Bamboo Forestry in China

Toward Environmentally Friendly Expansion

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Bamboo, with a long tradition in China, is one of the emerging sectors in the Chinese economy. It is making an increasingly large contribution to farmers' income and playing an important role in rural industrial development. Bamboo products are also being substituted for wood products, a process that has been accelerated by a variety of policy measures. However, the bamboo expansion has come at a cost to the environment. This article discusses the bamboo sector, with particular focus on Anji County (Zhejiang), and reviews the new policies being applied in an attempt to integrate the interests of development and the environment.

Keywords: alternative wood products; ecosystem management; international forestry

Forestry is an essential component of China's rural economy, for both farmers and industry. The agricultural reforms initiated in 1979 led to a parallel reform of the forest sector. The most important measures affecting forestry have been various land reforms and changes in industry, investment, and export policies that have
created both opportunities and incentives for expansion and intensification of high-value forest crops. These reforms took place in four stages (Li 1996; Ruiz-Pérez et al. 1996):

• 1979–84: The principles of the Household Responsibility System (HRS), giving private management rights to farm families through land contracts, were applied to forest areas, with individual forest management contracts established throughout the country.

• 1985–91: The resource allocation system was changed, removing restrictions imposed by the planned economy on forest management, particularly the practice of monopolized purchasing by state companies.

• 1992–98: Market mechanisms were increasingly used to improve general macroeconomic conditions. Given the long cycles of forestry activities, forest contracts that were coming to an end were extended to between 30 and 50 years, and new forms of forestland allocation were explored, including auctioning management rights for remote areas or bare or waste lands with forestry potential.

• 1998–present: Chinese forestry authorities have begun to pay more attention to quality and management of stocks and to environmental functions.

The bamboo sector in China is a fascinating microcosm of the general situation in the country, and it provides a valuable window on the forestry sector. By focusing on a fast-growing and valuable forest species, we are able to trace the dynamics of change over a fairly short period.

About Bamboo

With between 300 and 500 species (depending on taxonomic criteria used), China has the largest bamboo resource in the world (Zhu et al. 1994b). Bamboo occurs naturally in most of the country except in the very high mountains and the driest areas, although most species occur south of 40° N. Because of its availability and versatility, bamboo is deeply rooted in Chinese culture, having been cultivated since Neolithic times. Dense bamboo areas occupy 4 million hectares distributed among 17 provinces, of which 1.25 million hectares are managed as plantations and 2.75 million hectares are dense, natural bamboo forests (Ministry of Forestry 2000). In addition, an estimated 3 million hectares of sparse bamboo grows in mixed forests and small bamboo with low economic value grows in high mountain areas.

Half of China’s bamboo species have a clumping habit, with a cluster of closely spaced rhizomes. These are known as sympodial bamboos and their distribution is restricted to the tropical–subtropical areas south of 30° N. The rest of species have a longitudinal type of rhizome (monopodial bamboos) or, less frequently, a mix of cluster and longitudinal rhizome (amphipodial bamboos). Monopodial bamboos are more versatile and therefore more widely planted.

Bamboo has two clearly differentiated uses. Bamboo culms (the large, lignified stems) have special properties, some of them similar to those of timber, and are used in construction scaffolding, mats, handicrafts, furniture, and other forest products (i.e., bamboo particle board and plybamboo, bamboo flooring, and pulp and paper). Bamboo shoots (the apical part of the young, new sprouts) are a classical edible vegetable considered a superior commodity.

The most common species, moso bamboo (Phyllostachys heterocycla), grows on more than 2.8 million hectares. This versatile monopodial species is good for both culm and edible shoot production. However, the recent demand for new products, especially for bamboo shoots, has stimulated a trend toward diversification. Although moso bamboo is still dominant, other species increasingly are...
being cultivated, especially for bamboo shoots. Overall, more than 100 species of bamboo are currently used in China.

Production
The importance of bamboo to Chinese forestry is highlighted by the fact that, although bamboo represents only 3 percent of China's total forest area, it contributes to some 25 percent of total forest exports. In 1999, the value of bamboo production amounted to $1.47 billion and the value of the bamboo industry sector was $1.32 billion, with total exports of $272 million in 1999 (Ministry of Forestry 2000). Approximately 5.6 million people work part- or full-time in the bamboo sector in China, of whom 4.5 million are farmers and 1.1 million work in the bamboo processing industry (M. Zhong 2000, pers. commun.). China's Forestry Action Plan estimated an increase of 1.2 million hectares of bamboo plantations and an "improvement" (normally meaning intensification) of 0.73 million hectares by the year 2010, doubling the bamboo culm production of the mid-1990s (Ministry of Forestry 1995; Li and Xu 1998). Senior officers at the State Forestry Administration (formerly the Ministry of Forestry) forecast that the bamboo sector could be the dominant forestry industry in China by 2050 (Li and Xu 1998).

Under planned industrial development, most bamboo was processed in special industrial zones, normally in urban areas. Little of the value added in processing was captured in the bamboo-producing areas. As a result of the shift to a market system and more flexible rules governing enterprise establishment, the bamboo sector has experienced rapid growth. Many new enterprises have been set up in raw material-producing regions, leading the way for the expansion of bamboo plantations (Gu 1992). This expansion (fig. 1) has occurred mainly on bare or "waste" land (a vague official term that indicates areas of low vegetation cover and little economic use); on formerly cultivated land on steep slopes; and on old tree plantations, mainly Chinese fir (Cunninghamia lanceolata) and pine.

While secure management rights and economic incentives paved the way for a gradual intensification and expansion of bamboo plantations, fertilization, pest control, and silvicultural measures have allowed for significantly increased productivity (measured as production per hectare at harvest) while maintaining higher stock densities (fig. 1). One-third of the total increase in bamboo output is due to increased area, whereas two-thirds is due to more intensive management. The total bamboo standing culms increased from 63.5 million metric tons in 1980 to 112.5 million metric tons in 1999, a yearly increase of 3.2 percent. The average stock density, measured in metric tons per hectare, increased from 20.1 in 1980 to 26.3 in 1999.

From 1980 to the early 1990s, bamboo prices rose at a rate consistently higher than the general retail inflation rate. In 1994–95, however, prices of culms and shoots stagnated and in some cases declined sharply. This is an indication of a market glut that can be traced back to the explosive and frequently chaotic expansion of the industry. Once the original demand gap was filled, substantial overcapacity led to fierce competition among enterprises in the processing industry. They responded by cutting prices to sell stocks, and transferred the price cuts to farmers. The Asian economic crisis, with reduced demand from the traditional Chinese bamboo export market and more competitive prices from other bamboo-producing countries such as Thailand and Indonesia, also contributed to the decline in prices.

Exports
Exports are an important part of the bamboo market in China. Their evolution in the past two decades shows three distinct trends (fig. 2):

- From 1980 to 1987 exports were minimal, concentrating on bamboo culms and low-quality manufactured products for the Asian market.
- In 1987, trade and foreign investment liberalization reforms allowed for foreign joint ventures with an export focus. The cumbersome procedures to export through state-controlled bodies were simplified, which allowed large enterprises to conduct direct exports. This had a clear effect in the bamboo sector, which responded with a marked increase in exports between 1987 and 1994. Two sharp depreciations of the yuan in 1989 and 1993 caused exports to soar. Bamboo shoots became increasingly important, representing between 35 and 45 percent of total bamboo exports after 1991.
- Since 1995 exports have declined due to the combined effect of a strong

Figure 2. Chinese bamboo exports, 1981 to 1999. Source: Chinese Forestry Yearbook, several years.
currency and the Asian economic crisis. This trend has been partially offset by the continuous increase in exports of bamboo shoots (which accounted for half of total bamboo exports in 1999) and by increased attention on quality exports and on nontraditional markets in North America and Europe.

This temporary glut in the internal and foreign markets, however, has not stopped the expansion and intensification of bamboo plantations. The industry is responding by shifting to other types of bamboo products, innovating, and improving quality. County-level bamboo associations have been established to regulate different aspects of the sector. Moreover, bamboo products like bamboo panel-board, bamboo flooring, and even mixed timber-bamboo paper can replace some conventional timber products (Zhu et al. 1994a; Zhu 1996). To promote this substitution, the Ninth Five-Year Plan and 2010 Long-Term Plan for the Development of Forest Science and Technology includes a key research project to improve technology for processing bamboo culms, especially for the production of plybamboo and bamboo-based particle boards. By the year 2010 it is expected that bamboo will substitute for 29 million cubic meters of wood (China Forestry Information Center 1999).

The widespread logging ban and restrictions implemented in 1998 may further stimulate the substitution of wood-based products with bamboo-based alternatives (Lin 1999). After four years of stagnation, bamboo culm production has increased 30 percent since the logging ban was decreed. Prices increased 5 to 10 percent in 1999, and new bamboo plantations increased 16.7 percent that year, making them the second most rapidly expanding new forest plantations in recent times (Ministry of Forestry 2000).

Environmental Problems

Chinese forest authorities are beginning to recognize that the success and tremendous growth of China’s bamboo sector has had both positive and negative results. For example, bamboo has replaced unsustainable agricultural production activities on steep slopes in counties like Muchuan and Chagning (Sichuan), reducing erosion, reservoir siltation, and flood risks. Highly productive bamboo shoots plantations have taken over irrigated land in counties like Linan (Zhejiang). Plantations in bare or annual arable land can contribute to carbon sequestration. Current average standing biomass in bamboo plantations is 26.1 metric tons per hectare, but intense moso bamboo plantations have between 50 and 60 tons per hectare, producing up to 10 metric tons of fresh bamboo culms per hectare per year. Tropical sympodial bamboo can produce up to 33 metric tons of fresh bamboo culms per hectare per year (Fu and Banik 1996).

More recently, however, bamboo expansion has come at the expense of natural forests, shrubs, and low-yield mixed plantations, as in the case of Pingjiang and Taojiang (Hunan), or Longyou and Anji (Zhejiang). It is common practice to cut down existing trees and replace them with bamboo. As forestlands tend to be in hilly and mountainous areas with steep slopes, clearcutting has resulted in an increase in erosion until the bamboo becomes fully established, which typically takes two years. Natural forests in the vicinity of bamboo plantations have sometimes given way to bamboo as a result of deliberate efforts to replace them or because of the vigorous natural expansion of bamboo in logged-over forests. This process has also had a negative impact on biodiversity.

At the same time, the intensive management practices employed involve manual or chemical weeding and periodic tilling of the land to keep the soil clear of undergrowth. These practices increase erosion and result in a
single-species plantation over vast areas, with all of the attendant biodiversity costs and economic and ecological risks. The intensive use of chemicals (pesticides, weed killers, and fertilizers) also affects the environment, although in general the authorities seem to be less aware of or concerned about this than about the erosion problems. Forestry authorities also are aware of the pest risks associated with large areas of bamboo monocultures, like the bamboo locust (Ceratoccius kiangsu) that devastated one-fourth of the bamboo plantations in Taoljiang County (Hunan) in the mid-1980s and that also affected, although less dramatically, Pingjiang County (Hunan) in 1995–96.

These types of problems are not exclusive to the bamboo sector, having being identified for the whole forest sector (e.g., Harkness 1998). However, the strong trend towards intensification of the bamboo sector makes it particularly important as a benchmark to study problems and alternatives in current Chinese forestry.

The intensity of the problems and the awareness about them varies from region to region, as does the priority given to development and conservation objectives, resulting in a varied set of policies at the provincial and county levels. An innovative approach is being followed in Anji County (Zhejiang), which produces some 5 percent of the total moso bamboo culms of China and is considered a model for other bamboo areas in the country.

The Case of Anji County

Anji is a mountainous county in the north of the prosperous Zhejiang Province, eastern China. The county, with a total area of 1,887 square kilometers, lies in the upper watershed of the Xi Tiaoxi, a river that flows into Taihu Lake, one of the largest natural lakes in China. Taihu Lake plays a major role in the hydrological cycle and flood control in key eastern areas of the country, notably Shanghai. Forests cover 58.3 percent of Anji's area, and bamboo represents 57.6 percent of the forest area, or one-third of the total area of the county. The dominant species is moso bamboo (Phyllostachys heterocycla), which has been cultivated in the region for centuries. The Anji County forest sector is clearly dominated by bamboo, which represents about 70 percent of total forestry output value. An estimated 64 percent of farmers manage bamboo as part of their activities, representing 15 percent of the average total farmer's income in the county (Anji Forestry Bureau, several years).

Moso bamboo propagates mainly through rhizomes. Its silviculture includes planting offset (young stems with rhizome) and tending them until stands are closed after three or more years depending on the environmental conditions and management intensity. The species sprouts from the rhizome in alternate years, known as "on-year." The new stems grow to full height in one year, but take about six years to reach optimum size and quality for bamboo culm (timber) production. The young sprouts can also be harvested as edible bamboo shoots, although other species have higher shoot quality than Phyllostachys heterocycla.

The introduction of the Household Responsibility System in 1983 reinvigorated a stagnant sector. Culm and shoot production has increased 1.86 times and 3.66 times, respectively, since 1980. As in other counties, the increased production is the result of both an expansion of the bamboo area and increased productivity. However, unlike some other areas, the opportunity cost of land in Anji is high, and bamboo must compete with other valuable land uses. This has limited the expansion of bamboo plantations and encouraged greater productivity increases during this period (fig. 3). With higher opportunity costs of land and a relatively prosperous economy near the large markets of Hangzhou and Shanghai, the farmers have moved quickly along the intensification path, with 20 percent of all bamboo areas in Anji already under intensive management. It is estimated that, on average, farmers annually use 200 kg of fertilizers (almost exclusively nitrogen) per hectare of bamboo plantations in this county. Most of the fertilizer is applied in preparation for the on-year.

The bamboo industry in Anji is very well developed and includes most of the main bamboo products, with the exception of paper. The bamboo-processing industry has expanded enormously over the past 20 years, particularly since the reform of the rural industry and the establishment of private bamboo enterprises, growing at an av-
verage annual rate of 34.5 percent from 1980 to 1999. In 1999, 18,900 workers were employed in the bamboo industry, with a production value of $164 million (Anji Forestry Bureau). Although collective enterprises still represent 33 percent of total bamboo industrial output in Anji (since 1997 Anji no longer has state-owned enterprises), most of this growth has come from private and foreign joint-venture enterprises.

A significant portion of Anji's bamboo production is exported, mainly to other countries in the region. Most exports are now undertaken through direct arrangements between the producing companies and customers in foreign countries. These exports amounted to $56.3 million in 1998, representing 64.2 percent of the county's total exports that year (Anji Forestry Bureau) and 17.6 percent of total Chinese bamboo exports.

Realizing the impact of land-use changes and bamboo intensification, the water, forestry, and environmental authorities of Anji are acting jointly to address the problem, moving swiftly to try new policies that could reverse the situation and allow for a combination of economic and environmental objectives to be balanced in the new vision of the county's forestry. Two major national policies are at the core of this initiative: (1) the 1995 central government decree (implemented for the first time in 1998) establishing "ecological demonstration zones," which would help attract tourism and access the incipient green market; and (2) the logging ban that followed the disastrous floods of 1998.

Three types of measures are being combined to meet economic and environmental objectives. The first is to establish demonstration plots where mixed plantations are managed to achieve the new multiple objectives and to study the effects of bamboo management practices on the environment. Three villages have been selected to test the approach and to demonstrate its potential to farmers.

The second measure is promotion of bamboo-based tourism in these demonstration areas. A campaign is directed to the large number of tourists that come to Anji to visit its massive bamboo plantations. This measure is supported by the positive experience of the Anji Bamboo Arboretum, the largest of its kind in China; established in 1989, the arboretum attracts 300,000 visitors per year.

The third and most important measure is establishment of environmental regulations linked to the management responsibilities that the farmers have under the Household Responsibility Management Contract. These include:

- Prohibition of cultivation on slopes greater than 25 percent.
- Requirement to maintain a minimum stocking density of bamboo, enforced through controls in harvesting permits.
- Reducing intensity of management practices by stopping soil loosening and complete clearance of undergrowth and reducing the use of fertilizers and pesticides.
- Promotion of mixed agroforestry systems that will increase soil coverage and improve runoff control.
- Ban on treecutting (mainly for fuelwood) in natural-broadleaf forests, and strict logging controls in plantations. Bamboo or other tree plantations can no longer replace natural forests.

In support of this last regulation, farmers are eligible for subsidies to compensate for potential benefits that they could have derived from the use of their land. This is a new development in the bamboo sector in China, and its results are potentially important given the weight of the bamboo sector in the country. Current yearly subsidies amount to $5.50 per hectare per year, although the provincial government target is set at $12.70 per hectare per year. This new policy has affected some 70,000 farmers and more than 35,000 hectares of (mainly) bamboo plantations in 1999–2000 (Anji Forestry Bureau).

To implement the policy, Anji forestry authorities are signing environmental contracts with farmers for the allocation of new Household Responsibility System forestland (mainly from collective land) or auctioned forestland, as well as incorporating environmental clauses in the current forest management contracts. The environmental management contracts are being extended for an initial period of five years. However, the Forest Bureau admits that its objective is to maintain them for at least 15 years, and that the reduced initial period is meant to check the viability of the new scheme and to test the effects of the economic

| Figure 3. Bamboo area and average productivity in Anji County since 1980. Source: Anji Forestry Statistics, several years. |
incentives and the length for which they are needed.

Preliminary results of ongoing research by the Chinese Academy of Forestry and the Center for International Forestry Research (CIFOR) indicate that the measures have encountered some resistance, for the following reasons:

- Farmers must forgo benefits, such as access to fuelwood. This sacrifice is small in general terms, given the increasing wealth of most farmers and the consequent shift to other fuels. However, it may be a hardship for some particularly disadvantaged groups.

- The environmental contracts frustrate plans farmers may have had to apply for permission to change to more profitable land uses (like bamboo, tea, or chestnuts).

- The new restrictions generate a feeling of insecurity about land rights.

At the same time, the compensation given to eligible farmers, albeit small, has sent a positive signal, and its formalization under a contract agreement has given farmers some reassurance that they are not stepping backward in their acquired land rights. This, together with the memories of recent floods, the fact that many farmers have direct experience with erosion problems and have seen quick results with the new policy, and an interest in attracting ecotourism to the county, seems to be working in favor of a voluntary adoption of the policy.

In Anji County, for the first time environmental objectives are being incorporated in the thriving bamboo sector in China, and farmers are being offered some economic incentives to move to an enlarged vision of the role of bamboo plantations that includes environmental protection. This signals a significant change in forest management approaches in the country, and may offer a preview of things to come.

Literature Cited


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