffness : ≥20 GPa; Strength: ≥ 200 MPa**
- **Fatigue strength: residual strength≥50% after 10^6 cycles**
- **High size stability: ≤5 % in thickness expansion after two cycles of water boiling for 3 hours and drying 1 h.**
- **Higher added value: neat profit ≥30%**
- **Used in high-end fields: wind blade, cars, yacht et al**
- **Small variation in properties :CV ≤8 %**

Advanced bamboo/wood engineered composites has been developed in ICBR to replace glass fiber reinforced plastics for application in wind blade and yacht .

Pilot production is being carried out in a bamboo composite factory.

Pilot assembly for bamboo/wood engineered composites production



Bamboo/wood engineered composites

Used for yacht

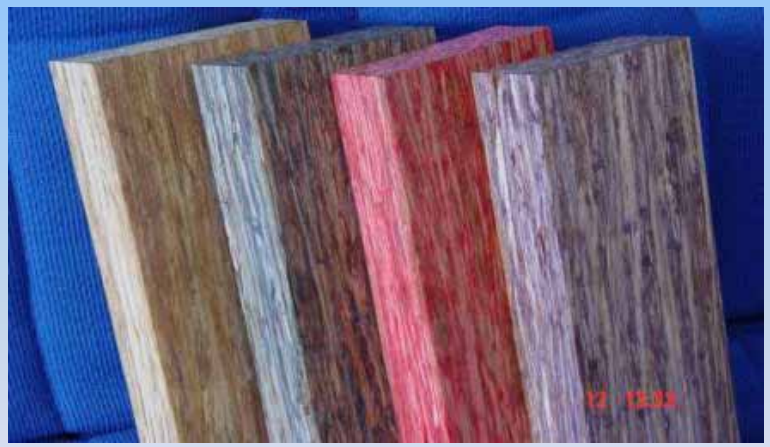
Used for wind blade

◆Bamboo scrimber

➢Bamboo scrimber is a novel structural bamboo composite commercialized in China only 7 years ago but developed most quickly in various bamboo composites.

➢It can be produced with small diameter bamboo with utilization ratio more than 90%.

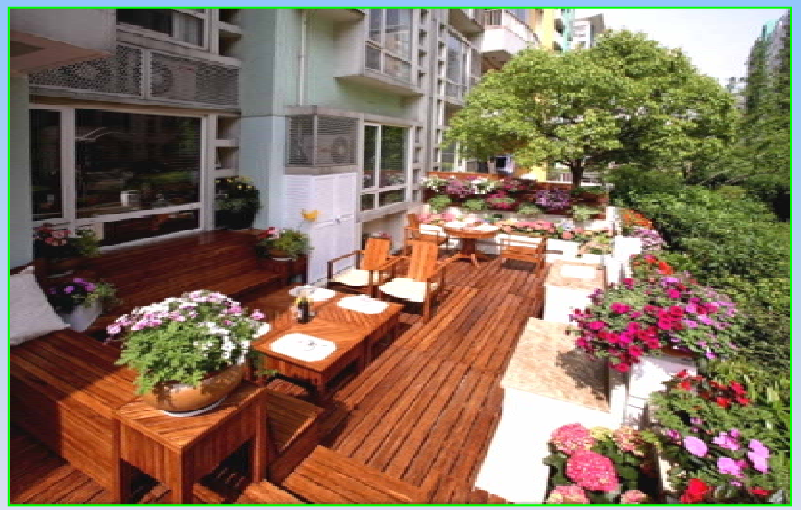
Production line



Bamboo scrimbers

Procedure of bamboo scrimber production: strand preparation

Procedure of bamboo scrimber production: panel production



Bamboo srcrimber can be use as: structural components in house, top-grade furniture and floorings both for indoor and outdoor application.

Bamboo fibers textiles

In China, bamboo has been successfully utilized to produce various textile fibers since 2000. Three kinds of textile fibers can be produced from bamboo:

- **Bamboo viscose fibers**
- **Bamboo lyocell fibers**
- **Natural bamboo fibers**

Bamboo viscose fibers

- **Bamboo viscose fibers belongs to regenerated cellulose fibers, which has been commercialized in China and has reached a production of more than 20000 tons/year in 2008.**
- **According to calculation, if the production of bamboo viscose fibers reached 600 thousands ton/year, 0.5 million hm^2 farmland could be saved .**

Natural bamboo fibers

- **Natural bamboo fibers are directly extracted from bamboo with physical and mechanical methods, remaining the characteristics of natural fibers.**
- **ICBR is being engaged in the development of natural bamboo fibers for textiles and has obtained several pilotscale products.**

Bamboo lyocell fibers

Bamboo lyocell fibers is a new type of regenerated cellulosic fibers characterized with the following advantages:

- **Environmental friendly**
- **Much higher mechanical properties and lower moisture regain ratio**
- **Bamboo lyocell fibers is still at the stage of Lab research**

New Bamboo carbon based products

Several institutes and universities are exploring the possibility of manufacturing bamboo carbon based high value-added end products:

- **lithium battery**
- **Conductive polymer;**

Bamboo carbon based lithium battery

Bamboo carbon/polymer conductive polymer

- **Bamboo leave flavonoids**

Flavonoids occur widely in bamboo species. Many flavonoids are active principles of medicinal plants and exhibit pharmacological effects.

• Feed additive derived from bamboo

Feed additive derived from bamboo could decrease the abuse of antibiotics in livestock and poultry farms.

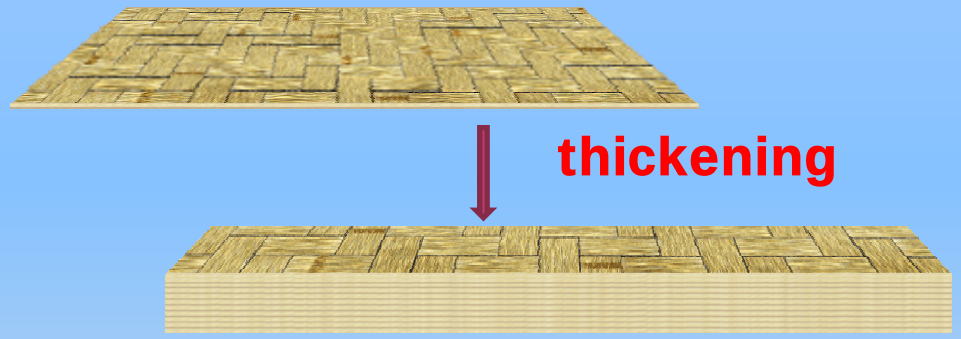
Feed additive derived from bamboo

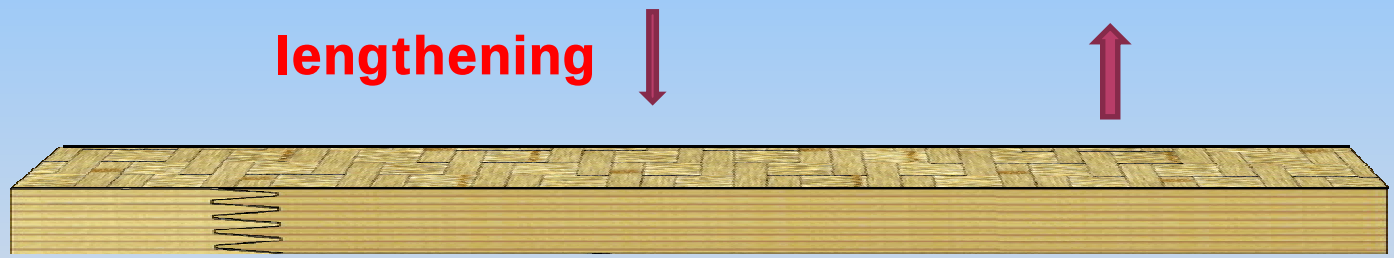
• Anti-oxidant agent from bamboo leaves

A production line of anti-oxidant agent extracted from bamboo leaves has been established in Zhejiang Province with a production of 100 tons/per. The price of this high value-added product is more than 50 thousands USD/ton.

Extend value-chain of bamboo products into in or important applications

◆Bamboo structural lumber





Bamboo structural lumber is made of traditional bamboo laminated panels through special thickening and lengthening process, mainly used as the loading component in construction.

Bamboo structural lumber was used as roofs and poles in a demonstrative conference hall

Elementary school built with bamboo structural lumber

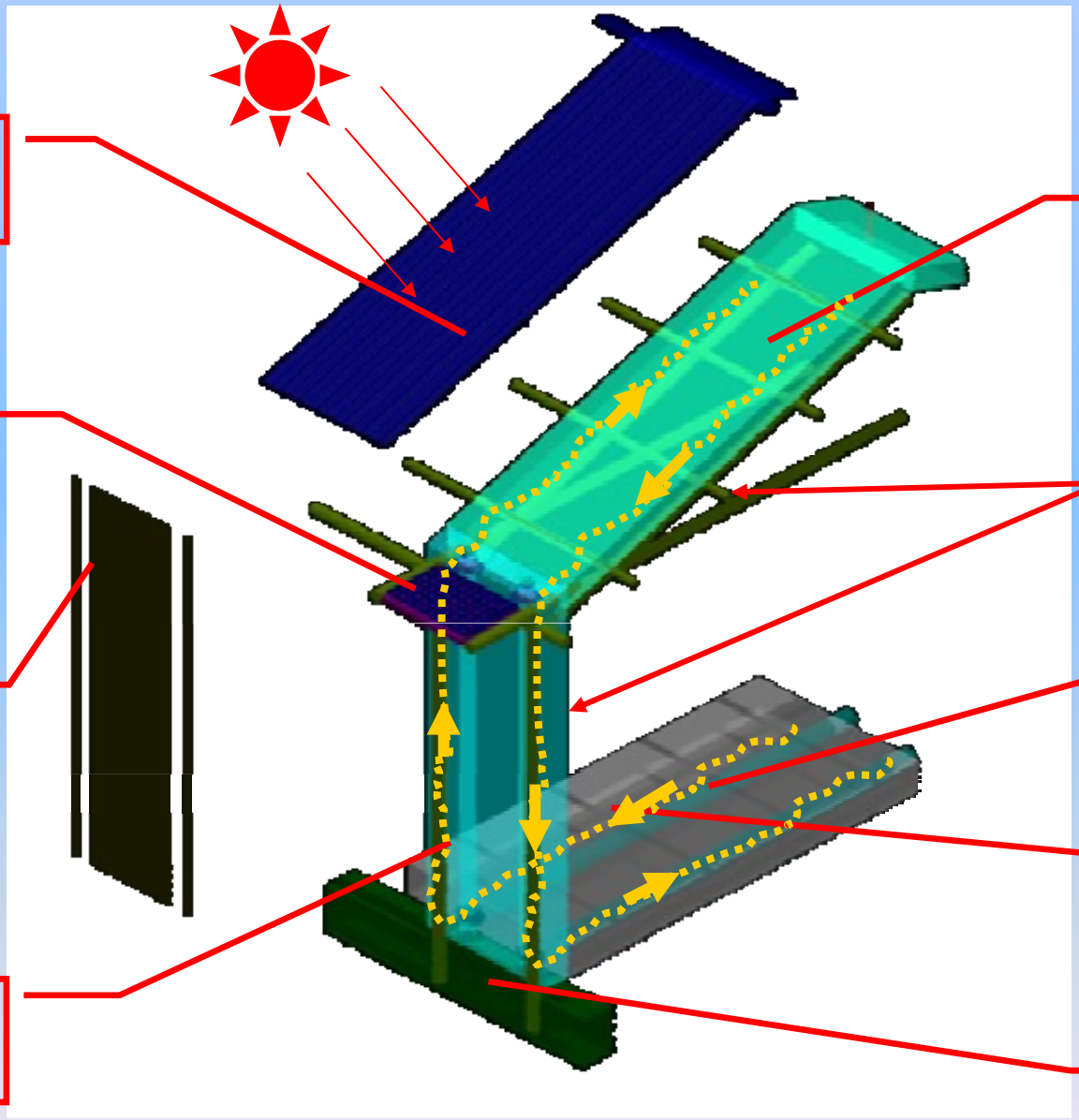
(located in Yunnan Province)

◆ Value-added utilization of bamboo culms in solar energy bamboo culm pre-fabricated house

Solar Energy Bamboo Culm Pre-fabricated House integrates collection technology of solar energy into bamboo culms prefabricated house. This bamboo house has the following characteristics:

◆ The bamboo culms are used both for structural materials and heat conduction channel;

◆ The application of solar energy technology and energy storage technology significantly decreases the consumption of energy during service life of house.



A schematic of solar energy/round bamboo demonstration house

Solar energy/round bamboo demonstration house developed by ICBR and CAF in China

Conclusions

- The both increase of bamboo biomass and production value during the past 30 years in China demonstrates that bamboo resources could be sustainablly utilized without resulting in negative effect on the environment.
- China has preliminarily realized the maximum value of bamboo culms by developing models of whole bamboo utilization. The primary processing factories play a very important role during the process.

Conclusions

- The value of bamboo products can be further added by secondary processing and broadening their fields of application;
- Scientific researches can stimulate the development of new high value-added bamboo based products or prolong the value chain of existing products, which are partially reflected by the rapid increase of bamboo industry of China since 2000 .


Thank you !