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CHAPTER 8

*Forestry, Poverty, and
Rural Development**Perspectives from the Bamboo
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THIS CHAPTER AND THE NEXT examine two issues, income distribution and the environment, that are increasingly important in contemporary China as a result of 20 years of successful reforms and economic growth. Rural incomes have increased more than 600% since 1978, but more rapid growth in China's urban areas and especially around its coastal cities has created an expanding disparity between the incomes of urban and rural households and particularly between western China and the rest of the country. China's leaders demonstrated their concern by introducing the Western Regional Development Program in 1997 to address the imbalance.

Meanwhile, China also experiences several environmental problems related to its rapid growth: deteriorating air quality in the cities, deteriorating water quality downstream from many industrial sources, and continued soil erosion, an age-old problem. China's leaders are addressing these environmental problems as well. Premier Zhu Rongji, in the Government Report to the People's Congress on March 5, 1999, identified sustainable development as one of two fundamental government policy strategies for the twenty-first century. President Jiang Zemin stressed the importance of environmental protection at the annual workshop on Population, Resource, and Environment on March 13, 1999, when he announced that any enterprise not in environmental compliance by 2000 would be closed.

We are most interested in forestry's role with respect to these issues, particularly its potential for helping overcome poverty and income disparity and its function as a source of both environmental loss and environmental recovery. We will examine the first issue in this chapter, and Sayer and Sun will examine a component of the second in Chapter 9. Both topics include an extensive range of issues, yet little empirical research has been conducted on either. Therefore, we will rely on evidence from our own research in the bamboo subsector of forestry

to illustrate the impacts of forest development on rural households and, in Chapter 9, Sayer and Sun will highlight their concern for the loss of natural forest habitat as an example of the very serious environmental consequences of China's forest transition.

This chapter begins with a summary of the state of rural poverty in China and the potential role for forestry. It continues with a general discussion of the bamboo sector and then presents evidence from our own research regarding the household income effects of the rapid expansion in bamboo production. Bamboo in all of its many uses is the third most important forest product in China (after fuelwood and commercial timber). It is a particularly useful product for our inquiry because it has not been subject to as many policy restrictions as commercial timber. Therefore, its recent history is more representative of the impacts that unfettered forestry-sector development could have on household incomes and general regional development. We will observe that many households have benefited from the expansion in bamboo production, but the poorest have not been the greatest benefactors. Furthermore, bamboo seems to have a role in development, but its importance declines as development progresses. These observations on bamboo do not reject the standard arguments about forestry as a development leader. However, they do prompt us to urge caution in their applications, particularly with regard to assistance for the very poorest.

Poverty and Forestry

Despite China's rapid growth, tens of millions of its people are still poor. In 1998, 230 million people, 18.5% of the population, lived below the US\$1 per day international standard of poverty. Even under China's narrower standard of income poverty, 60 million people, 4.6% of its population, are considered absolutely poor (World Bank 2000).¹

Poverty is more pronounced in the rural areas. Average rural per capita income is less than 40% of the urban average, and rural living expenditures are less than 35% of urban expenditures per capita (*China Statistical Yearbook* 2000). The nature of poverty is different in rural and urban settings as well. Because the land distribution component of China's reforms was conducted in an egalitarian manner within each village, rural poverty has less to do with food security than with a generally lower level of social services and a higher level of vulnerability to natural hazards and macroeconomic fluctuations (Chapters 1 and 2, Jalan and Ravallion 1999, Liu et al. 1999).

Economic development has been a source of increasing household and regional differences. For example, per capita gross domestic product (GDP) in southwestern China is only 44% of that in the eastern coastal areas, and that gap has been increasing (*China Statistical Yearbook* 2000). For another example, minority nationalities account for only 9% of China's total population, but they account for around 40% of the population in absolute poverty (World Bank 2000).

Remoteness and isolation are correlated with poverty. In the mid-1990s, 496 of the 592 officially designated poverty-stricken counties were in mountainous

regions (MOF 1995). It is frequently in these less accessible areas, where natural constraints limit agriculture, that forests have been preserved. Therefore, the pattern of isolation, poverty, and extensive forest cover is common, and disentangling the causal links is a difficult task.

The poor performance of the forest industry relative to China's full industrial sector compounds the situation (Research Group of Forestry Economics 1998). The Third National Industry Survey showed that financial losses are common in all forest enterprises, but state-owned forest enterprises (SOFEs) fare the worst. The average deficit in the SOFEs was 13.9 percentage points higher than the average for all industrial sectors (SFA 1999). Forest workers have among the lowest standards of living in China, and their salaries appear at the bottom of the list of more than 60 sectors published in the national statistics. The average forest worker receives only 55% of the national average salary (Chen and Lu 1999, *China Statistical Yearbook* 2000).

At the same time, forestry often represents the main—and sometimes the only—income-generating activity in many poor regions. At a national level, forestry contributes only 2% to farm-derived rural cash income (*China Statistical Yearbook* 2000). However, in some of the income-poor but forest-rich counties, forestry is the source of up to 80% of household revenues (Da 1999, Zhang 2000). Indeed, forest industries are often the only industry in many poor counties. In these cases, they are both a pillar for the development of the local economy and a critical taxpayer (Peng 1999, Zhang and Yuan 1999).

Some argue, with reference to the high correlation between the occurrence of forests and poverty, that the depletion of forest reserves aggravates poverty (Niu and Harris 1996, Smil 1997, Harkness 1998). Others see it differently. Li and Veeck (1999) explored the contribution of forests to rural income in poor areas with multicounty economic models based on county and provincial statistics. They found significant overlap between counties officially classified as having abundant forest resources (*senlin fengfu xian*) and those classified with severe poverty (*pinkun xian*), yet no relationship between forest variables and income. They concluded that the availability of forest resources contributes only slightly to per capita income.

Therefore, opinion is divided, and the question remains: do forest resources and forestry activities promote rural development, or are they part of the poverty trap? We will explore this issue with reference to the bamboo subsector.

General Forestry Opportunity and the Bamboo Subsector

Why is bamboo an appropriate focus for our inquiry? Bamboo has comparative advantages over commercial timber: a short production cycle, expanding demand, relatively unregulated harvest and shipment, and low taxation. It is an alternative investment for farmers who recognize the potential gain from commercial timber investments but find timber operations highly regulated. The regulations reduce timber's financial returns and also make them less certain. Farmers are more confident that they can claim the eventual gains from invest-

ments in bamboo for themselves. In Chapter 2, Liu and Edmunds observed farmers investing in bamboo for this reason in Hunan and Zhejiang. In Chapter 3, Liu et al. observed the same behavior throughout the Southern Collective Forest Region. Others have observed it as well (Joint Survey Group 1999, Wang and Zhao 1999, Cao and Zhang 1997). It suggests that our observations of investment behavior and income returns in bamboo are indicative of what we might expect if China loosened its regulations on harvest levels and shipments for commercial timber.

Private Forest Opportunity

China has one of the lowest per capita forest endowments in the world—about one-half the world's average. This implies that the accessible natural forest is small relative to the demand for forest products and, therefore, it is not surprising that China relies on managed stands for a large share of its forest production. Farm production of forest products is unusually important.

This point affects forest investment and development planning, and it has a direct effect on how forestry contributes to household incomes and poverty alleviation. Forestry departments at different administrative levels, as sole authorities or in conjunction with other departments, have the mandate to implement development plans on forestland. However, their regulations constrain timber harvest levels and shipment, even from farmlands, and the taxes and charges they impose are further disincentives. Furthermore, forestry departments generally permit the conversion of designated forestland to other uses only with the (unlikely) permission of the local planning authority. Therefore, farmers looking for opportunities to improve the returns on their lands within the restrictions of the law often turn to crops such as bamboo and fruit trees.² China classifies these crops as “economic forestry” in its unusually broad definition of forests.

In sum, this means that farmers, forest farms, and the forest authorities actively engage in the expansion of orchards and bamboo plantations on forestland, auctioned wasteland, and even some former cropland (Hanstad and Li 1997, Yu et al. 1999). Economic forestry expanded from 6.1 million ha with 7 million metric tons of output in 1978 to 21.9 million ha with 53 million metric tons of output in 1997. China ranks first in the world in the area and output for these crops. Similarly, bamboo plantations increased from 3.2 million ha and 4.4 million metric tons of output in 1980 to 4.3 million ha and 14.2 million metric tons of output in 1999 (Ruiz Pérez et al. 2001). Thus, while conventional timber forests have been depleted and the timber-based forest industry shows signs of stagnation, economic forests in general and bamboo plantations and their associated industries in particular are thriving, offering farmers good opportunities to increase their incomes and to emerge from poverty.

The Bamboo Subsector

The remainder of this chapter traces the recent development of China's bamboo sector beginning with a discussion of bamboo itself and continuing with our

research experience, first in Anji County and then in an extended comparison of six counties.

Between 300 and 500 species of bamboo (depending on the taxonomic criteria) grow in China. More than 100 have commercial value (Zhu et al. 1994). In the mid-1990s, China had 7 million ha of commercial bamboo forest, 4 million ha in plantations, and the remainder in natural stands. The most common species, moso bamboo (*Phyllostachys heterocycla*), occupied 2.8 million ha. By 1999, bamboo accounted for 3% of China's total forest cover, but contributed about 25% of the value of China's forest exports. The total value of unprocessed and processed bamboo products was 23.14 billion yuan (US\$2.8 billion) (SFA 1999).

Bamboo's uses fall into two main categories. The culms (stems) are used in timberlike applications in unprocessed (poles and scaffolding) or processed (panels, bamboo flooring, pulp, and paper) forms. Edible bamboo shoots are used as a vegetable, fresh or in various processed forms.³ Because of this dual use, bamboo has economic characteristics of both conventional timber-oriented forests and fruit-bearing trees.

Bamboo plantations have several attractive economic attributes. Their investment costs are low, their production cycle is annual or biennial, and their multiple products allow for flexible market responses. Culm production has a longer production cycle than shoot production. It provides a generally stable core economic activity with reliable financial returns. For moso bamboo, shoots are a biennial crop. The financial returns are often greater than those of culms, but the prices of moso shoots are also more volatile, and it is easier to expand or contract shoot production in response to changing market conditions. Bamboo plantations are more profitable than industrial timber, generating between two and five times the income per unit of land generated by Chinese fir or pine plantations. Consequently, when environmental conditions allow, farmers find bamboo more attractive than timber plantations and they actively replace conifers with bamboo.

The logging ban imposed in 1998 increased the demand for timber substitutes, and bamboo production benefited immediately. Bamboo prices were still increasing at a 5–10% annual rate in 1999, and new bamboo plantations increased by almost 17% in the same year. Culm production has increased by 30% since 1997. Some expect that bamboo will substitute for 29 million m³ of wood by 2010 (CFIC 1998), and some at the State Forestry Administration believe that bamboo could become the dominant forest industry in China by 2050 (Li and Xu 1998).

Anji's Experience⁴

Anji County is in Zhejiang, an economically dynamic coastal province near Shanghai. It is one of four provinces that account for two-thirds of China's bamboo plantation area, and one of ten provinces known as the “native place of bamboo.” The province in general and its bamboo sector in particular began developing earlier and more rapidly than some others, but its pattern of development is a pattern that other bamboo producing provinces have followed since, and it is a pattern that we might anticipate for forest development in general.

In 1975, Anji had 51,400 ha of bamboo, almost 99% of it managed by local collectives with the small remainder managed by state farms. Bamboo was sold through the state marketing cooperative (a monopoly) at a fixed procurement price. By 1998, primary bamboo production accounted for 70% of the forest output value in Anji and 15% of total farm income. The bamboo-processing sector accounted for 67% of the county's total industrial output, a very substantial increase from only 8% in 1980.

Beginning in 1980, the government allowed market sales of all output in excess of production quotas. The productive area in bamboo immediately increased almost 5%. However, the sharpest increase in Anji's production came in 1983–1984, with the adoption of the household responsibility system (HRS). The collectives managed 43,000 ha of moso bamboo in 1982 but only 3,400 ha by 1984. Individual farm household management increased from zero in 1982 to 40,000 ha by 1984. Total output in the county increased 63% between 1983 and 1988, mostly due to intensification and with little expansion in the land area devoted to bamboo. Average production increased from 208 culms/ha in 1975 to 224 culms/ha in 1982 to 333 culms/ha in 1989.

Market prices were higher than procurement prices during the early reform years. They were an incentive for farmers to bypass the quotas and the lower procurement prices, and most of the increase in production after the introduction of HRS was sold at the higher market price. This forced the government to continually revise its procurement prices upward until the two-price system was eliminated in 1985. By this time, individual farmers were responsible for 91% of the county's total production of bamboo.

Prices and production continued to increase until 1990, when excess supply caused prices to decline temporarily. Production declined 12% in response but subsequently more than recovered, increasing another 29% by 1994. Altogether, prices increased almost 300% (in constant terms) between the late 1970s and mid-1990s. The production of culms increased 79% over the same period and 90% by 1998. Total production increased even more if the output of bamboo shoots is included.

The Development of the Processing Sector. In 1978, 96% of Anji's bamboo was sold in unprocessed form and shipped out of the county. Nineteen local bamboo-processing establishments employing 460 workers produced three general categories of processed goods—mats and flooring, shoots, and handicrafts and furniture—worth only 960,000 yuan (US\$670,000).

Local processing capacity grew rapidly, however. The initial reforms in the marketing system that allowed market sales of production in excess of quotas provided a basis for many new nonstate (township and village enterprise or TVE) processing facilities. The TVEs also provided an outlet for China's vast accumulation of private savings. By 1985, Anji had 154 bamboo-processing establishments that employed 3,370 workers and produced 12.31 million yuan (US\$4.16 million) of annual output.

Joint ventures with foreign investors were approved for operation in Anji in 1988, and Chinese participants were permitted to retain their foreign currency

earnings. This reform fueled a second round of expansion in processing capacity. Nineteen new joint ventures employed more than 3,000 workers and produced 36 million yuan (US\$4.5 million) of annual output by the mid-1990s. Much of their output was exported, as exports from domestic operations and joint ventures combined exploded from US\$100,000 in 1980 to \$23.4 million in 1994 to \$56.3 million in 1998.

The joint ventures introduced new physical capital and improved technologies, creating a wider range of products and enhancing product quality. Competitiveness and opportunities in external markets improved, and they created a local multiplier effect that increased the demand for culms and shoots and encouraged the establishment of many small household preprocessing units in support of some of the larger joint ventures.

Rapid growth in the processing sector put upward pressure on the prices of the primary bamboo resource until the mid-1990s. In response, the marketing system gradually grew more specialized. Marketing intermediaries began appearing until more than 200 bamboo traders were operating by the mid-1990s. Meanwhile, some processing establishments, concerned for the supply of their own raw materials, began arranging production agreements with farmers at prices agreed upon before the harvest period. Some agreements even included cash advances. Eventually, the processing sector began importing raw material from other counties.

By 1998, 1,182 processing establishments employing 18,914 workers were operating in Anji. Annual production exceeded 875 million yuan (US\$105 million) in value. However, the entire increase in processing between 1975 and 1998 occurred while the number of bamboo farmers expanded only moderately from 111,000 to 123,000. By 1998, infrastructure development and specialization in processing had developed to the point where Anji's farmers shipped one-third of their unprocessed bamboo (mainly low-value small culms and branches) out of the county, while the processing industry imported an amount equal to 20% of local raw material production.

The sector went through a period of stagnation in the mid-1990s, but it has since recovered. First, the new supplies of raw materials from outside the county dampened the upward pressure on raw material prices, then the East Asian financial crisis of 1997 decreased export demand. The processing sector experienced a period of overcapacity and adjustment. It recovered in the late 1990s, and growth has continued, although at a diminished rate. The sector we observe today, including both its raw material and its processing components, could probably be called "mature."

Bamboo and the Distribution of Farm Income.⁵ The growth in primary bamboo production over the period of China's reforms has been impressive, but it has been achieved with little expansion in the number of farm households or area managed. The sector has diversified from a strictly farming activity to incorporate a full range of marketing and processing activities that employed almost 19,000 new workers in the county by 1998. However, the bulk of those affected by the rapid expansion of Anji's bamboo sector remain the more than 120,000

Table 8-1. Basic Township Data, 1994–1995

Township	Population	Total area (mu)	Population				Bamboo (mu/person)
			density per km ²	Riceland (mu)	Rice (mu/person)	Bamboo (mu)	
Kuntong	16,155	135,036	179.5	5,571	0.34	68,633	4.25
Fenghuang	14,918	130,510	171.5	5,928	0.40	57,496	3.85
Gangkou	9,783	71,609	204.9	4,737	0.48	48,067	4.91
Tianhuang	19,001	151,952	187.6	11,475	0.60	64,848	3.41
Baofu	18,316	200,636	136.9	8,303	0.45	94,506	5.16
Zhangchun	15,656	131,071	179.2	6,867	0.44	64,728	4.13
Yonghe	13,463	162,980	123.9	5,337	0.40	80,225	5.96
Chiwu	12,479	111,550	167.8	6,092	0.49	47,896	3.84

Note: Mu is a traditional measure of land area that varies according to land use. For the normal mu used here, 15 mu = 1 ha.

Source: Anji Bureau of Statistics.

bamboo farmers themselves. We will examine the effects of the sector's growth on their incomes.

Our analysis is based on several years of research. We began with discussions with key informants across the county, and followed these discussions with a household questionnaire inquiring about land status and land use, income sources, labor, and expenditures. Two hundred survey participants were selected from a stratified random sample of households from five villages per town in each of the eight towns in the county. We assembled the data from the questionnaires in biennial increments corresponding with bamboo's two-year production cycle, and we supplemented the survey data with evidence from farm records since 1989–1990. We feel confident of farm records dating forward from that time.

Tables 8-1 and 8-2 summarize the basic township data and characterize the typical farm household in 1994–1995. Average farm household income was 14,033 yuan. Farm income derived from four principal sources: rice production, livestock, bamboo production, and off-farm employment. Bamboo was the second most important source (after off-farm employment). It provided 25% of average household income, 21% from culms, 2.5% from shoots, and 1.5% from branches. The 1989–1990 farm records do not provide the full data for comparison, but we know that bamboo provided 24% of farm household income in 1989–1990, and household incomes in the mountainous regions of Anji rose 37% in real terms between 1989–1990 and 1994–1995. The rate of income increase among our households (6.7% per year) was slower than for all Chinese households but more rapid than for all farm households.

We separated the 200 farm households into five income classes to examine whether the importance of bamboo changed with the level of farm income. Figures 8-1 and 8-2 describe the results for each income quintile for 1989–1990 and 1994–1995, respectively. Both figures demonstrate a convex shape, which means

Table 8-2. Basic Data of the Farmer Sample in Anji County, 1994–1995

Variable	Mean	Standard deviation	Minimum	Maximum
Age, head of household (years)	43.6	8.88	24	69
Family size	4.0	1.05	1	7
Workers per family	2.6	0.89	1	6
Education level ^a	2.1	0.74	1	3
Arable land (mu)	2.7	1.83	0.2	18
Cash trees (mu)	0.4	1.53	0	14
Bamboo (mu)	14.9	10.05	1	70
Other forest (mu)	3.5	10.49	0	111
Total land (mu)	21.2	15.64	2.8	127

^aEducation level in three categories: 1 = high school (12 years); 2 = secondary school (9 years); 3 = primary school (4 years).

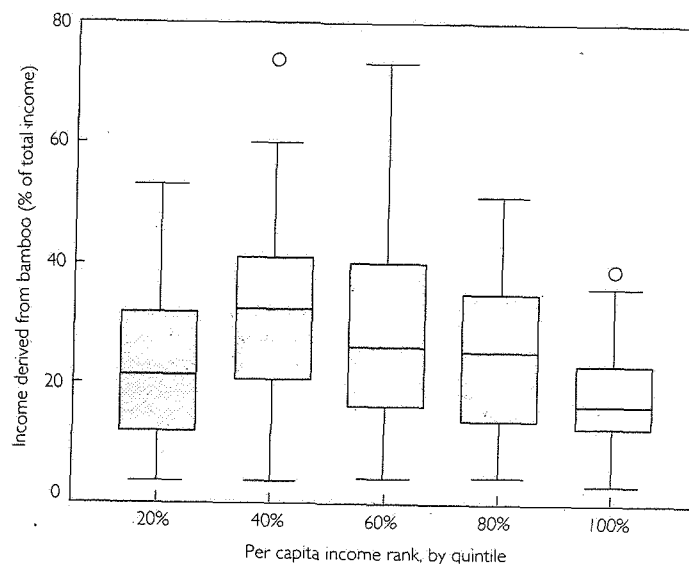


Figure 8-1. Relative Importance of Bamboo Income in Anji County, by Household Income Class, 1989–1990

Note: Median, interquintile range, and extreme values for the contribution of bamboo income to total income in each quintile.

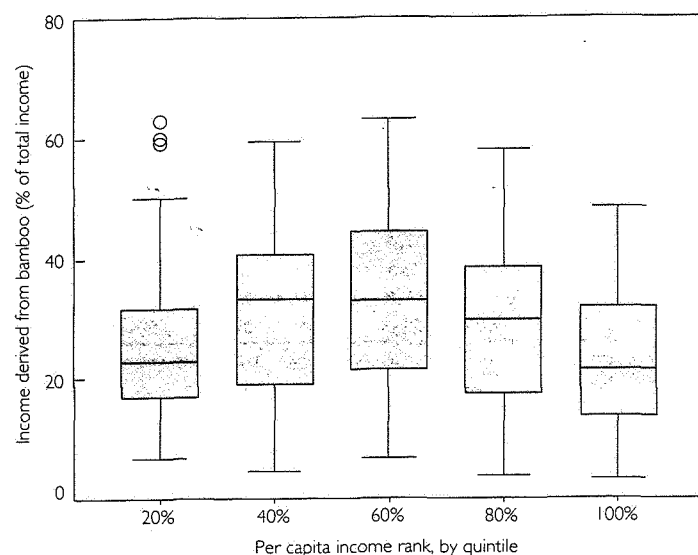


Figure 8-2. Relative Importance of Bamboo Income in Anji County, by Household Income Class, 1994–1995

Note: Median, interquintile range, and extreme values for the contribution of bamboo income to total income in each quintile.

that bamboo was a more important source of income for middle-income quintiles—providing up to 30% of household income for the second quintile in 1989–1990 and the third quintile in 1994–1995. Bamboo was the source of barely 20% of total income for the extreme quintiles in either period.

The 1994–1995 survey shows that agricultural income was relatively constant across all quintiles. Therefore, we conclude that agriculture provided a common economic foundation for all farm households. Income from bamboo increased in absolute terms (but not relative terms) for higher quintile households. It was an increasingly important source of on-farm income for higher quintile households. However, off-farm employment was the largest source of the income difference between households in the different quintiles, and it was especially important for households in the highest income quintile.

We are at least as interested in what explained the growth in household income. This is the information that will show whether bamboo helped increase household income and helped the poorest households escape poverty. We examined the sources of income growth by regressing the difference in per capita income over the five-year period on various measures of household labor and land resources. Table 8-3 reports the results. Clearly, male labor, arable land, bam-

Table 8-3. Sources of Difference in Per Capita Income in Anji County, 1989–1990 to 1994–1995

Variable	B-coefficient	β -coefficient	T-value
Age, head of household (years)	-19.8	-0.127	-1.996
Family size	-297.8	-0.225	-3.198
Male/total labor ratio	1,361.6	0.152	2.244
Arable land	114.6	0.151	2.373
Bamboo land	53.9	0.390	5.997
Off-farm/total work ratio	855.2	0.157	2.420
Township	107.5	0.178	2.717
Constant	1,632.8		2.863
$R^2 = 0.341$	Adjusted $R^2 = 0.317$	$F = 14.178$	Probability $F < 0.0001$

boo land, and off-farm employment had critical income-increasing effects. The income elasticities of bamboo land and off-farm labor are 0.32 and 0.48, respectively. They mean that a 1% increase in bamboo land increased household income only 0.32% for the average family, while a 1% increase in the ratio of off-farm employment to farm employment increased household income 0.48%. Once more, it is clear that the improvements in bamboo production opportunities benefited household incomes, but additional off-farm labor opportunity was the crucial ingredient for the significant income growth that occurred over the period between 1989–1990 and 1995–1996.

Multicounty Comparison of Bamboo Development

Anji is an interesting case because it illustrates a complete pattern of development from the expansion of production of the primary resource to the early development of a resource-processing sector to the sector's full diversification, technological advance, and participation in global markets. The period of this pattern corresponds to the 20-odd year period since the beginning of China's economic reforms. However, Anji is only one county, and confirmation (or rejection) of its growth pattern with evidence from other regions would provide a better basis for conclusions that can be generalized about bamboo or broader forest production, development, and impacts on household incomes.

Therefore, we extended our earlier research to include six counties in three provinces along the east-west gradient of China's subtropical bamboo producing region (Anji and Longyou in Zhejiang Province, Pingjiang and Taojiang in Hunan Province, and Muchuan and Changning in Sichuan Province [Figure 8-3]). The eastern counties are closer to the larger domestic markets and also to the coast and its export opportunities. Household incomes are higher in the east, and the two eastern counties have grown more rapidly than the other four. In fact,

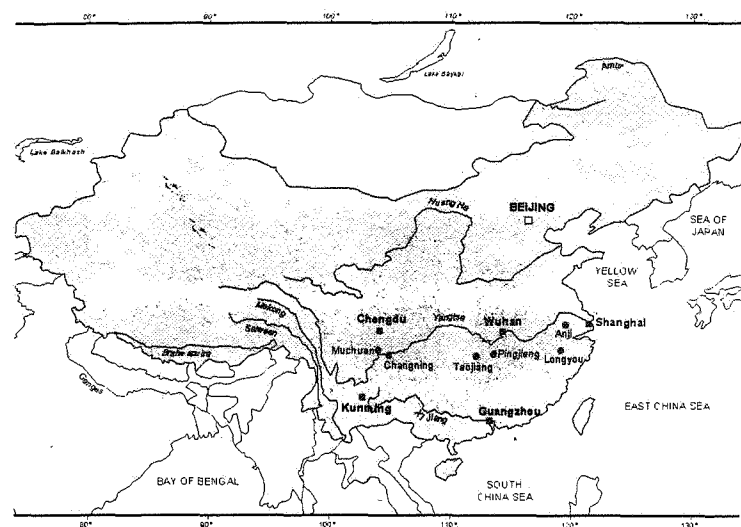


Figure 8-3. Areas of Bamboo Research

Note: Circles indicate counties where research was conducted; dark squares indicate provincial cities.

GDP growth in these two counties was even more rapid than national growth between 1980 and 1998. This eastern growth has contributed to the increasing regional income differences that have become a major new policy concern in China and one justification for this chapter.

On the other hand, China has actively invested in infrastructure over the past 15 years. This investment, especially in highways and railroads, and continued economic reform should have improved the competitive position of producers in the less accessible western regions. Where development in western China has followed Anji's experience, only with a lag in time, we have the information to draw generalizable conclusions about bamboo, development, and impacts on household incomes. Otherwise, observations different from or even contrary to those of Anji would raise new questions and prompt us to use caution in making generalizations from Anji experience. Observations on the pattern of development have become more critical since China embarked on its aggressive Western Regional Development Program in 1997. Evidence that conforms with the pattern of development observed in Anji will allow us to anticipate some of the potential future effects of this new program.

Our assessment of the six new counties is based on county-level statistics from 1980 to 1998, interviews with key informants in all six counties, and detailed surveys of farm households and industrial firm managers in three of those counties (Longyou, Pingjiang, and Muchuan).⁶

Primary Production⁷

In general, bamboo prices increased relative to the national price index for all commodities from the mid-1980s until 1994. They provided a signal for expansion and intensification (Gu 1992). Price stagnation in 1994 deterred further growth in the sector until the logging ban in 1998 provided a new stimulus for bamboo as a substitute for industrial timber. The number of farmers growing bamboo in the six counties increased from 244,000 in 1980 to 465,000 in 1998 as the share of all farmers growing bamboo expanded from 19% to 26%.

Production increased in each of the six counties, and key informants in all six identified the stable policy environment as a precondition for expansion. (This observation supports a central point of Chapters 2 and 4.) Culms were the dominant product in all three regions (from moso bamboo in the east and center, and from *Sinocalamus affinis* in the west), but all counties have begun diversifying and expanding their production of bamboo shoots. Land opportunity costs were greatest in the two richer eastern counties. Both the land area in bamboo and the number of farmers growing bamboo expanded least in these counties. The eastern counties are mountainous, and the expansion that occurred in these counties was assisted by regulations restricting agriculture and encouraging forestry on slopes greater than 25%. The central county of Taojiang suffered a bamboo locust plague in 1983 that affected 25% of the county, sharply reducing its production and limiting the expansion of its land area in bamboo for several years. The land area in bamboo expanded most rapidly in the two western counties.

Productivity per land unit was higher in the eastern counties than in the central counties, and the expansion in eastern bamboo production was almost entirely due to intensification. The richest county, Anji, experienced the highest average productivity (25 culms/mu or 315 culms/ha), and the poorest, Pingjiang, experienced the lowest (only 7 culms/mu or 105 culms/ha). This difference is consistent with the expectation of greater farm specialization, capital availability, and opportunity costs of land and labor in the richest counties, where farmers invest more in their bamboo plots.

Bamboo production expanded most rapidly in the two western counties, although productivity is not strictly comparable between the west and the other two regions. The species typically planted in the west cost less to establish and have a shorter production cycle than that planted in the east.

The Processing Sector

The processing industry expanded in five of the six counties, offering opportunities for farmers to increase their bamboo production and obtain additional income from household-based preprocessing as well as off-farm employment in the processing industry (Table 8-4). However, the profile of the processing industry differed markedly across counties, both in its 20-year growth trend and its current composition. We will review the experience of those three counties (Muchuan in the west, Taojiang in the center, and Longyou in the east) for which we have the benefit of survey responses from enterprise managers.

Table 8-4. *Percentage of Local Processing of Bamboo Culms*

County	Local processing (%)		
	1980–1985	1995–1998	Increase
Anji	14	62	48
Longyou	10 ^a	71	61
Pingjiang	41	23	-18
Taojiang	38	100	61
Changning	23	88	65
Muchuan	100	100	0

^aData for 1983–1985 only.

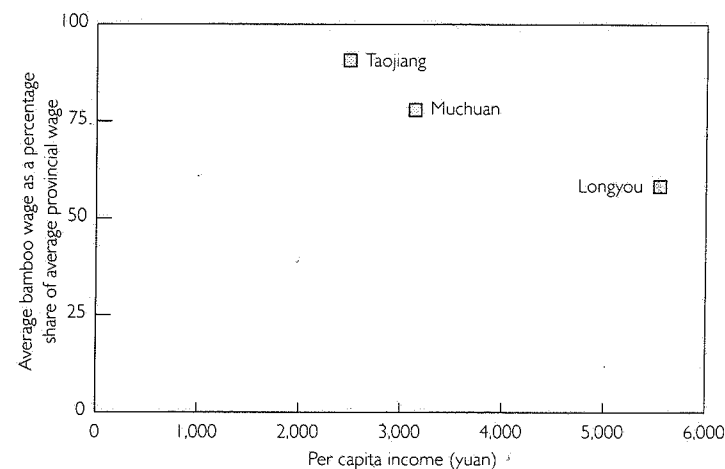
Muchuan. Muchuan's industrial sector is not diverse, neither generally nor in its bamboo processing. Paper accounted for 99% of all processed bamboo products and 36% of all county industrial output in 1998. The many small-scale, labor-intensive, private mills that produce specialty ceremonial papers characterize the industry, and they have been responsible for the sector's greatest growth over the past 20 years. Nevertheless, the county does contain a few mechanized mills, one of which increased its capacity to 60,000 tons/year in 2001.

The high rate of profit in Muchuan's paper industry (24%) indicates an industry that is growing and that will continue to expand. In fact, we should expect continued growth because China's aggregate growth has been so strong and sustained and because the paper industry generally grows faster than per capita income growth in most countries.

Taojiang. Taojiang's economy is somewhat more diverse than that of Muchuan or Longyou. Bamboo processing made up only 12% of total industrial output in 1998. Bamboo mats, an industry that did not exist in Taojiang before 1992, comprise 84% of all processed bamboo output. The industry's 19% profit rate indicates that it is still growing and probably will continue to grow.

Of the three counties, Taojiang has the lowest wage, lowest per capita income, and highest contribution of the primary sector to county GDP. The opportunity for the processing sector has been good. The industry can take advantage of low wages, and it has expanded more rapidly than the industry in Muchuan or Longyou.

Longyou. Longyou is the most developed of the three counties. Its per capita income is approximately twice that of Muchuan or Taojiang, and its industrial structure is more diverse. Bamboo processing comprised only 7% of total industrial production in 1991, and it has declined ever since. The paper industry dominates the bamboo sector with 54% of total output, but the plybamboo and bamboo shoot industries have expanded more rapidly. [The sector also includes the lesser (but important) flooring, mat, broom, and chopstick industries.] The sector has grown over the past 20 years, but its current rate of profit (8%) is approximately that observed in other industries in the county. This means that bamboo processing has no competitive edge in Longyou, and it is no longer a leading industry.

Figure 8-4. *Relationship between Per Capita Income and Relative Ratio of Bamboo Industry Wage, 1998*

Wages, Employment, and Farm Incomes

Wages and Employment in the Processing Sector. Forestry-sector wages were only 55% of the national average in 1998. Their relation to wages in other sectors varies widely. They were among the lowest of any sector in China. In our three counties, wages were 78% of the provincial average in Muchuan, 91% of the provincial average in Taojiang, and only 58% of the provincial average in Longyou.

The implications of these observations on relative wages become clearer when we compare them with per capita income in the forestry sector (Figure 8-4). They lead us to develop a three-part proposition:

- In regions where both the industrial diversity and the general state of economic development are greater, then industry in general and the forest industry in particular must compete for labor, and salaries and incomes in the sector are bid up. Forestry-sector salaries are higher than forestry-sector salaries in other regions because they have been bid up by the other local industries, but forestry-sector employment is still compensated at a lower rate than alternative employment in these regions. Because wages are high, this sector is not a likely candidate for the expansion of relatively labor-intensive forest activities.
- In regions where neither the industrial diversity nor the level of regional development is as great, employment alternatives are more limited, and forestry-sector wages are closer to those of alternative employment. All wages, including those for the forestry sector, are low—reflecting the lower level of

regional development and, perhaps, greater competition for low-wage employment.

- The opportunities for industrial expansion are greater in the latter case, especially for relatively more labor-intensive industries such as bamboo production and processing, for which low wages have the most beneficial effect on production costs.

The first case characterizes Longyou, which has a diversified industrial sector in general and a diversified bamboo-processing sector in particular. It is the most developed and has the highest per capita income of the three representative counties. Wages are higher in general in Longyou, but bamboo-processing wages are lower than those for other industries. The growth of the bamboo-processing industry in Longyou is probably past its peak.

The second case characterizes a county like Taojiang. Taojiang displays the greatest contribution of the primary bamboo-growing sector to county GDP, a low level of industrial diversity, and the lowest level of regional development of the three counties. Wages are low in Taojiang in general and in the bamboo mat industry that dominates bamboo processing. The bamboo processing industry is expanding more rapidly in this county than in either of the others because it takes advantage of the relatively low local wages.

Muchuan is an intermediate case with an established industry and a primary sector that makes an intermediate contribution to total county GDP. Yet, wages are still low, and the processing sector is still growing.

The evidence on women's employment complements our proposition. Muchuan and Taojiang employ smaller percentages of women in their bamboo processing industries, 46% and 47%, respectively. In contrast, women comprise 62% of the workforce for bamboo processing in more-developed Longyou. This difference is consistent with the argument that bamboo processing is a lower wage and otherwise less attractive source of employment in developed markets, and with observations from gender assessments in China that show women to be overrepresented in the less attractive sectors (Riley 1995, Hare 1999).

Farm Incomes. A perspective on the role of bamboo in economic development is emerging from our county-level observations, but what about the role of bamboo in the growth of household incomes and the alleviation of poverty? Does bamboo's contribution to household income form the same convex shape observed for Anji in Figures 8-1 and 8-2?

Farm household incomes increased in all three counties, much as they did for average households across all of China. They increased both most rapidly and in greatest absolute value in Longyou in the more developed eastern counties. Greater growth in the China's East and Southeast has been the common trend across all sectors and it has been a source of political concern.

Differences within each county's farm households are also growing. The Gini coefficients for households in our sample increased for all three counties. The smallest increase was from 0.24 in 1989-1990 to 0.25 in 1995-1996 for Longyou, while the largest was from 0.23 to 0.29 over the same period for Taojiang.⁸ The

increase in each county was largely due to an increasing disparity between incomes from farm and off-farm activities. Therefore, the increases in the Gini coefficients are largely due to activity outside the agricultural sector, and they probably are representative of the increased disparity between agriculture and those other sectors. They suggest that growing local income differences will reinforce the policy concerns with distributional issues that originally grew out of the pattern of regional differences between China's East and West.

Bamboo production and preprocessing in the home has generally improved farm household incomes in all three counties. The share of household income originating from bamboo activities increased without interruption for all two-year periods from 1989-1990 to 1995-1996 in all three counties.⁹ Longyou households always earned the largest share from bamboo, 25% in 1989-1990 increasing to 41% in 1995-1996. Muchuan households experienced the most rapid gains, from 14% of household income in 1989-1990 to 37% in 1995-1996. Muchuan's expansion was due to the general expansion of the paper industry and new restrictions on the cultivation of steep land (more than 25° slope). It is consistent with our knowledge that bamboo production expanded more rapidly in the western counties. The expansion in Muchuan's infrastructure has been impressive, but more recent—and its effect on production is more recent as well.¹⁰

The distribution of bamboo income across households is increasingly diverse. Figure 8-5 shows how this distribution has changed for Taojiang. More households earned more income from bamboo in 1995-1996 than in 1989-1990. The spread in income levels also increased. Households in Muchuan and Longyou shared this experiences. The major differences across counties were the greater levels and wider spread of bamboo incomes in Longyou, two differences that we would expect in a more developed county with a more diversified economy.

Figure 8-6 shows the distribution of total farm incomes attributed to bamboo in 1995-1996, and Figure 8-7 shows the shares of the growth in income attributed to bamboo. Figure 8-6 compares with Figure 8-2 for Anji, and Figure 8-7 is related to the regression in Table 8-3. Once more, it is clear that bamboo contributed more to incomes in Longyou than in the other counties. It contributed least for households in Taojiang, at all income levels. Only the data for Muchuan demonstrate the convex form we observed for Anji, with middle-income households obtaining a larger share of their income from bamboo production. The lowest-income households never obtain large income shares from bamboo.

Figure 8-7 reinforces this second point. Bamboo is a more important source of income growth for high-income households than for medium- and low-income households in all three counties, and it was more important for middle- than low-income households in two of three counties. (An analysis of variance shows that these differences are statistically significant.)

These results support part of our findings in Anji. In particular, bamboo is not a "poor man's timber." On the contrary, in regions where bamboo has a leading role in economic development, the poor benefit, but they benefit proportionally less than those in higher income classes. In Anji, it was the middle-income and not the higher-income farmers that benefited most, whereas in the extended

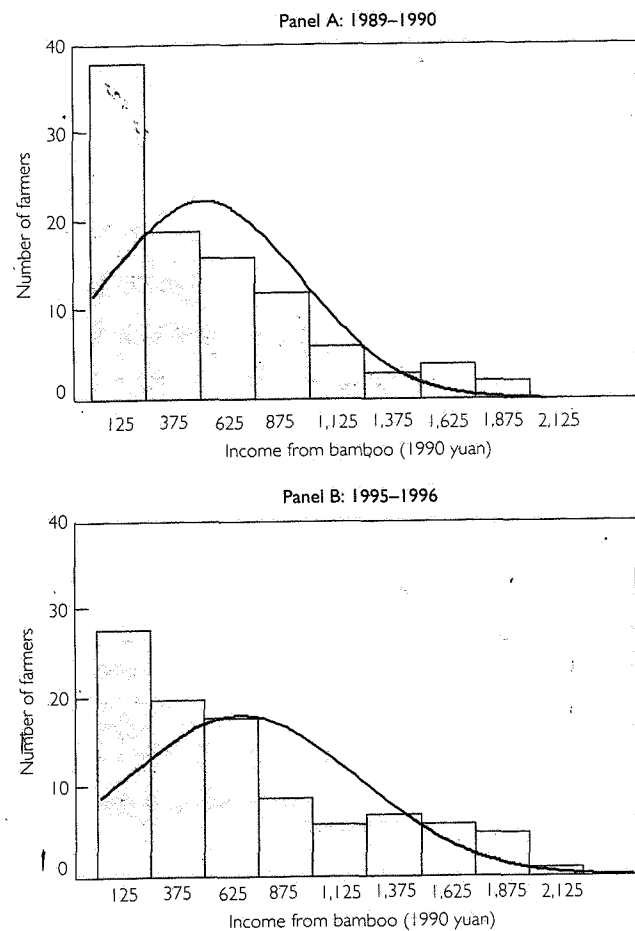


Figure 8-5. Changing Distribution of Household Income from Bamboo in Taojiang

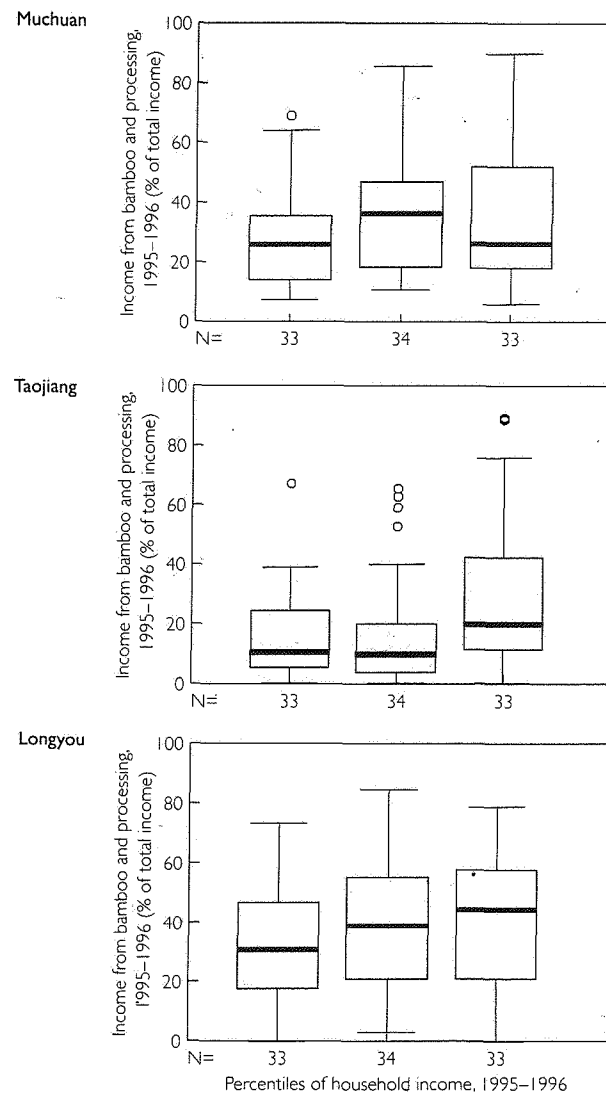


Figure 8-6. Relative Importance of Bamboo to Household Income for Low-, Middle-, and High-Income Farmers in Three Counties, 1995-1996

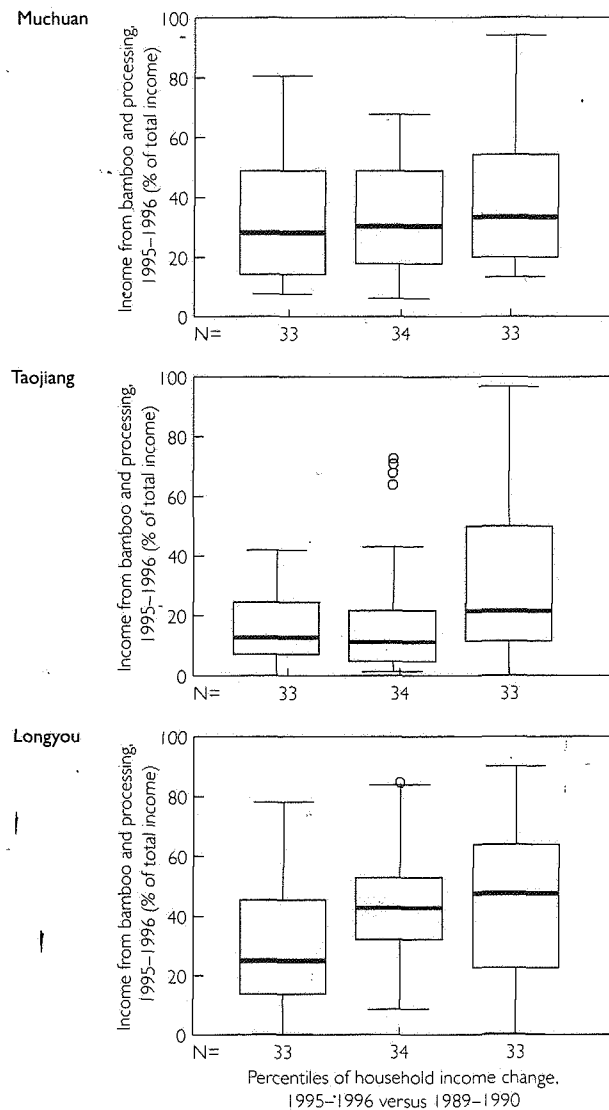


Figure 8-7. Role of Bamboo in the Change in Household Income for Low-, Middle-, and High-Income Farmers in Three Counties

sample of three counties, the higher-income farmers gained the greatest advantage.¹¹ [Middle income farmers in Anji occupy a place between those who do not need bamboo (i.e., the richer farmers who can earn more income from off-farm activities) and those who cannot take full advantage (i.e., the poorer farmers who do not have the resources to make the most of the opportunity).] However, Anji is far richer than the other five counties, with a per capita income that is twice as large as the next richest, Longyou. This causes us to offer the proposition that as the counties develop, their income distributions due to bamboo will look more like Anji's. The role of bamboo as a driving force for income growth will become less important, giving way to other more profitable activities (normally away from the farm) that will be taken up by more entrepreneurial farmers.

Conclusions

Can bamboo contribute to rural development and poverty alleviation? We have described China's experience with bamboo production and processing, with emphasis on the experiences of six counties. Bamboo frequently represents a superior option to traditional timber production. Bamboo forests, together with tree crops such as fruits and nuts, are classified as "economic forests" in China's official statistics. These economic forests are responsible for a major share of the expansion of forest investment that has occurred since reforms began in 1978. There are clear reasons for this, including earlier returns on investment (which, in turn, are related to pure financial considerations and to a wariness of policy inconsistencies), regular financial returns from annual or more frequent harvests, easier integration with agriculture (smaller units can be managed), and the absence of many regulations that act as disincentives for traditional forest investments.

This experience with bamboo is also instructive of the potential contribution of commercial timber production to poverty alleviation and rural development. If some of the taxes and regulations that act as disincentives for traditional forest investment were reduced, then timber production and the general performance of the timber sector could follow more closely many of our observations for bamboo. The markets are similar. On the demand side, bamboo and timber compete in many of the same markets—panels, flooring, plywood, fiber for paper production, and even some construction framing materials. On the supply side, they compete for similar farm resources because China's natural forests have been substantially depleted of their accessible bamboo and commercial timber. Therefore, expansion in either timber or bamboo production must largely come from planned investments in managed stands.

Farmers in the counties that we studied exhibited a proactive attitude toward bamboo, expanding their plantations when conditions were favorable. Bamboo processing was an important component of rural development. The small scale and low level of initial investment necessary in most bamboo-processing industries permitted the creation of a decentralized bamboo-processing industry, increased local demand and, therefore, increased local prices for bamboo. It

offered farmers additional opportunities for income generation from investments of labor and capital in the farm, preprocessing activities on the farm, and off-farm bamboo employment in bamboo processing establishments. The improvements in local opportunity increased household wealth.

Bamboo's role in local enterprise and household welfare changes as the region develops. In the counties we studied, bamboo-based industries provide a good focal point for early industrialization, offering a number of opportunities, from markets for locally produced raw material to off-farm income and even some foreign currency. However, this pioneering role seems to be limited, and our evidence suggests that bamboo industries lose their dynamic nature as the county develops and enters more advanced stages of industrialization.

This does not imply that the bamboo sector can be dispensed with once development occurs. On the contrary, in Anji, the richest county in our sample, bamboo production and bamboo processing constitute a fundamental component of the county's industrial base, even if some other sectors now grow more quickly. It appears that bamboo will have a significant role in the county for a long time, especially as a supplier of raw material for Anji's modern, mechanized paper industry and as a producer of specialized bamboo products for the export market.

Policy reform has been instrumental in encouraging the development of the bamboo sector. Policy reform has changed the decision set, and the people have responded enthusiastically. The key elements of the reform have been the increased strength and security of land and resource tenure, the liberalization of international trade and investment policies allowing for private and joint-venture development and management of processing enterprises (with related gains in overseas investment and technology transfer), and the liberalization of domestic exchange allowing market mechanisms for the pricing and allocation of resources and providing easier access to domestic markets. These reforms have stimulated demand, and the resulting price increases have provided the incentive for intensified bamboo production. We anticipate that the same reforms would have similar effects in other components of the forestry sector as well.

What about the effects of bamboo-sector development on local income? Although most farmers in our county samples expanded their bamboo production activities and their bamboo-based income, the expansion was not uniform for all income classes. Middle- and higher-income classes of farmers did better, both absolutely and relatively. Bamboo preprocessing and off-farm activities in general offered the best opportunities for improved income, and the middle- and higher-income groups benefited most from these activities as well. Lower-income farmers seem to have benefited less, both absolutely and relatively. Apparently, market opportunities are not the most critical factors when it comes to explaining poverty. Improved markets and policies have improved the financial resources of all farmers, but many poor farmers remain relatively poor despite improvements in their incomes over the past 10–20 years.

As we conducted this research, we detected two trends that merit further inquiry. First, as development proceeds, we observe a trend toward specialization in some of the large family farms that are better positioned to take advantage of

wasteland contracts, contracts for former collective lands, and other opportunities for land reallocation that could expand their forest-based activities. For example, we found farmers with 200 mu of tea—10 times the average holding of forestland in Longyou. Another farmer managed 700 mu of timberland and nearly 200 mu of bamboo land—20 times the average holding of forestland in Muchuan. The trend toward increasing scale and specialization also applies to the bamboo-processing industry, as in the case of a farmer in Taojiang who receives 115,000 yuan annually from his bamboo workshop. Interestingly, forest-based activities seem to be more suitable for expansion and specialization than agricultural crops, especially rice, at least at this stage of development and in the counties we studied.

This leads to the intriguing question of whether forest development is a source of increasing farmer segregation and differentiation in rural China.¹² The egalitarian base of rural China is changing as the economy develops and rural households exploit new opportunities. Farmers are becoming more specialized, and disparities in their income levels and their access to land and other resources are growing. Will a class of large landowners emerge? And what is the role of forest property for these landowners?

The second trend is toward an increasing specialization at the county level that links bamboo-based primary and secondary processing activities with tertiary activities. Anji County provides a prominent example with bamboo-based tourism.¹³ Anji's position in the middle of one of the richest and most dynamic regions in China has provided incentives to shift from quantity to quality, including scenic values, landscape and species diversity, and a generally new environmental concern. New policies and accompanying economic measures to support them are shifting the focus of bamboo plantations from very intensive monocultures to more mixed systems in which maintaining the appropriate soil coverage and a larger number of species is a component of production (Ruiz Pérez et al. 2001).

Finally, we have focused on income and employment generation in the production and processing of forest products. There are many other important issues that we have been unable to address. For example, we have not discussed either the important subsistence and safety net functions of forests or the role of non-timber products from natural forests (a large subsector in China), or how either of these have been affected by policy reforms. Some policies have had substantial negative effects even as they may have improved the condition of the forest or the effectiveness of forest management. The massive unemployment created as subsidies for state forest farms have been reduced and the new logging ban is implemented is an example. The examination of these additional issues is part of our continuing research, and it will be an important element of Chapter 10.

Notes

1. Poverty is a multidimensional phenomenon. Although it is frequently characterized by reduced levels of consumption of food and material goods, poverty also has aspects of depriva-

tion related to lack of education, deficient health, vulnerability, voicelessness, and powerlessness (World Bank 2000).

2. Newer programs within the Western Regional Development Program and the Natural Forest Protection Program beginning in 1998 encourage reforestation and afforestation on degraded or sloping lands, especially in major watersheds.

3. Some marginal uses in drinks, medicinal applications, and even in the flavoring or coloring for rice do not fall within these two main categories.

4. The next two sections draw on the more extensive discussion of policy effects on the bamboo sector that appears in Ruiz Pérez et al. 1996.

5. This section draws on information previously published in more complete form in Ruiz Pérez et al. 1999.

6. Longyou was established as a separate county in 1983. Its county-level statistics begin with that year.

7. This section draws on Ruiz Pérez and Belcher 2001.

8. The *Gini coefficient* is a measure of income inequality: A coefficient of zero indicates that all households in a sample have the same income, whereas a coefficient of one indicates that all income is the possession of only one household. The *Gini coefficient* ranges from about 0.26 to 0.60 worldwide. A coefficient of 0.40 is normal for most developed countries.

9. For Anji, we examined bamboo income as a share of household income. In Muchuan, Taojiang, and Longyou, we examined bamboo income plus income from the preprocessing of bamboo products that occurs in the home. Preprocessing is important in Taojiang, less important in Muchuan and Longyou, and minimal in Anji.

10. Improved roads have cut travel time to Chengdu in half since the late 1990s.

11. The difference in percentage of income from bamboo between high- and middle-income farmers tends to be small, whereas the difference between these two income groups and low-income farmers is larger and statistically significant.

12. This process of segregation and differentiation takes place mainly through auctioning wastelands and other collective lands that include forests as an important component of their alternative uses (Hanstad and Li 1997).

13. Forest-based tourism is growing very rapidly and it has great potential in China. More than 63 million people visited forest areas (mostly in developed regions and highly populated areas around cities) for recreational reasons in 1995 (Da 1999).

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