Bamboo in Anji, China: a Case Study of an Intensive Production-to-Consumption System

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FOREWORD

In the 1990s, bamboo has made significant contributions to the development of the mountainous Anji County in Zhejiang, China, both in terms. of income generation and rural employment creation. The County stands as an example of how political will and entrepreneurial skills can combine to elevate a local resource, in this case bamboo, into a major tool for socio-economic development.

Well-considered policy reforms and well-planned development strategies preceded the bamboo-based economic turnabout of rural Anji. Policy makers and forestry managers had to contend with a host of problems in the 1980s when they attempted to formulate development interventions: fast-depleting resource, wasteful harvest, 'inefficient raw material use, absence of competition, monopolistic processing and marketing regimes, lack of advanced technologies... The changes effected, which ranged from a shift in economic practices to remodelling of institutional arrangements to accelerated, research in bamboo production and processing techniques, make a study of the bamboo sector in Anji a fascinating and worthwhile exercise.

In 1995, under its Socio-Economic and Policy Research Program, the International Network for Bamboo and Rattan (INBAR) commissioned a series of studies on the production-to-utilization systems that exist and operate in bamboo and rattan producing countries. One of them was on the bamboo sector in Anji County, as it was thought that information on the County's bamboo sector development experiences would benefit other countries in the region.

This study was carried out by Zhong Maogong, Xie Chen, Zheng Wei, Fu Maoyi and Xie Jinzhong under the auspices of the China National Forestry Economic and Development Research Centre and the Chinese Academy of Forestry. The research examined practical operations of new bamboo management and marketing systems, as well as bamboo's contribution to the local community's economic development. The study concludes by presenting suggestions on how sustainable development of bamboo forest and bamboo production can be achieved. We hope that the information contained herein would be of assistance to policy makers, development experts, social scientists and others in other countries in formulating appropriate development interventions.

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1 INTRODUCTION

China is a country rich in bamboo resources. In recent years, its bamboo area has expanded and management has improved significantly to make bamboo one of the most important forest products in the country. These changes are in part a result of production, processing and marketing reforms carried out during the 1980s. Places such as Anji County, with abundant bamboo resources, saw dramatic improvements in local economic development as a result of these reforms.

Growth of the bamboo sector in Anji County has been broad-based and its impact has reached many families. Bamboo plantations now under private management are much more productive as some farmers have intensified production. There has been remarkable growth in small, privately owned enterprises as well as in the formation of joint ventures that have increased added value output. Also, traders have opened up export markets and have raised competition (and prices) for raw materials. In all, about 25% of the population in Anji receives some income from bamboo.

Some issues in bamboo production, management and marketing remain to be worked out. For example, ambiguities in property and management rights, inefficient production systems and inadequate marketing facilities have all limited the potential for development. It is important to address these issues to maintain sustainable development of the bamboo sector in Anji and other bamboo areas across China.

This study was conducted to examine in depth the status and constraints of bamboo sector development in China. It joins a series of other studies conducted in other parts of Asia to shed light on common problems as well as solutions. The study was carried out by the China National Forestry Economic and Development Research Centre of the Chinese Academy of Forestry (CAF), with support and guidance from the International Network for Bamboo and Rattan (INBAR).

Case Study Preparation and Background

The case study was conducted by two integrated working groups. The Lead Group consisted of research scientists and local government officials. The Survey Group comprised research scientists, local technicians and village officials. The members of the latter group provided integral support for the study in several-areas including survey planning and implementation, local transport, and coordination with bamboo management units and enterprises.

In preparing for the study, several important decisions were made regarding the organization of working groups, types of data to be collected and survey sites, plans, designs and forms. In particular, the working groups selected Anji County of Zhejiang Province based on the following criteria:

- The extent of resources, distribution, production and management of bamboo;
- Facilities for processing bamboo materials;
- The interest of local government and people; and
- Convenience of local transport.

The types of information to be collected included: (1) the socio-economic features of local communities; (2) status and recent changes in bamboo resources; (3) production, processing and trade of bamboo; (4) marketing; and (5) local policies, rules and regulations.

Survey Design and Analysis

Survey samples

Anji County is composed of 263 villages in 26 townships and is home to 527 bamboo processing units and hundreds of trade units. Working groups used group and system sampling methods to select 40 villages from eight townships (five villages from each township), and 212 families of different financial strata from these villages for interviews. For the bamboo production enterprise survey, the team selected a sample of 28 units representing a range of products. Also, 60 worker families from these enterprises were visited. Finally, product trade data were obtained from a sample of 18 trade units from the eight selected townships.

Survey implementation

A two-day training course 'held for the survey teams outlined the objectives and methods to be used. The course. covered the content, importance, methods and requirements of the survey, particularly regarding the questionnaire forms. Also, during the investigation, survey teams were instructed to phrase questions properly so that persons being interviewed would feel comfortable, particularly for sensitive questions.

The rapid rural appraisal (RRA) method was applied in an 'on-the-spot' survey. The survey teams first contacted farmers or enterprises prior to being interviewed to improve the survey quality. During interviews, responses were recorded in person. If any data was subsequently lost or found unusual, the household or enterprise was re-surveyed later.

Analyses

Both quantitative and qualitative analyses were applied in examining the impact of policy and management changes. Economic benefit analyses were conducted to compare net present worth and cost-benefit ratios of production management systems and product processing units, respectively.

Project Area

Physical features

The dominant land features in Anji are mountains (21607 ha) and hills (119 214 ha), which together encompass almost 75% of the County's 1884 km* land area. Nearly

65% of Anji (118 692 ha) is forested and about half of this (57 315 ha) contains bamboo ('Fig. 1). The remaining land area of Anji (47733 ha) consists of plains. In all, arable land encompasses 20 870 ha (11% of the total), of which about 18 839 ha is irrigated farmland.

The average annual temperature is 15.5°C. which includes 228 days a year with temperatures above 10°C. In a year, about 226 days are frost-free. Annual rainfall averages 1350 mm. At elevations up to 800 m, the soil is red, and above this the soil is yellow.

Anji is well-connected to larger markets and big cities. The distance from Anji to Hangzhou, the capital of Zhejiang Province, is only 76 km, and to China's largest city, Shanghai, it is about 223 km. The transportation system is adequate, and with a road density of 0.4 km/km*, there is good access to the external markets.

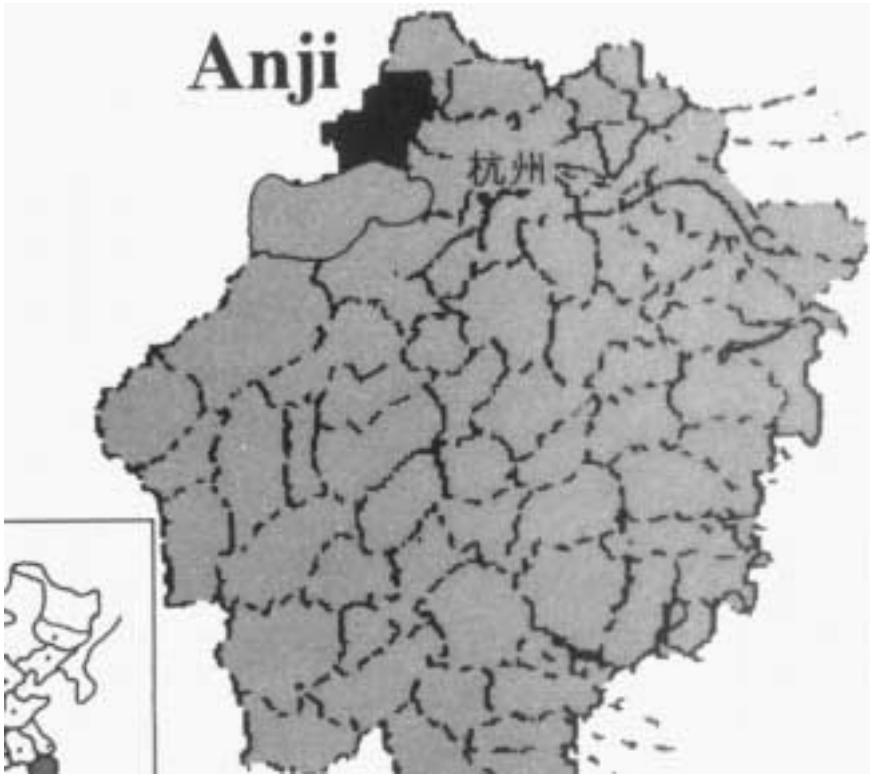


Fig. 1: Anji County

Socio-economic profile

Anji county is home to 443 800 people of whom 385 700 (118 700 households) live in rural areas. Considering just the rural population, average land per capita would be 0.31 ha in all forests and 0.15 ha in just bamboo forests. Farmland is limited to 0.05 ha per capita. Agricultural production, the main crop being rice, is just enough to meet local food needs. In 1994, the rural per capita net income in Anji was 2 896 yuan (US$1 = 8.03 yuan), an amount significantly higher than the state's average of 1 221 yuan. During that year, bank savings of Anji rural residents reached 393 million yuan, which is equivalent to 1020 yuan per capita. An average-sized house in the county has about 33 m^2 of space per person.

In 1994, the total agricultural and industrial output in Anji County was worth 4793 million yuan, of which the industrial sector accounted for more than 88% (about 4 240 million yuan). within the industrial sector, 73% of the output value (3 111 million yuan) was produced by township and village enterprises. Privately owned enterprises, which have grown rapidly in number, produced 31% of the output while township and village collectives produced 28% and 159%, respectively. The output value from agriculture was 998 million yuan, of which bamboo contributed about 25%.

2 BAMBOO RESOURCES MANAGEMENT AND PRODUCTION

For bamboo plantations, the main producers are farmer households, collectives and state farms. Products include bamboo culms and bamboo shoots. In marketing, most raw bamboo traders are individual intermediaries whose trade volumes account for more than 80% of the total. Township and village enterprises lead in manufacture. The main products are bamboo mats, handicrafts, plybamboo and board, bamboo shoots and bamboo brooms. Finished products are sold through two types of outlets: foreign trade companies whose trade volumes account for nearly half of the county's bamboo trade; and other traders (such as wholesalers, trading companies, retailers and enterprises) who deal in smaller quantities and deliver products directly to final consumers in domestic markets. Detailed information on these actors and transactions is depicted in Fig.

Bamboo Resources Management

Changes in resources

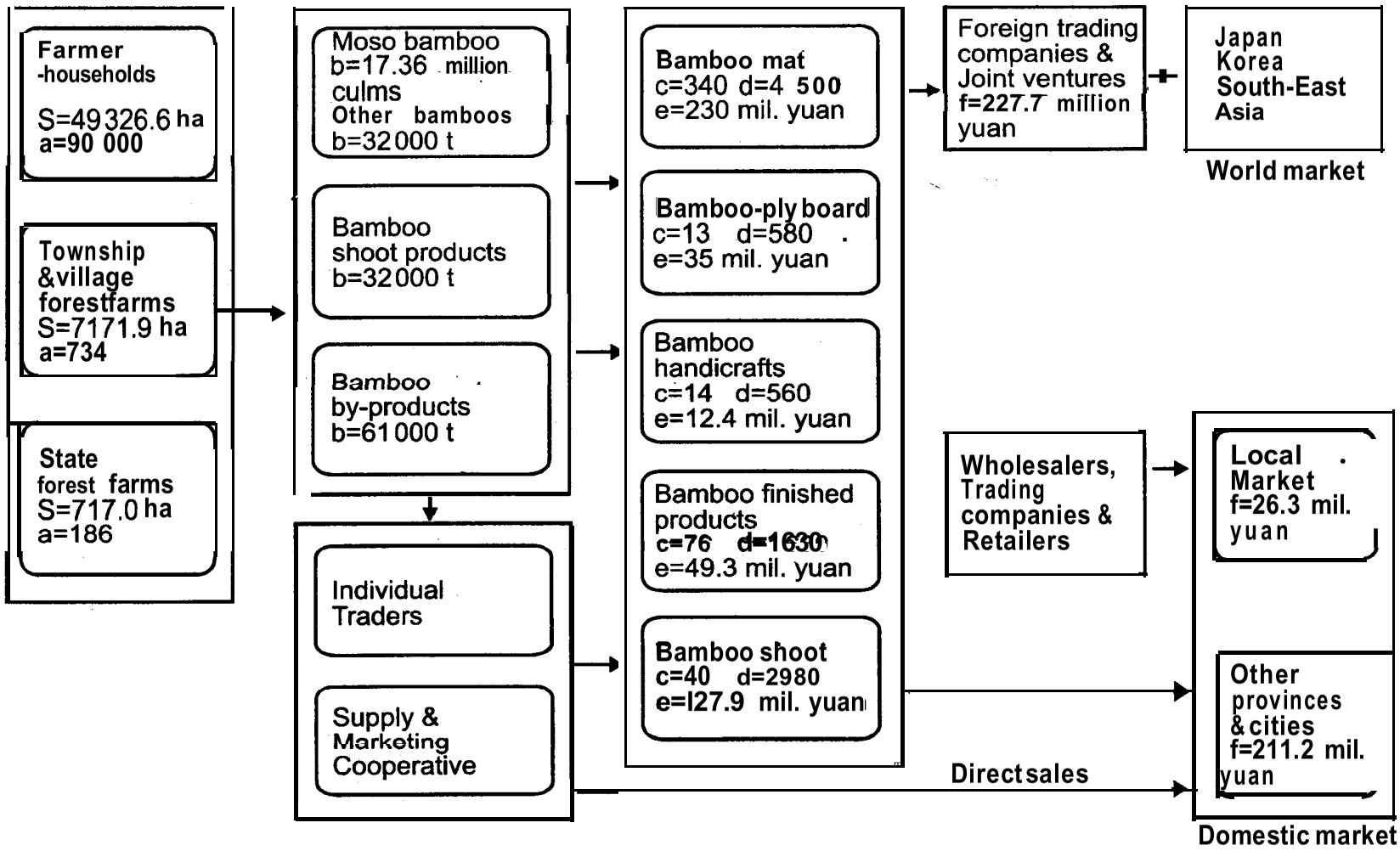
Bamboo plantations in Anji produce 43 species of bamboo belonging to seven genera. The most prevalent species is phyllosrachys heterocycla var. pubescens (Mazel) Ohwi (moso bamboo), which covers more than three-fourths of the total bamboo area (44520 of the total 57315 ha). Other species, such as P. nuda McClure, P. iridenscens Yao et Chen, P. meyeri McClure, P. propinqua McClure and P. angusta McClure, cover the remaining 12 795 ha of land.

Changes in bamboo resources have occurred both in terms of coverage and standing culms. A recent forest inventory by the Anji Forest Department shows that the total bamboo area grew from 45466 ha in 1975 to 57315 ha in 1994 (a 26% increase, see Table 1). This increase is shared by moso bamboo, which increased by 24%, and a variety of other bamboo species (such as P. iridenscens, P. nuda, P. propinqua and P. meyeri) which together increased by over 32% (from 9660 ha in 1957 to 12 795 ha in 1994). Growth in the area of two bamboo species, P. propinqua and P. iridenscens, was more rapid because of higher yields of bamboo shoots and culms.

Table 1: Bamboo area and standing culms in Anji

Year	Total area (ha)	Moso bamboo			Other bamboos		
		Area (ha)	Standing culms (1000)	Density (culms/ha)	Area (ha)	Standing culms (1000)	Density (culms/ha)
1957	45466	35800	62380	1740	9666	-	—
1975	51400	42800	88 140	2059	8600	129	15.0
1983	54022	43611	110867	2542	10410	161	15.4
1989	55496	44019	112263	2550	11477	184	16.0
1994	57315	44520	114567	2573	12795	235	18.4

Source: Yearbook of Anji Forest Bureau



a = no. of people b = output c = no. of enterprises d = no. of workers e = output value f = sales volume

S = Area of bamboo forest

Fig. 2: Bamboo production-to-consumption system in Anji

The density of standing culms has also grown dramatically (Table 1). For example, in 1957, moso bamboo standing culms totalled about 62 million with a density of 1740 culms/ha. By 1994, standing culms of moso had increased by more than 80% to reach 114 million culms. While a roughly 25% increase in moso coverage (35 800 ha to 44520 ha) explains some of this growth, most of it must be attributed to intensified bamboo cultivation as culm density grew by almost 50% during the period.

Institutional changes

A 1956 law – Regulation of Advanced Agricultural Production Cooperation – had given property rights on forest and forest land to the State and collectives, by organizing forestry activities at the township and village forest farm levels into 'collectives'. Farmers who participated in collectives to cultivate bamboo were eligible to receive an equitable income. Yet, many of these collectives operated under arbitrary and unclear guidelines, and did not assign any property rights to individual farmers. In practice, farmers did not make decisions with. regard to production or income distribution and, in some cases,. did not obtain benefits due to them. Moreover, the law held that the higher collective authority could possess the prop, erty of lower collective organizations without paying any compensation. As a result, many collectives were inefficiently managed and farmers were discouraged enough to shun active involvement.

The 1980s marked a period of significant reforms in the rules governing the rural economy, ending many years of inadequate management by the State and collective farms. During this period, China launched several policy reforms to bring economic benefits to rural areas. Most notable for Anji County bamboo was The *Decision on* Some Problems of Protection Forest and Development Forestry, promulgated by the State *Council in 1981. This Act was followed by the 'Three Fix' policy, which laid down' forest and forest land property rights and allocated forest plots to farmer households. The reforms culminated in a policy called Forestry Production Responsibility System, a significant step forward for China's forestry development. The complete reform package established:

1. A forest land boundary between townships and villages;
2. Bamboo plots for farmer households to meet their fuelwood and timber needs; and
3. The Forestry Production Responsibility System, rent/contract system covering collective bamboo land.

The Forestry Responsibility System has had a profound effect on the entire bamboo sector, including growth in production and species diversity. Under this system,

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' About 6% (3 466 ha) of the total bamboo land was divided equally among farmer households for this purpose. Farmers were granted production, management and income rights over the land.

farmers were encouraged to rent collective bamboo land under contract.2 The basic elements of the contract defined:

1. Farmer households as production decision-makers;
2. A contract duration of 30 years (originally set at 15 years, later modified);
3. The contract fee that the farmers must pay villages (generally 5-10% of bamboo income, though this varied by village).

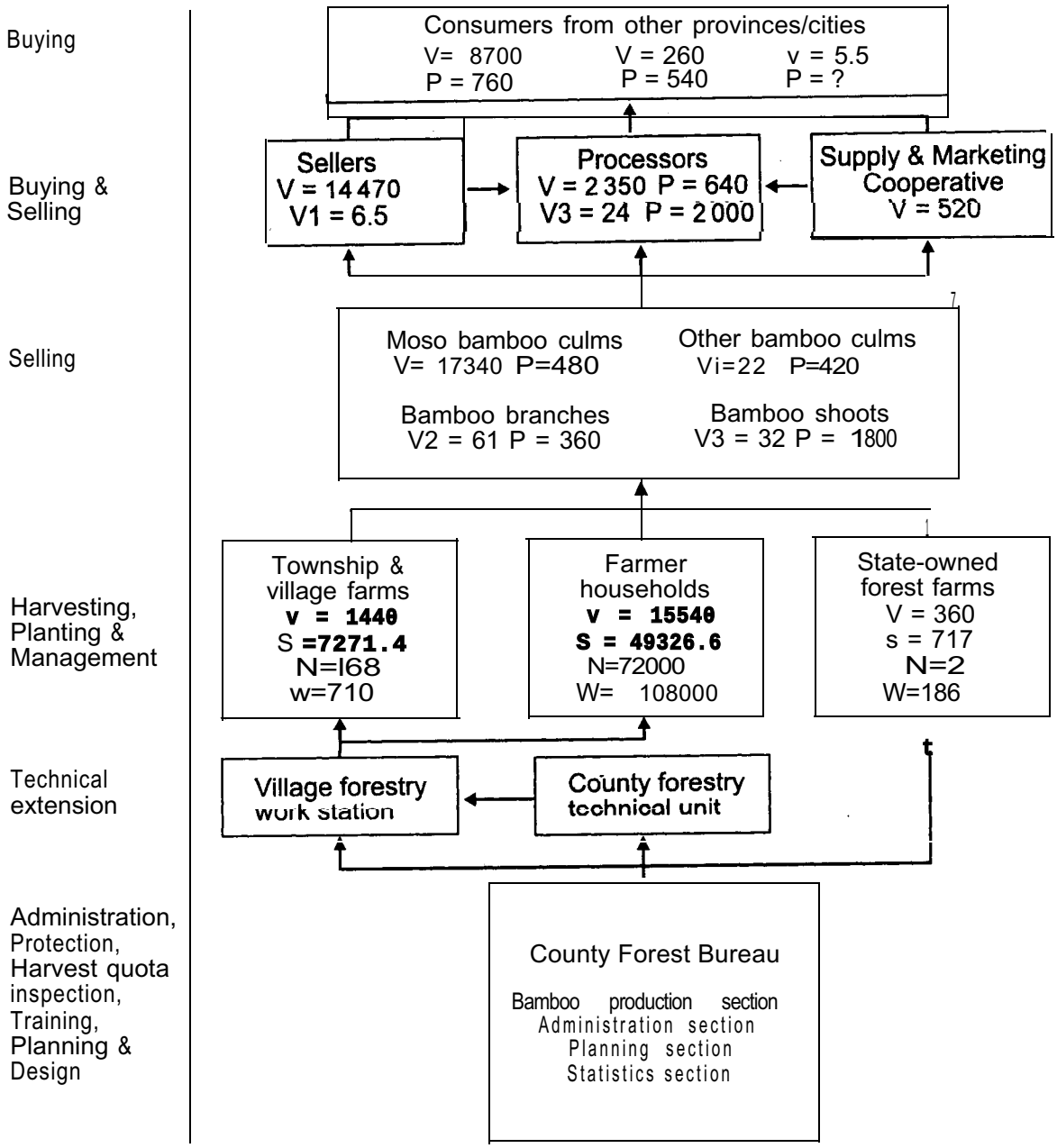
During their tenure, farmers must observe bamboo harvest limits set by the Anji Forestry Department. In addition, when the contract expires, farmers would be fined if they had not increased, by at least 5-10%, the amount of standing bamboo culms.

The Farmer Household Responsibility System is the most creative and successful aspect of the Chinese rural economic reforms. The salient aspect of the reform was legally separating 'ownership' of bamboo resources from 'management rights'. This enabled the collective to retain ownership and still grant farmer households individual rights of management. Thus, farmer households could decide when and how to plant, manage and harvest their bamboo, and where and at what price to sell their products. Also, within the contract period, the farmers had land management transfer and inheritance rights.

In general,. the reform has succeeded in increasing benefits to farmers and improving resource management. Some issues, however, are still to be worked out. For example, household population changes have led to land allocation problems since, according to legal guidelines, land of a household should be proportional to the number of members of that household. In an attempt to solve this problem, the government released, following an agreement between the local government and farmer households, a supplementary regulation based on the formula "change benefit but not bamboo land". The regulation allows families that have declined in size to keep the total land contracted as long as an agreed amount derived from the surplus land is submitted to the collective. The amount thus collected is then redistributed among families which have grown in number and whose bamboo land has thus reduced proportionally. A household can retain any income that is in excess of the agreed amount. In addition, households retain rights to all bamboo shoots and by-products produced on their land. The regulation has eased some conflicts but further modifications may be needed as the situation evolves. The participants in the present bamboo management system and their functions are illustrated in Fig. 3.

Allocation of bamboo land followed a combined procedure in the State's effort to distribute land equitably. First, based on village groups (in a village there are several village groups), each household received an equal amount of land from 50% of the village's total amount of bamboo land fixed for renting out under contract. Each household then received additional bamboo land, depending on their family size and composition (basically, adults received a higher allocation than children), from the remaining 50% of bamboo land.

3 Shortly after the main reforms were implemented, the State passed bamboo harvest regulations to prevent excessive harvest by farmers.



V = culm yield of moso bamboo in 1000 culms; VI = culm yield of other bamboos in 1000 tons; V2 = bamboo branch yield in 1000 tons; V3 = bamboo shoot yield in 1000 tons.

P = price in yuan/ton; S = area of bamboo forest in ha; N = number; W = no. of workers.

Fig. 3: Participants in bamboo management and their functions

Changes in bamboo management methods

In addition to property rights reforms, the government and other agencies have developed several bamboo plantation and harvest methods, including:

1 Bamboo root stimulation and artificial plantation techniques. The bamboo root stimulation technique is mainly used on degraded .bamboo lands and mixed bamboo forest lands, as the technique requires only low inputs and assures an early harvest (and therefore, fast income returns). Artificial plantation techniques are mainly used in bamboo shoots production. Both techniques have helped to expand bamboo area and yield.

2 Best bamboo resources management practices. The government has recommended several bamboo management measures such as reclaiming, soil tilling and weeding, fertilizing, pest control, digging shoots and top log cutting. For some of these, such as the use of fertilizers, the government provides incentives for adoption. Even then, use of fertilizers is not common and is practised 'only on intensive production sites where farmers have sufficient capital. The local government also offers technical training courses for farmers and sets up model bamboo plantation farmer households.

.Farmers usually carry out soil tillage, weeding, top-log cutting and 'nieyou'. Top-log cutting and nieyou are bamboo management techniques specific to-- Anji. Top-log cutting involves cutting a third off the top from one-year old bamboo culms. This practice protects bamboo from heavy snow stress in winter and allows more light to penetrate bamboo stands. The cut portion is used for broom-making. Nieyou is another efficient bamboo management practice, wherein farmers write dates and' their names on one-year old bamboo culms using a special indelible ink. This practice makes it easy to identify the age and owner of bamboo during management and harvest seasons.

3 Harvest regulation. Harvest regulation, imposed by the government on contract land to avoid overexploitation of bamboo resources, has played a significant role in maintaining bamboo resources and encouraging intensive bamboo cultivation in Anji.. According to the regulation, the post-harvest number of standing culms per ha should not be less than 1650. The steps involved in the implementation of the regulation include the following:

1. The County Forestry Department submits data on the bamboo stock volume and possible harvest volume to the Province Forestry Department;
2. The Province Forestry Department releases ,a bamboo harvest quota to each bamboo county based on bamboo harvest allowances fixed by the Ministry of Forestry;
3. Sub-quotas are then allocated by the county for townships, villages and households; and
4. Harvest quota certificates are issued to farmers by the Township Forestry Station-. The certificates are" used to monitor harvests when farmers sell bamboo. For moso bamboo, certain additional measures – such as a strict harvest season

(from 15 September to 31 March) and culm maturity (culms 4 years or older) - are in place.

Governmental assistance

Although it has been shown that intensive management is effective and profitable (please see the socio-economic analyses in Chapter 3, the practice requires high capital investment and technical training,- as well as a basic change in outlook for most farmers. In Anji, bamboo forests under intensive management account for only 1520% of the total area. About 50-60% is under normal traditional management and another 20-30% is under extensive management. The measures that the Anji government has taken to help farmers in the transition to more intensive management include:

- Financial support for transforming the low-yield bamboo forests through a subsidy of 750 yuan per ha;
- Technical training and introduction of new technology; and
  Establishment of demonstration households which 'have had successful experiences.

These measures were greatly welcomed by farmers in Anji and the results speak for themselves. Most notably, annually more than 1400 ha of low-yield bamboo forest have become more productive. Yet, even though intensive management can bring higher benefits to farmers, it has not been widely adopted because households still face capital and labour shortages.

Management of Bamboo Forest Plantations

The reforms dramatically changed bamboo management as farmers switched from collective to individual systems. Immediately following the reforms, farmers contracted 85% of the collective bamboo forest. By 1994, farmers had brought more land under individual management, increasing their holdings to 91% of all moso bamboo forests. The few lands that remained under collective management were remote and inconvenient for single household cultivation. A recent inventory found that 72 000 families (100 000 people or 23% of Anji's population), are involved in bamboo forest farming and management. Collective township and village forest farms are now the second largest in area. As Table 2 shows, these now occupy 3 378 ha, or about 8% of all bamboo land.

Table 2: Anji moso bamboo management regimes

Year	State farm		Collective forest farm		Individual farmers	
	Area (ha)	Percent	Area (ha)	Percent	Area (ha)	Percent
1957	617	14.	42 183	98.6	0	0
1975	617	14.	42 993	98.6	0	0
1983	617	14.	3 377	77 I	39 773	90.9
1989	617	14.	3377	77 I	40 025	90.9
1994	630	14.	3378	76	40 512	91.0

Source: Yearbook of Anji Forest Bureau

* Many rural people. prefer higher paying jobs in cities and townships.

In Anji, there are 28 cooperative farms owned by townships and 140 village-owned farms. These farms are staffed by 716 employees who fall under the supervision of the respective township and village authorities. The Forestry Department of Anji County is ultimately responsible for collective farms, as it supervises harvest planning and implementation, monitors harvesting operations, introduces new techniques, and provides technical training. It also formulates investment plans and manages the farms' plantation fund that helps sustain bamboo production development.[5]

The state-owned forest farm, under the Forestry Department, is the smallest unit of bamboo forest management. The land under management amounts to 630 ha, which is about 1% of the total bamboo area. A total of 186 employees, including 98 women, work at the- farm. In addition to raw bamboo production, the Department is involved with bamboo product processing and sales. The forest farm, an independent accounting unit, contributes part of its profit to the Forestry Department. In return, the Forestry Department is responsible for capital investment, technical assistance and sets production targets for the farm.

Raw bamboo production

The production of raw bamboo – culms, shoots and branches – has grown rapidly in recent years owing to management and marketing system reforms. As shown in Table 3, bamboo timber output increased by 95% between 1975 and 1995 with an annual growth rate of over 3%. Growth has accelerated in recent years; before the 1980s, the annual growth rate was only about 1% (based on data between 1975 and 1983). In 1983 when the Farmer Households Production Responsibility System was implemented, farmers responded quickly to the new marketing system – a combination of contract and free-market selling – by increasing moso bamboo production at an average annual rate of over 5%. Although production stagnated and fell for the years 'between 1988 and 1990 after government sales quotas were cancelled, 'it soon responded positively to a rising demand from a growing processing sector. Since 1990, moso bamboo production under more mature market conditions has regained its 5% average annual rate.

Table 3: Yearly bamboo harvest in Anji (1975-95)

Year	1975	1976	1977	1978	1979	1980	1981
Moso bamboo (1000 culms)	8 890	9500	9220	10970	9 790	9490	9460
Other bamboos (1000 culms)	-	-	-	-	-	13.6	7.9

Year	1982	1983	1984	1985	1986	1987	1988
Moso bamboo (1000 culms)	10 370	9410	11940	12030	14080	15310	14900
Other bamboos (1000 culms)	10.9	3.0	2.3	.3.2	6.3	9.7	22.6

[5] Responsibilities are outlined under Act of P. R. China and Harvesting Operation Regulations issued by the Ministry of Forestry.

Year	1989	1990	1991	1992	1993	1994	1995
Moso bamboo (1000 culms)	13800	13 500	15 170	15050	17350	17370	17340
Other bamboos (1000 culms)	7.6	6.8	9.9	15.5	12.4	21 6	23.8

Source: Yearbook of Anji Forest Bureau

Part of the growth in bamboo productivity has been because of a gradual shift from extensive to intensive management, as some farmers sought higher incomes per unit of bamboo land. It can be noted in Table 4 that in comparative terms, the increase in standing culms is larger than that of harvest volume. This is because, before the 1980s, the State used administrative orders and applied afforestation subsidies to directly increase bamboo resources through area expansion. The local government also organized farmers to reforest degraded forest land and bamboo resources. Since the 1980s, the emphasis has shifted to higher productivity through more intensive management. Degraded forest land has already been reforested and the management pattern has changed from collective to farmer households. At present, nearly 20% of production by area is under intensive management.

Table 4: Standing culms and harvest volumes of moso bamboo

Year	Standing culms (1000 culms)	Harvest volume (culms/ha)	Total harvest volume (1000 culms)
1957	62 380	246	8 800
1975	88140	208	8890
1983	110867	237	9410
1989	112263	314	13 800
1994	114567	390	17 370

Source: Yearbook of Anji Forest Bureau

Harvest volumes of bamboo timber, bamboo shoots and bamboo by-products have recently been around 28000-32 000 tons, 3 000 tons and 6000-8000 tons, respectively. At present, the annual harvest of moso bamboo is in the range of 17-18 million culms (harvest volume has almost doubled since 1975).

Besides moso, most other species have shown similar rates of growth. A crpss-section survey of, intensive plantation systems revealed data (in terms of standing culms/ha and harvest yield/ha/du)6 of phyllostachys iridenscens (16 000 culms and 2.4 tons), P. angusta (31000 culms and 19 tons) and P. meyeri (3 000 culms and 28 tons). Timber production from these species is about 22000 tons. The annual culm yield of moderate and small-size species is 18 000 to 20 000, accounting for 189-200 million yuan per year.

' 'Du' is a two-year period involving an 'on-year' and an 'off-year'. Farmers harvest once per du from' a given stand.

Combining all species, the annual harvest of bamboo shoots reaches 30000 tons. As indicated in Table 3, production of bamboos other 'than moso which are primarily used for shoots rose by 75% between 1980 and 1995.' Part of this growth is explained by the growth in the bamboo shoots processing industry which caused the raw shoot price to rise sharply from 0.2 yuan/kg to 2.2 yuan/kg between 1980 and 1995. Improved plantation techniques for bamboo shoot production have helped increase the yield from 16000 tons to 32000 tons.[8]

Bamboo branches are another important bamboo by-product. Top-log cutting yields branches useful for broom-making. Branches are also directly harvested for use in fences' and broom-making. The annual yield of bamboo branches in Anji county is around 60000-80000 tons. ,

Socio-economic Benefits from Bamboo Plantations

Although policy reforms have opened the doors for bamboo sector development, it has been the farmers' initiative that has enhanced production. One of the main reasons for increased bamboo cultivation must be its potential economic returns. By granting individual property and production rights, the reforms have provided farmers with the incentive to exploit the basic .attractiveness of bamboo cultivation: lower input requirements, higher benefits and more rapid investment returns as compared with other timber -production. In the first one or two years, bamboo can .be intercropped with other crops, and after six years, harvesting can occur every other year on .a sustainable basis. Farmers now have more confidence in production and have started. making long-term inputs using intensive management techniques.

In Anji County, individual forest farmers manage about 51015 ha of bamboo forest, 89% of the total bamboo land. This is equivalent to about 0.22 ha of bamboo forest per capita. According to county data, the total value of bamboo production in 1994 was 250 million yuan, or an average of 4361 yuan per ha. Bamboo production is the second largest income source for these farmers and is an important source of cash income for local forest farmers. The share of different sources in the income of a household is shown in Table 5.

Table 5: Composition of household income (yuan)

Annual income per capita	Annual incomes per household						
	Total	Bamboo	Agriculture	Bamboo by-product	Labour	Forestry	Others
3 570	14279	3 89 3	2 041	2 467	4461	405	1012
1 0 0 %	100%	27.3%	14.3%	17.3%	31.2%	2.8%	7.1%

Source: Case Study Household Survey

Moso bamboo, the dominant species, still accounts for 70% of shoot. production.

[8] A cross-section investigation revealed that intensive plantation of fresh bamboo produced from the Shoots Forest is about 800 kg/ha/year, while for the Urn-Shoots Forest, the figure is 330 kg/ha/year.

A survey of 200 households (conducted by this study) in eight townships shows an average per capita income of 973 yuan from bamboo production, constituting 27% of the total income per capita.[9] Anji farmers earn approximately 7800 yuan/ha from bamboo – 6320 yuan from the timber, 730 yuan from the shoots and 750 yuan from the. branches. Their management costs per ha of bamboo forest are about 3675 yuan, including fertilizer, protection, contract fees and wages (the. largest component). For these farmers, the net income from moso bamboo production is 3825 yuan with a cost-profit ratio of about 104%. These farmers also earn an average of 1600 yuan from bamboo processing enterprises, bringing their total bamboo-related income to 5428 yuan/ha.

The survey data also suggest that there is a direct and significant relationship between bamboo area per capita and bamboo income per capita. In Tables 6 and 7, income sources are compared with bamboo area on a township basis. Dramatic differences can be 'noted in the case of bamboo forest and income from bamboo production per household in Gangkou Township and Chiwu Township.

Table 6: Comparison between two counties

Township	Bamboo forest (ha/capita)	Capital income (yuan/capita)	Income from bamboo (yuan/capita)	Percentage income from bamboo (%)
Gangkou	0.30	3 269	1358	41.5
Chiwu	0.11	2 050	459	22.3

Source: Case Study Household Survey

Bamboo production and management play an important role in the economic development of the household and local community. Table 8 shows that in 1994-95, almost. 90% of the households surveyed had an annual per capita income that was over 2 300 yuan, a figure that is nearly 30% higher than that of the national rural average. In addition, 127 households had a per capita annual income of over 1 000 yuan from bamboo production. In Gangkou Township, about 90% of households had annual incomes from bamboo production that exceeded 1000 yuan. At the same time, the survey revealed that 10% of the survey sample had low annual bamboo-related incomes; many of these families were in Chiwu.

[9] The eight townships together have 38 574 ha of bamboo, relatively more bamboo forest area than other townships. For the 40961 families there, this amounted to 0.96 ha per family (0.74 ha of moso bamboo and 0.22 ha of other bamboo species). Annual average harvests by each family were 273 culms of moso and 0.26 ton of minor bamboo species and bamboo branches, with a combined value of 3102 yuan.

[10] This figure is not a precise measurement because wages from bamboo processing are not measured on a per hectare basis.

Table 7: Annual income and bamboo income of townships surveyed (1994-95)

Township	Bamboo area (ha/capita)	Annual income A (yuan/capita)	Bamboo income B (yuan/capita)	Percentage (B/A)	Value (yuan/ha)
Kuntong	0.23	4321	924	21.4	4018
Fenhuangshan	0.23	3450	983	28.5	4221
Guangkou	0.30	3 270	1.360	41.5	4571
Pinghuangbei	0.35	4 248	1282	30.2	3652
Banfu	0.25	4 886.	924	18.9	3739
Zhangcun	0.21	2346	709	30.2	3 527
Yonghe	0.31	3 180	1180	37.1	3 795
Chiwu	0.11	2 050	459	22.4	4 170

Source: Case Study Household Survey

Table 8: Income of 200 farmer households in Anji

Annual income per person A (yuan)	Number of households B	Number of people C	Bamboo area per capita D (ha)	Income per capita from bamboo E (yuan)	E/A (%)
3 801-5 700	62	236	0.32	1 132	23.1
3 301-3 800	34	135	0.26	1048	29.5
2 801-3 300	31	127	0.26	1098	35.6
2 301-2 800	35	128	0.22	874	34.0
<2 300	38	179	0.12	486	26.2

Source: Case Study Household Survey

Growth in bamboo incomes has significantly changed the economic well-being of the people in Anji County, improving their dressing and eating habits. The people are also enthusiastic about further development of the local economy and improvement . in living standards. Rural homes . have changed from simple dwellings to buildings with increased living space per person. Around 55% of households have a television or radio, and some have begun to use refrigerators and washing machines. Every village in Anji County has been equipped with a telephone. Farmers now use more coal and gas as fuel instead of wood; a transition that has greatly reduced the demand for fuel wood from forest and bamboo resources.

The household survey found that farmers have changed their economic activities and performance levels as a result of higher 'income expectations that are explicitly due to property right reforms. Most farmers (95% of the sample) exhibit a high level of satisfaction with the contract system, and they hope the system will remain stable in the future. Their decision to manage bamboo forest depended on the benefits they would gain from the bamboo products. Many farmers were willing to manage the bamboo forest instead of engaging in other businesses because techniques have improved, ensuring higher returns. . The survey indicated that 96% of households

expected to contract more bamboo forest because of the increasing number of members. Most households (92%) were willing to continue the contract for bamboo forest management after the current contract expires. Only 8% of households planned to transfer the management contract to other farmers because they could gain higher income from other businesses.

Analysis of economic returns to bamboo plantations

. Economic returns from traditional bamboo management

Traditional bamboo management is a profitable activity, according to data from 18 farmer households which together managed 23 ha of bamboo forests. The measures these farmers regularly undertake include: loosening the soil, weeding, top-cutting and pest control. Table 9 gives the average costs incurred in traditional bamboo management.

Table 9: Costs of traditional management of moso bamboo

Item	Soil & loosening weeding	Top-cut	Protection	Shoot production	Felling	Others	Total
Labour (days)	18	15	1	18	30	5	87
Cost (yuan/ha)	540	450	30	540	1200	150	2910

Source: Case Study Survey

. Table 10 illustrates the output value from bamboo production per ha. Income per ha from production was 3 611 yuan. After subtracting 300 yuan of contract. fees, the farmers' net income in bamboo products from one hectare was, 3 311 yuan.

Table 10: Quantity and value (per ha per du) of products from moso bamboo forest

Bamboo Timber		Bamboo Shoots		Bamboo by-products		Total
Quantity (ton)	Value (yuan)	Quantity (ton)	Value (yuan)	Quantity (ton)	Value (yuan)	Value (yuan)
11.3	5 203	0.5 .	728	16 .	590	6521

Source: Case Study Survey

It is apparent from these figures that the farmers interviewed were producing bamboo under a traditional system and yielding positive returns. Production indicators for traditional management include:

- Net income: 3 311 yuan
- Benefit-cost ratio: 3 311 2 910 x 100 = 113.7%
  Ratio of output-input: 1 : 2.24
- Labour productivity: 6521 87 = 75 yuan/day

Economic returns from intensive bamboo management

Intensive management of bamboo production involves more frequent soil loosening, weeding and topping, and more fertilizer application. Also, about 255 working days are put into forest management. The total production costs, 10250 yuan, consist of 8 415 yuan in salaries, 1650 yuan for fertilizer, 35 yuan for protection and 150 yuan for miscellaneous items. The bamboo production output includes: 29 tons of bamboo culms, 46 tons of bamboo shoots and 2.5 tons of bamboo by-products. The total output value of bamboo products from one hectare is approximately 22 180 yuan. Production indicators for intensive management include:

- Net income: 22 180 - 10 250 - 300 = 11 630 yuan/ha/du
  Benefit-cost ratio: 11630 + 10 550 x 100 = 110%
- Ratio of input-output: 1 : 2.16
- Labour productivity: 22 180 + 255 = 87 yuan/day

Comparison of traditional and intensive management systems

To comprehensively assess the management options for bamboo production, it is necessary to determine their net present values." The basic assumptions and data for the analyses of traditional and intensive bamboo production are detailed in Annexe A. The analyses indicate a net present value (NPV) for traditional management production to be 924.03 yuan. The benefit-cost (B/C) ratio is 1.6 and the financial internal rate of return (FIRR) is 10.7%. For intensive management, the NPV is estimated to be 14877 yuan. The B/C ratio is 2.05 and the FIRR is 16.69%.

A comparison of bamboo production methods using these indicators shows that bamboo production under intensive .management yields a significantly higher NPV than that of traditional practices; the B/C ratio is 0.4 points higher; and the FIRR is 'about six points more. On the basis of this data, intensive management should be strongly encouraged.

The analyses and comparisons presented here should be considered as approximations of real situations. There is a need to conduct additional financial and economic analyses to consider the variations in plantation costs and returns for different bamboo species under different plantation models. An immediate application of these analyses is in comparing the bamboo shoots forest model and- the bamboo culms-shoots forest model. While there has been a "rapid increase in bamboo resources, a lack of standard plantation practices for these and other models (combination of density, species, plantation measures) has led to lower outputs.

Improvement of production

La bour organization in bamboo forest management

Household labour supplies with regard to bamboo forest management in Anji have changed significantly in the last decade as people have sought employment in other economic spheres. Family sizes have also altered. These two changes have hindered

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Shadow price and shadow salary analyses were not conducted owing to limited data.

the development of bamboo production and improvement of the local economy for two reasons:

1. Hjouseholds with less labour may opt for the easier bamboo harvesting rather than other management activities, thereby decreasing the bamboo forest quality.
2. Households with more labour would be inclined to reduce inputs to bamboo foreest because of a lower average return per capita. This tendency would also decrease the bamboo forest quality.

To correct these deficiencies and make households cooperate more effectively, the local government has facilitated the formation of working groups consisting of several households. These working groups have helped balance the labour distribution among households. In addition, they are incentive-compatible as the income of a working group member depends on the quantity and quality of his/her work. The government should continue to explore ways of encouraging labour organization and improving their effectiveness.

Rehabilitating low-yield bamboo forests

Two factors that have constrained the development of intensive management are a shortage of capital investment and farmers' familiarity with the traditional planting system. Further development of the bamboo forest under intensive management can be extended in two ways:

1. Guidance from local government forestry departments to farmers for establishing a sample forest base and changing traditional management ideas and performance; and
2. Subsidies from local government forestry departments to farmers for rehabilitating low-yield bamboo forests.

A special forest product tax — 16% of the output value of bamboo products — should be imposed. Half of the revenue extracted, 8% of the output value, should' be earmarked for rehabilitating low-yield bamboo forests.

3 BAMBOO PROCESSING SECTOR

In 1994, bamboo processing enterprises numbered 527 and employed 10 700 people. Among them were 443 enterprises, which annually processed 8.5-9 million culms of moso bamboo (about 50% of the total annual moso production) and 170 tons of other bamboo culms (about 73% of annual production of non-moso bamboo). Another 40 bamboo shoot processing enterprises annually processed 30000 tons of moso bamboo shoots, and 44 other enterprises annually processed 35 000-40 000 tons of bamboo by-products to make articles such as brooms. The annual value of raw bamboo'materials consumed by all processing enterprises was estimated at 135 million yuan and the value of the products at 468 million yuan. If inflation is considered, 70% of the increase in value would come from new products and increased output. The annual profit on bamboo processing was around 65 million yuan with an annual profit ratio of 14%

As for individual products, bamboo mats dominated all others in 1994; with an annual consumption of 5.6 to 6 million culms of bamboo. In 1994, 340 enterprises produced bamboo mats worth 230 million yuan, or about half of all income from bamboo-related enterprises in Anji. Bamboo shoot processing is the second most important industry as it annually uses 37000 tons of raw shoots to produce 22 000 tons of canned shoots. The value of this product is about 127 million yuan. The current status of shoot processing is a direct result of the reforms during the 1980s, which helped the industry transform from one in which shoots were sold fresh, without processing, to one that caters to a world market. Other bamboo products in Anji include bamboo handicrafts, bamboo panel and bamboo floor boards. In Fig. 4 and 5, the partaicipants in the production, management and flow of bamboo mat and shoot products are illustrated.

Institutional Changes

In the 1980s, a series of policy directives were issued to create incentives for rural industry development. In 1983, the State issued a directive, *Current Problems* Concerning Economic Policy in the Countryside, which allowed farmers to process and market surplus farm products, including bamboo, once they had supplied a set quota to the State. In 1984, the state government altered this policy to more directly , stimulate the rural industry. The new law allowed farmers and collectives to freely circulate their capital and at the same time encouraged investment in non-agricultural businesses and cooperatives. In addition, the government passed reforms to

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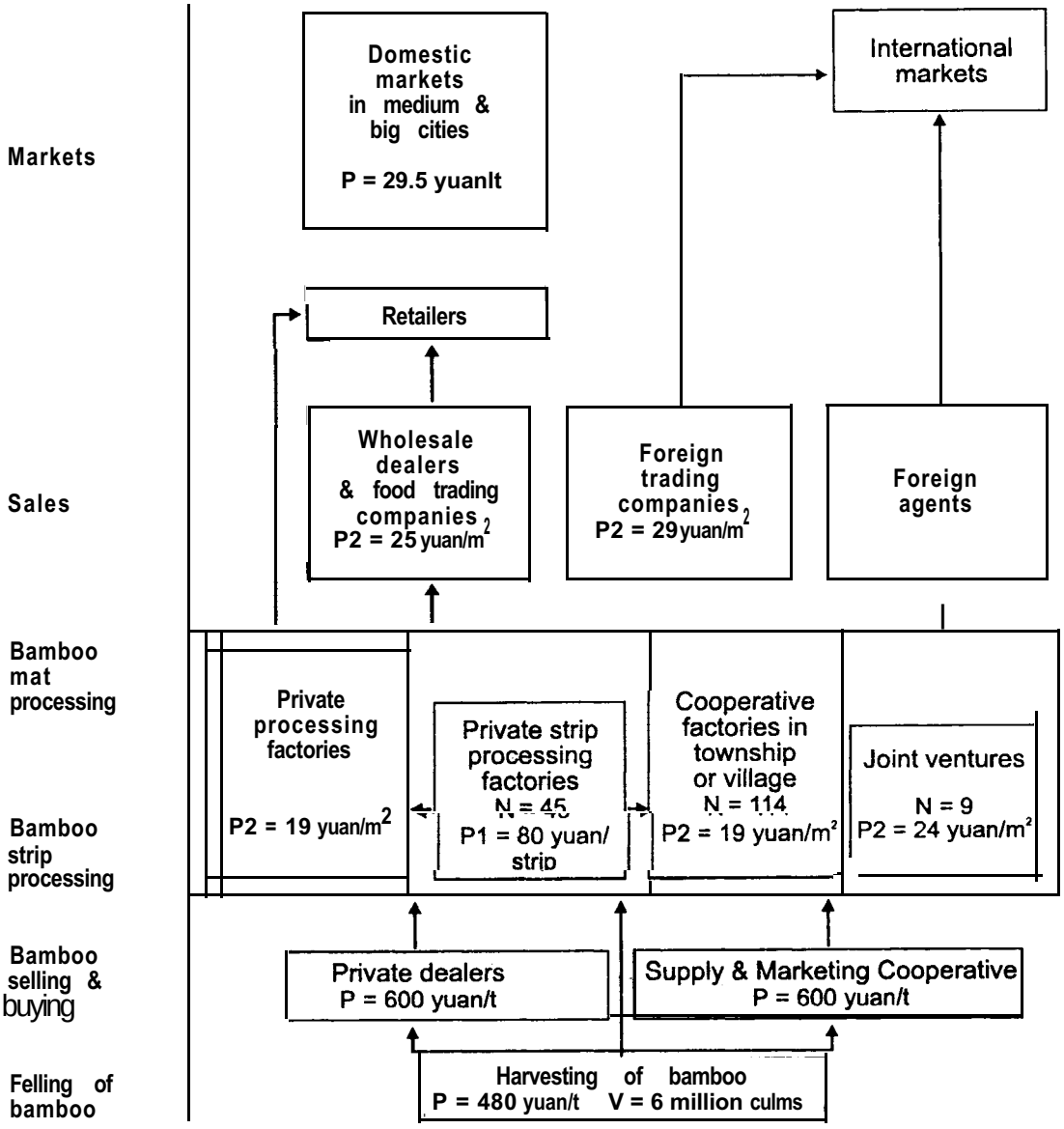
* Anji county only supplies about 10 000 tons of shoots; around 20 000 tons are provided by suppliers from Fujian Province.

Anji County Statistics, 1994.

Two policies — the Farmer Household Production Responsibility System and the Open Market Policy-have affected the processing industry indirectly. These policies are discussed elsewhere.

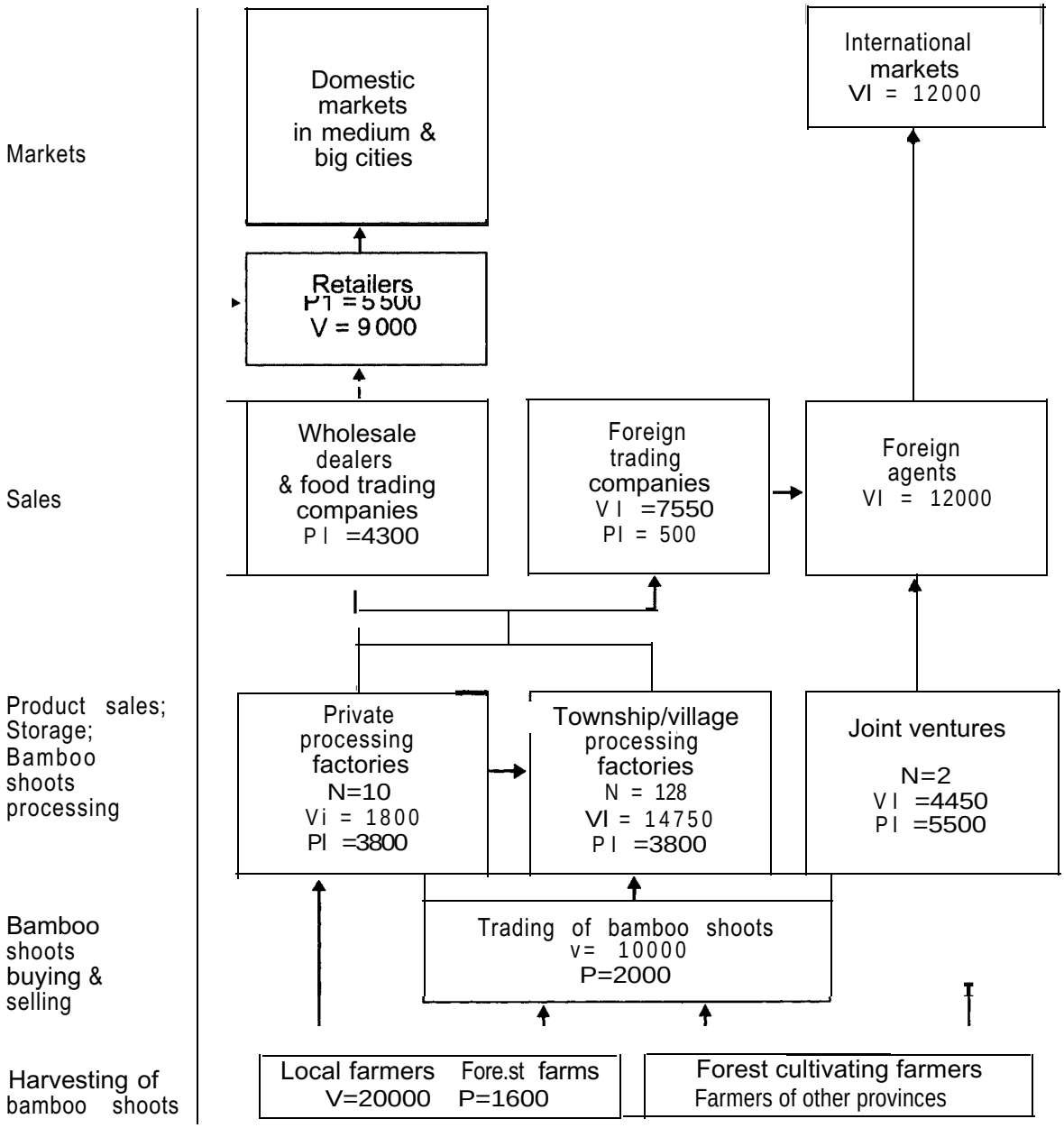
encourage foreign investment and trade, and made it possible for the formation of bamboo-based joint ventures. Local governments also made efforts to coordinate activities of various related government agencies – Forestry, Industry, Commerce and Foreign Trade – to facilitate bamboo industry development in raw material Supply, operation certification, loans and export.



V = culm yield of moSo bamboo; N = no. of enterprises; P = price of bamboo; PI = price of bamboo strip; P2 = price of bamboo mats

Fig. 4: Participants and their functions in the production and trade of bamboo mats

The first two such ventures in Anji County appeared in 1989.



V = yield of bamboo shoots (tons); VI = Sale volume of canned bamboo shoots (18 kg/can) N = no. of enterprises; P = price of fresh bamboo shoots (yuan/ton); PI = price of canned bamboo shoots (yuan/ton)

Fig. 5: Participants and their functions in the production and trade of bamboo shoots

Structure and Management of Enterprises

Reform policies have contributed to rapid growth in the number and turnover of bamboo-based enterprises. In 1978, only 490 people worked in 19 bamboo-based enterprises (six township and 13 village enterprises) none of which were privately owned. By 1985, the number of bamboo factories had grown to 154. In the years that followed, many bamboo farmers, townships and villages reinvested earnings back into bamboo activities to accelerate bamboo processing sector development: Ten years later, in 1995, the number of bamboo-based enterprises had more than tripled to reach a. total of 527.

In the development process, the ownership structure of bamboo enterprises changed significantly. In 1985, 111 (72%) of the 154 bamboo enterprises were township and village enterprises, while the rest were owned by private concerns. By 1995, although the number of bamboo township and village enterprises had risen to 188, their share dropped to about 35% of the total ownership. Private factories took the lead by growing in number to reach 320, or about 61%. Among these enterprises, 18 were relatively new joint ventures.

Although private enterprises dominate in number, they are considerably smaller than the large producers. If data on joint ventures and domestically-owned enterprises are separated, as they are in Table 11, processing* and market influences are revealed. Collectively owned enterprises and joint ventures dominate the bamboo processing industry in terms of output value and staff strength. Also, the data suggest that joint ventures achieve the highest marginal returns to labour while local private enterprises operate at the lowest?

Table 11: A comparison of processing enterprises by ownership

Item	Collective	Private	Joint Venture	State-owned
Output value	53%	16%	30.5%	0.5%
No. of workers	53%	21%	25.8%	0.2%

Overall, the composition of bamboo finished products and producers has gradually changed owing to a desire for higher profits through value addition to meet market demands. For example, private enterprises had been the key producers of traditional products like farm tools and simple furniture. Recently, production of these

16 A better classification would divide enterprises into three groups according to their production scale, capital investment, techniques and equipment: (1) Independent enterprises-larger in scale; use advanced techniques and equipment, and produce raw material, semi-finished products and final products; (2) Subcontract producers-mainly small-scale private and individual producers who focus on semi-finished products like bamboo splits to be sold to independent enterprises; and (3) Family mills-the smallest in scale and produce low-end products such as dried bamboo shoots and bamboo brooms for the local market. Although such a classification is not extensively used in this analysis, it is important because it reveals the potential for development of higher-end product enterprises and job creation as well as identifies the risks of capital investment, especially for family mills. The classification more clearly identifies those (mostly independent enterprises) which have used financial support from banks to create raw material storage. This investment substantially increases price competitiveness since bamboo harvests are concentrated during a regulated season.

items has fallen as private enterprises have focused on higher-end products such as newly designed bamboo mats, boards and handicrafts. This pattern has emerged even though many private enterprises produce only semi-finished products for sale to collective and joint venture enterprises. In bamboo shoot processing, a series of products, such as water bamboo shoots, canned bamboo shoots and flavoured shoots, have expanded the diversity of products from the more simple dry bamboo shoot processing. Use of bamboo by-products in manufacture (for instance, for broom-making) has been further developed. As is evident in Tables 12 and 13, most private enterprises have gone into mat processing which requires less capital investment and still gives good financial returns.

Table 12: Iabour and output value of enterprises by bamboo product type (1995)

Item	Shoot	Mat	Handi-crafts	Plyboard	Broom	Other products	White bamboo	Total
No. of enterprises	40	340	14	50	13	44	26	527
No. of workers	2 890	4 500	560	1050	580	540	580	10 700
Output value (million yuan)	127.9	230	12.4	34.2	35	13.5	15	468

Source: Yearbook of Anji Forest Bureau

Table 13: Enterprise ownership and bamboo product specialization (1995)

Ownership	Shoot	Mat	Handi-crafts	Plyboard	Broom	Other products	White bamboo	Total
Township	28	114	9	13	7	3	14	188
Private	10	217	5	35	0	41	12	320
Joint Venture	2	9	0	2	5	0	0	18
State-owned	0	0	0	0	1	0	0	1
Total	40	340	14	50	13	44	26	527

Source: Yearbook of Anji Forest Bureau

Socio-economic Benefits

The bamboo sector produces much of the county's household and administrative income. In major bamboo townships, the bamboo industry output value accounts for as much as 50430% of their total industrial value. In the ten years between 1985 and 1995, bamboo output value soared from about 12 million to 468 million yuan, contributing 11% of the county's total industrial output value. In 1995, the total raw material costs were 135 million yuan; which means that the processing sector produced 333 million yuan in added value. In the same year, the bamboo sector provided 28 million yuan in taxes or about 30% of the county's revenue.

Development of the bamboo processing industry has increased employment opportunities and incomes for many families. For instance, employment in bamboo pro-

cessing industries rose from 3 370 in 1985 to 10700 in 1995. A survey of 62 worker families shows that between 1994 and 1995, the average household income was 13 572 yuan. Income from bamboo processing was 5 061 yuan, 37% of the total household income (Tables 14 and 15). Overall, private and state-run enterprises pay workers about the same wages, but only the latter provide health care and pension support.

Table 14: Average household income from bamboo processing in Anji (1994-95)

Enterprise type	Families surveyed	Number of persons	Total income per family*	Income from bamboo*	Income share of bamboo (%)
Bamboo mat factory	10	38	11083	3 363	30.3
Bamboo mat factory	11	35	12408	6225	50.2
Bamboo mat factory	11	40	14 386	5361	37.3
Bamboo shoot factory	10	31	15 588	4554	29.2
Bamboo shoot factory	11	47	14 516	6 267	43.2
Bamboo wear factory	9	32	13 451	4602	34.2
Average			13 572	5062	37.3

Note: * in yuan
Source: Case Study Survey

The bamboo processing industry also offers many employment opportunities for rural women. In the 29 privately owned bamboo enterprises surveyed, women accounted for about 60% of the workforce. The average monthly wages of female and male employees were 413 yuan and 510 yuan, respectively (Table 15). Part of this income difference can be explained because women were primarily workers while men were managers.

Table 15: Employment and wage structure in bamboo factories

Enterprise type	Employment structure (%)		Wage structure (yuan/month)	
	Male	Female	Male	Female
Bamboo mat factory	32.25	67.75	565	423
Bamboo shoot factory	30	70	465	410
Bamboo broom factory	26.8	73.2	543	416
White Bamboo factory	62	38	480	410

Source: Case Study Survey

Cost-benefit Analyses of Bamboo Products

Bamboo mat

Bamboo mats are a major bamboo product in Anji. Every year, approximately 0.9 million pieces of mat are produced from 0.13 million tons of bamboo culms. About

two moso bamboo culms (50 kg) can produce 450 strips needed to make one bamboo mat. Taking machine-made striped bamboo mats as an example, costs and revenues can be analysed. The standard processing procedure includes: splitting, sliver making, weaving, gauze covering, edging, wrapping and finishing. Data from the enterprise survey on costs can be found in Annexe B. Average costs incurred by these enterprises were used in this analysis.

The costs and benefits for one piece of bamboo mat are as follows:

- Costs: total production cost – 54.96 yuan
  raw bamboo – 32.08 yuan
  wages – 3.37 yuan
  - supplementary raw material (gauze, etc.) – 13.93 yuan
  - energy – 1.12 yuan
  - others – 4.46 yuan
- Benefit: total benefit – 72.15 yuan
  - factory price of bamboo mat – 66 yuan
  - surplus raw material - 6. 15 yuan
- Cost-benefit ratio: (72.15 -54.96 + 54.96 x 100 = 31.3%
- Tax @8% of sale price=66*8/100=5.28 yuan
- Cost-profit ratio: (72.15 – 54.96 – 5.28) / 54.96 x 100 = 21.7%
- Raw material costs: raw bamboo + supplemental material + energy = 32.08 + 13.93 + 1.12' = 47.13 yuan
- Added value (over value of inputs, wages excluded): ,72.15-47.13 = 25.02 yuan
- Value added ratio (over value of inputs, wages excluded): 25.02 \ 72.15 x 100 = 34.7%

Bamboo shoot

This analysis uses water bamboo shoots, the major industrial product, as the example. Raw moso bamboo shoots produced in the spring is the main raw material. The ratio of raw bamboo shoots to finished bamboo shoots is 1:1 .62. The basic technological procedure involves shell peeling, pre-boiling, cooling, rinsing, grading, packing, sterilizing at high temperatures and sealing.

Data on production costs from several *enterprises of different production scales are shown in Annexe C. The data indicate that the relative production costs of the three main non-wage expenses are: raw material – 67% of total costs; packing – 20%; and energy - 2%. Total cost per ton is 4018 yuan. The analysis uses the average raw bamboo shoot price, 1656 yuan per ton, to account for differences in quality and purchasing times. At present, 63% of the processed bamboo shoots in Anji are exported at an average price of 5 500 yuan/ton. The other 37% are consumed domestically and sold at 3 600 yuan/ton wholesale price. If the mixed price is 4797 yuan/ton, the net profit is 779 yuan/ton. Considering these figures, the industry's production indicators are the following:

- Cost-benefit ratio: (4797 – 4018) / 4018 x 100 = 19.4%
- Tax @7% of price: 7 / 4797 x 100 = 336 yuan
  Cost-profit ratio: (4 797 – 4 018 336) / 4 018 x 100 = 11%
  Added value (over value of *inputs, wages excluded): 4797 -3 578 = 1219 yuan

- Value added ratio (over value of inputs, wages excluded): 1219 / 4797 x 100 25.4%

Bamboo-based boards

Bamboo-based board includes sub-categories such as woven board, sliver board, curtain board, particleboard, floor board, etc. These products are mainly used for carriage floors, building board, packing board and decoration board. Recently, Anji's bamboo-based board production has dropped because of constraints in equipment, technique and cost. This study found that 1 m^3 of bamboo board used for carriage floor costs 4720 yuan just in materials? If the marketing price of the final product is 5 300-5 500 yuan (as is the case), the factory must be incurring a loss since costs of other inputs – labour,. management, transportation, selling, interest, etc. – are still to be added. By contrast, there has been an upward trend in bamboo floor board production and demand. An analysis of the following costs and revenue for 1 m^2 of the floor board (90 x 90 mm, 9 mm thick) suggests positive returns.

- Total costs: 195 yuan (including other items besides the folloying)
  - bamboo: 49.5 yuan (75 kg)
  - supplementary materials: 13.5 yuan
  - energy: 29.0 yuan
- Sales income: 220 + 15 = 235 yuan
  - factory price: 220 yuan
  - surplus raw material: 15 yuan
- Cost-benefit ratio: (235 - .195)"+ 195 x 100 = 20.5%
- Tax @80/o of factory price: 220 x 8 / 100 = 17.6 yuan

Cost-profit ratio: (235 - 195 - 17.6) / 195 x 100 = 11.5%

- Added value (over value of inputs, wages excluded): 235 - 92 = 143 yuan
- Value added ratio (over value of inputs, wages excluded): 143 / 235 x 100 = 61%

The analysis shows that bamboo floor board is a high value added product and has bright prospects. If the raw bamboo price rose by 10%, the profit would drop by only about 3%. This means that the enterprises can withstand fluctuations in raw material prices.

white bamboo

White bamboo is a semi-finished product made from *phyllostachys nigra* var. *henonis* (Mitf.) Stapfex Rendle and P. *angusta* McClure by boiling and polishing. The product, used for decorative purposes, is mainly sold in Japan in standard lengths of 4, 2, 1.06 and 1.5 m. Costs and revenues for this analysis are based on the calculation that 100 kg of raw bamboo produces 70 pieces each of 2 m and 1.06 m lengths. The factory prices for 2 m and 1.06 m white bamboo are 1.05 yuan and 0.75 yuan, respectively.

- Total cost: 97.35 yuan

"A 1 m^3 (1200 x 2 400 x 15 mm) board requires 260 pieces of moso bamboo (5-5.5 tons) at a cost of 3495 yuan, 66 kg phenol glue (for bonding) at 515 yuan, and energy at 710 yuan.

- wage: 13.5 yuan
- energy: 0.9 yuan
- management: 0.8 yuan
- transportation: 2.85 yuan
- interest: 2.2 yuan
- selling expense: 1 .1 yuan
- raw bamboo: 76 yuan

- Total benefit: 140 yuan
  - output value: 126 yuan
  - surplus material: 14 yuan
- Cost-benefit ratio: (140 - 97.35) / 97.35 x 100 = 44%
- Tax @6% of output value: 126 x 6 / 100 = 7.56 yuan
- Cost-profit ratio: (140 - 97.5 7.56) / 97.35 x 100 = 36%
- Added value (over value of inputs, wages excluded): 140' - 76.9 = 63 yuan
- Value added ratio (over value of inputs, wages excluded): 63 / 140 x 100 = 45%

Bamboo broom

Bamboo broom is a traditional bamboo product in Anji. An annual output of around 5.5-6 million brooms requires about 15 000-20 000 tons of bamboo branches and top logs. In recent years, 50-60% of these products were -exported to Japan.

- Total costs: 2.18 vuan
- average raw material cost: 0.95 yuan
- handle: 0.3 yuan
- supplemental material cost: 0.20 yuan
- energy: 0.03 yuan
- wage: 0.4 yuan
- transportation: 0. 1 yuan
- interest: 0.05 yuan
- selling cost: 0. 1 yuan
- others: 0.05 yuan
- Price: 2.5 yuan

Thus, the profit is 0.32 yuan with 15% cost-benefit ratio, 9% cost-profit ratio and 46% added value.

Summary

As can be seen from Table 16, economic analyses indicate positive returns for all of the described products. Despite wide differences in production scale, the analysis of bamboo mats reveals it to be one of the most stable enterprises. Indicators of white bamboo production suggest that there are high returns to be captured as well. Returns in bamboo shoot processing appear to suffer from high raw material costs. Finally, bamboo brooms are likely to generate high levels of added value that are particularly important to the small family enterprises involved in its production.

Table 16: Economic analyses summary of bamboo products in Anji (1995)

Parameter	Mat	Shoot	Floor-board	White bamboo	Broom
Cost-benefit ratio (%)	31	19	21	44	15
Cost-profit ratio (%)	23	11	11	36	9
Added value ratio (%)	34	25	61	45	46

Reasons for the Rapid Development of Bamboo Processing Industries

Interest of farmers

Farmers and collective economic organizations have welcomed the development of bamboo processing industry as it has increased their incomes, improved their standard' of living and created more employment opportunities. Collective economic organizations have found a reduction in the risk of unmarketable or low-selling products, while farmers have gained the opportunity to develop enterprises themselves, not under the direction of others.

Strong market demand

The economic reforms opened the bamboo sector to larger domestic and world markets which, in turn, attracted higher investments. Not long ago, bamboo products were limited 'to bamboo baskets and furniture and these were sold in small, local markets. Now, higher farm incomes have raised the demand for a more diverse set of bamboo products. In addition, joint venture and collective enterprises have begun to export, to meet the international demand. These sources of demand have increased the output value of bamboo products (from 25 million yuan in 1990 to 119 million yuan today) as well as the availability of consumer products.

Economic returns

Economic returns are an important factor in determining the level of capital investment. In the mid-1980s, the profit rate of bamboo products ranged from 25 to 30%. This high profit rate attracted capital from investors, who used it to increase competitiveness throughout the industry. Although the profit rate decreased to 11% in the mid-1990s because of higher raw material costs, this rate was still larger than the interest on bank savings, making the bamboo industry an attractive investment.

Low capital investment and technological requirements

Since the reforms, money has flowed into those enterprises that require small capital investments, simple technologies and short construction periods. Bamboo mat and shoot were the obvious targets to investors and entrepreneurs. Many of these enterprises are now scattered across a large area of Anji, and provide many farmers with nearby outlets for raw materials. By contrast, enterprises with more

intensive capital investment and technical requirements, such as panel and flooring products, have progressed more slowly and some have even stopped production.

Improvement of Bamboo Processing

Despite impressive growth in enterprise development and output value, the overall type of growth has not been suitable to the requirements of a developing market economy. What is required for a rapid expansion of the bamboo-related industry is an increase in market competition and regional growth of small-sized production and an upgrading of trade organizations. In 1995, the State reiterated that economic development must rely on switching from the old mode of extensive growth. But to realize the sector's potential, further re-adjustments and reforms of industrial structure and operational mechanisms may be required. In light of the rising world market competition and fluctuating demands for bamboo products, enterprises should improve product quality and reduce prices to competitive levels. Several additional measures and activities that could assist in broad, sustainable development of bamboo industries include the following.

Formation of enterprise groups

To ensure sustained and stable development of bamboo industries, production and management entities should form 'Enterprise Groups' and 'Enterprise Combinations' along product lines. Currently, bamboo enterprises have grown through external production expansion and as a result, many are small-sized, geographically scattered and operate under complicated management systems. This type of growth has spread the limited capital, technicians and skilled workers across the county and has otherwise limited the improvement of product quality and development of new products. Consequently, although production and marketing have increased, the enterprises have become less competitive instead of gaining a stronger position.

Enterprise Combinations represent an alternative form of industrial development. Within Combinations, individual enterprises enjoy mutual support and benefit from technology and capital. Combinations build up unified information and sales networks that reinforce inherent competitiveness. If industrial conditions are mature, farmers and business people should establish vertically integrated Enterprise Groups that link enterprises with farmers to produce certain kinds of products at lower costs and risks. For these Groups, more sophisticated management and distribution systems, and information, technical and service networks can be established to expand the overall development of the industry.

Bamboo product orientation and development

Enterprises must study market demands to anticipate future changes in the structure of bamboo finished products. Anji County, with more raw material resources than other provinces such as Jiangxi and Hunan, has a comparative advantage in products such as bed mats and bamboo shoots. Farmers and entrepreneurs have also done well in entering markets and raising their competitiveness. Yet, while mats are the principal product in Anji, this study found that the market for bamboo strip mat

is moving towards saturation, while the demand for bamboo square mat is increasing. A market demand analysis of finished .products is therefore imperative to achieve further expansion of mat production.

In the bamboo shoot industry, several constraints ,obscure potential opportunities for growth. In recent years, the export market spurred the rapid development of the bamboo shoot industry while the domestic market growth has been slow mainly because of lower prices. Further growth in 'bamboo shoot processing depends on expanding the local market and, most importantly, lowering production costs; currently, bamboo as raw material accounts for 67% of total prosessing costs. In this regard, a limited survey during this study found that the costs in management, sales and energy of large-scale factories were lower than those 'of smaller ones. Ad& - tional studies on the relationship between the scale of operation. and competitiveness should be a top priority. Finally, because bamboo shoot prosessing is seasonal, the raw material supply enterprises should develop other products that would allow better use of equipment and storage to maximize the 'returns on investment.

The potential for new products is also high, especially' since 50% of bamboo-related products remain to be sold as bamboo culms and only 20% of the culm is fully utilized under current processing regimes. Traditional bamboo handicrafts are likely to enjoy sustained growth owing to a high value added ratio and an expanded market demand. Bamboo-ply board production has suffered losses and paused production; yet the output of bamboo floor board may increase to meet the market demand. With annual increases in bamboo culm harvests, enterprise analyses of bamboo pulp and bamboo-ply board processing could yield timely results, especially since the State has placed bamboo panels and bamboo floor boards in its development plan.

Production services system

Small-sized enterprises typically have complicated management systems that inadequately deliver information, respond to technical innovations and meet product sales. The establishment of a 'Production Service System would provide useful technical assistance and information to these enterprises. The county should set up such a service with subsidiaries at the township level. The service centres can deliver information to enterprises, organize their product sales and new product development, as well as assist them in collecting funds, serving enterprises in pre-production, mid-production and post-production.

Improvement of bamboo sector administration

Multiple and competing levels of sector administration is another constraint in bamboo sector development. At present, bamboo enterprises are administrated by one or several government agencies, such as the Forestry Department, the Light Industry Department, the Industry and Commercial .Management Bureau, and the Foreign Trade Committee. Each of these institutions has established its own enterprises to protect and promote sector benefits as it sees fit. This has sometimes been done without considering the raw material supply and final products market. A better approach would be to increase collaboration within these departments and thereby more effectively allocate resources.

Redefining property rights in collective enterprises

In contrast to property relationships with respect to bamboo land, the property rights of collective enterprises are unclear. At the township and village levels, the economy is growing without organization. With reforms, the township government has assumed control over collective property even though at the village level, individual farmers can exercise rights over the same collective property. In the absence of clear rules, enterprises are being operated by a few public officials under the contract responsibility system. However, this arrangement has produced conflicting results because enterprise profits are owned by a few people but losses are borne collectively. Problems associated with this include short-term interests, insufficient accumulation of enterprise assets, and a negative influence on the development of other enterprises and on farmers' enthusiasm.

The relationships of enterprise property rights must be clearly defined. One way is to change the contract responsibility system for collective economic organizations to one that involves share-holding cooperative management. Collective assets could be evaluated and distributed or allocated to farmers, giving each a tangible share of the benefits and risks. In this style of management, farmers .would hold shares and enjoy enterprise profits, and enterprise managers would be supervised by a board of director-s.

4 MARKETING

Institutional Changes

Significant reforms have also been carried out in the bamboo marketing system. Previously, the State regulated bamboo as a Class-2 good and gave the Supply and Marketing Cooperative (SMC) the power to establish purchase stations to procure at fixed prices all agricultural products, including bamboo. SMC held a marketing monopoly and allowed farmers to keep only a few products for family use. In the early 1980s, this marketing monopoly was cancelled in favour of a contract system. Under this system, the province set production quotas for each village; once the quota was fulfilled, farmers could sell surplus bamboo by themselves or to the SMC. This regime changed again in 1985, when bamboo was reclassified as a Class-3 good, meaning that no restrictions governed its sale. This rule lifted price, contract and trade controls and allowed all traders – whether they were individual intermediaries, enterprises or trade companies – to market bamboo. Thus a diversified bamboo marketing system was formed.

Marketing of Raw Bamboo

Table 17 shows the changes in the marketing of raw bamboo in Anji over the years of reform. Private traders have dominated the raw bamboo market since 1985 and have extended their contacts from local to outside trading companies and enterprises. In so doing, they have provided a bridge between bamboo plantations and the market. A survey of 200 farmer households showed that in 1994-95, 83% of bamboo was traded through individual intermediaries. Some bamboo culms were brought by traders to local processing factories and the rest transported to construction or trading companies for use as scaffolding in places such as Shanghai, Jiangshu and Shandong. In Anji county, about half of all raw bamboo is processed in local enterprises; the rest is marketed to Shanghai and Jiangshu province (Table 18). In the case of bamboo shoots, about 70% of the product is purchased by local processing enterprises with the rest transported to the market as food.

Some private traders were local farmers from Anji's townships and villages who, after the marketing reforms, began trading and cultivating bamboo. While some farmers transported the culms harvested from mountainous and hilly areas to the highway for sale to traders, others directly sold culms to the processing factories.

The rise of private marketing can also be attributed to the poor performance of SMC. The decline of SMC was as much a result of rigid management, fewer purchase stations and lower wages as it was of the trade policy reforms. After losing its marketing monopoly, SMC could not compete against the profit-seeking and more flexible intermediaries. Table 17 tracks the decline of total purchases by SMC to the point where they now account for just 3% of the total raw bamboo purchased. Enterprises have a greater purchasing power as they procure 14% of all raw bamboo traded.

Around half of moso bamboo culms is sold in other provinces.

Table 17: Market channels for raw bamboo in Anji (1983-94)

Year	State-run Supply and Marketing Cooperative					Other State-run market outlets		Private market outlets
	Moso bamboo				Others	Moso culms (1000 tons)		Moso culms (1-000 tons)
	Culms (1000)			Branches (1000 tons)	Culms (tons)	Diameter		
	Diameter >6 cm	Diameter <6 cm	Sub-standard			>6 cm	<6 cm	
1983	6 335	241	633	36	9 209	750	0	1 878
1984	6 982	473	730	5	2 316	732	0	2 365
1985	5 388	229	633	14	3 929	11	0	3 962
1986	3 257	278	526	19	2 400	1 097	0	6 796
1987	3 488	139	299	21	2 555	334	6	8 729
1988	3 091	231	539	25	1 663	260	6	8 532
1989	,I 739	147	0	9	637	433	44	9 826
1990	I 867	118	0	1 4	0	351	27	10 462
1991	1 384	120	0	14	0	1 144	41	12 477
1992	2 167	75	0	11	0	1 261	72	10 210
	2 236,	0	0	4 1	0	0	0	15 113
1994	1435	0	0	23	0	0	0	15 931

Source: Yearbook of A

Table 18: Marketing pattern of raw bamboo produced in Anji (Unit: million culms)

Year	Total output	Destination		
		Local market	Other county province	Export market
1990	13.50	3.85	9.65	—
1991	15.17	4.70	10.4	0.07
1992	15.05	5.18	9.71	0.16
1993	17.35	6.26	10.8	0.29
1994	17.37	8.50	8.69	0.18

Source: Yearbook of Anji Forest Bureau

Private traders have made it easier for farmers to sell their products. Yet, when market conditions are unfavourable, farmers become vulnerable; private traders aim only to maximize their profits, and stop buying products from farmers or force the prices down when profit margins become tight. To overcome this problem, farmers have formed their own trade organizations. These organizations endorse legal contracts with processing enterprises on supply and price. They also engage in selling bamboo products as well as providing farmers with production inputs such as fertilizer. An added benefit is that many farmers who work in the trade organization gain additional incomes in the process.

Market Prices for Raw Bamboo

Market reforms in bamboo trade have increased benefits to farmers not only by raising direct returns to farmers but also by liberalizing. market demand; and hence prices that farmers could receive. With the opening up of the marketing process, product prices came to be governed by supply and demand forces; the local government was involved only in developing new techniques and in development planning, not in market intervention or price control. The cumulative effect was that the processing industry rapidly developed and increased its demand for raw bamboo. Industrial demand for raw bamboo culms and shoots expanded 4.5 and 30 times, respectively, between 1985 and 1994. As a result, the prices increased at annual rates of 17% and 23%, respectively, with some of the benefits from these higher prices going to the farmers.

Table 19 shows the historical price changes between 1985 and 1995. The average annual price increase of moso bamboo is about 16%, while for other bamboos the figure is almost 13%. Taking 1985 as the base, the price index in 1995 was 459%; roughly equal to the change in national prices for agricultural products (excluding taxes and other charges).

Table 19: Price changes of moso bamboo in Anji (1985-95) (Unit: yuan/ton)

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
price	112.0	128.1	145.2	202.6	184.8	231.0	250.0	349.8	402.6	475.2	514.0

Source: Yearbook of Anji Forest Bureau

Marketing of Finished Bamboo Products

Finished bamboo products from Anji are sold both in domestic and international markets. In the domestic market, bamboo is purchased by wholesalers, trading companies, retailers, and small, individual traders. Most bamboo trade is carried out by wholesale cooperatives at the province and county levels, or by individual trade groups. Some bamboo factories have set up their own shops in the city for selling finished products in the retail and wholesale business. At present, unstable contracts between manufacturers and traders have created problems resulting in a relatively high risk for marketing enterprises.

From 1990 to 1994, the local share in the total sale volume of bamboo shoot products dropped from 15.8% to 7%, while that of other finished products was reduced from 27.8% to 16.7% (Table 20). This means that much of the county's bamboo products were transferred to markets in other counties or provinces via wholesalers.

In recent years, there has been an upward trend in bamboo product exports. In 1994, the export value of bamboo culms and shoot products accounted for 44% and 62% of their total values, respectively. The export value rose from US$8.6 million in 1990 to US$27.4 million in 1994, a more than three-fold increase.

The data in Table 21 illustrate the importance of exports to Anji's bamboo production and marketing. For instance, not once since 1990 was the share of export value to total value less than 40%. Moreover, the table indicates a dramatic rise in the nominal export value. Nevertheless, the share of export value declined between 1990 and 1994 for bamboo shoots and other products. This decline suggests a growing significance for the development of the domestic market.

Table 20: Sale volume of bamboo shoot and other finished products
(Unit: 1 million yuan)

Year	Bamboo shoot products			Other finished products		
	Anji	Outside	% in Anji	Anji	Outside	% in Anji
1990	09 .	48	15.8	22	57	27.8
1991	10 .	64	13.5	24	16.2	12.9
1992	28 .	34.4	75	83	27.0	23.5
1993	29	30.0	88	19.3	111.1	14.8
1994	34. 70	44.9 .	16.7	22.8	113.6	

Source: Yearbook of Anji Forest Bureau

Table 21: Bamboo exports from Anji (1990-94) (Unit: 1 million yuan)

Year	Bamboo shoot products			Other finished products		
	Total Value	Export Value	Export %	Total Value	Export Value	Export %
1990	28.18	22.56	80.05	26.65	18.25	70.35
1991	39.91	32.49	81.40	42.66	24.13	56.56
1992	68.95	31.82	46.15	79.28	43.21	54.50
1993	88.14	55.00	62.62	212.46	87.15	41.25
1994	127.95	59.68	62.30	284.37	147.99	52.04

Source: Yearbook of Anji Forest Bureau

Bamboo exporters are mainly foreign trading companies at the province and county levels since they are granted export rights. Products are primarily sold in Japan, Korea and Southeast Asia. In most cases, foreign trading companies provide enterprises with information concerning quantity, quality and size of bamboo products demanded by foreign buyers, but do not enter into a price contract with them. In other cases, foreign trade companies sign supply contracts with bamboo factories. Prices are set by foreign companies based on export prices and negotiations. Advance payment, usually 30% of the total, may be made to producers through a circulating fund. The remaining payment is made after the products are sold.

Market Prices for Finished Products

The prices of finished bamboo products have been rising because of increased manufacturing costs. The problem of raw bamboo price changes poses an increased risk for manufacturers as there is a delay between purchase of raw bamboo and sale of finished products. Manufacturers purchase raw bamboo between October and December, but sell their products only between April to August in the following year. Since most bamboo factories are small-scale, it is difficult for them to obtain reliable market information and to anticipate price changes.

Two products for which this has happened are bamboo shoots and mats. Canned water bamboo shoots were factory priced at 1800 yuan/ton in 1990 but by 1995, the price doubled to 3 600 yuan. This rise in price was required to keep pace with raw bamboo shoot costs which increased by 60% over the factory price. In 1995, the retail price of canned bamboo shoot was 6 500 yuan/ton, about 80% higher than the factory price. The list below gives the cost and prices of canned bamboo shoot to its various producers.

Production cost : 4 018 yuan
Ex-factory price : 3 600 yuan
Wholesale price : 5 200 yuan
Retail price : 6 500 yuan

⑲ Following a market slump in 1994 for canned bamboo shoots, the ex-factory price was pegged at a figure less than the actual production cost.

Another example is bamboo mat (1.95 x 1.8 m) the price of which rose from 40 yuan/piece in 1980 to 66 yuan/piece in 1995, a 65% increase. Meanwhile, the bamboo culm price increased by 122.6% resulting in lost profits to enterprises.

Production cost : 56.08 yuan
Ex-factory price : 66 yuan
Wholesale price : 82 yuan
Retail price : 102 yuan

Income Distribution

Regarding income distribution, traders often receive the largest share of the benefits. For example, Table 22 shows incomes from a 3.5 m^2 machine-made strip bamboo mat. The product requires 50 kg moso bamboo. Based on the data, traders as a group earn 38% of the total value added income.

Table 22: Distribution of income from bamboo mat production

Item	Farmer households	Local financier	Enterprises	Wholesaler	Retailer
Net income (yuan)	14.6	10.2	12.5	10.3	12.7
Percentage	24.2	16.9	20.7	17.1	21.1

Market System Improvements

Marketing services system

Farmers mainly sell bamboo culms to individual businessmen or privately operating wholesalers. However, traders often leave farmers vulnerable because, as profit-seekers, they actively purchase when operating profit is high and limit purchases or withdraw from business when the market is sluggish. This approach adversely affects thousands of rural households which are engaged in bamboo production but lack access to transportation and information on national and international markets.

To rectify this, the households need a marketing service system and a set of facilities that directly markets products through contracts. This would help reduce marketing expenses and risks of individual farmers, and widen their external market contacts. Small enterprises would also benefit from marketing services as they face competition from larger companies with better access to information, greater purchasing power and marketing channels. Also, the county should actively establish special marketplaces and facilities for bamboo products, providing prominent marketing spaces for bamboo products, and promote information exchange. These activities would significantly enhance the domestic market.

International trade and improved contracting

The export of Anji's bamboo products has been negatively affected by market fluctuations in the few countries and regions to which it exports. In Anji, 50% of the total production is exported to Japan, Korea and Taiwan-China. Expansion of international trade is currently an urgent matter. Foreign trading companies in the county should actively set up trade relations with other countries or regions. Also, trading companies and processing enterprises should sign purchasing contracts to share risks equally for long-term benefit.

5 CONCLUSION

This case study illustrates that in mountainous and hilly areas, such as Anji County, where bamboo grows well, the bamboo sector is an important factor in establishing a stable ecological environment, improving the rural economy, generating employment opportunities and increasing incomes. The development of Anji's bamboo sector is the cumulative result of policy reforms, the removal of price controls and monopoly marketing, and the promotion of bamboo manufacturing and trade. The development of bamboo resources and improvement of product output have enhanced the socio-economic well-being of those working in the bamboo sector. In addition, periodic readjustment of reforms has preserved the goals of equality in income and benefits.

The management pattern of bamboo production in Anji has gradually shifted from traditional or extensive to a more intensive one. Farmers are adopting new techniques and increasing inputs. Under intensive management, standing volume of moso bamboo can reach 3750-4 100 culms per ha with 25-28 tons of harvest volume per du. The net income per du is around 10000-12 000 yuan with a 103% cost-benefit ratio which is 17% higher than for extensive plantation. Driven by increased demand, improved culm-and-shoot plantation techniques have been generated and widely adopted. It has been proved that intensive plantation is an efficient approach to promote forest land productivity and economic benefits. Yet, in Anji and other low-yield forests across China, more efforts should be made to address the reasons why intensive management has been slow to pick up.

Further development of bamboo plantations will rely on the expansion of the bamboo industry. The development of the industry not only broadens the market for raw bamboo but also improves profit for manufacturers through added value. In Anji, the average value addition of various bamboo products is around 35-60%, with cost-benefit ratios of between 11% and 19%. For bamboo shoot processing, the value added is 25-30% and cost-profit ratio is 10-20%. Further production strategies should target products with higher value added and profit, such as bamboo floor board and bamboo mats. In contrast, bamboo-plyboard may lack competitiveness because it requires large investments and has high fixed costs. Handicrafts and decoration materials made of small bamboo may have better economic potential. A more apparent need is to generate new and high-quality bamboo shoot products.

Township and village enterprises have played an important role in bamboo sector development and rural welfare improvement in Anji, especially since the market opened up. Seasonal production of raw material, however, has made it difficult for the bamboo industry to organize large-scale manufacturing. As a result, diverse, small-scale enterprises form the main body of the industry. With flexible management strategies, they could quickly respond to market changes either by obtaining raw material or by designing and selling products. What is needed is better cooperation between manufacturers and the formation of non-governmental associations.

International trade is significant in Anji's bamboo sector. The annual trade value of the sector is about 460 million yuan, of which international trade accounts for more than 50%. with high-quality export products like bamboo shoots and handicrafts, and with extensive experience in international marketing and trade, Anji ranks among the most important counties for the bamboo sector. However, since international markets involve high risk and competition, Anji must generate new and high-quality products for the domestic market as well as to maintain its position.

Lessons learned from this study for the rest of China are varied. Since many other bamboo growing and processing regions in China will lack the export opportunities that exist in Anji, other issues should be pursued with greater intensity.

6 RECOMMENDATIONS

The bamboo sector has grown extensively in the past 10-15 years and is likely to continue its growth. However, the capacity and direction of growth can be better guided with the timely adoption of appropriate measures. The following are some recommendations which would help the bamboo sector in Anji County continue its pace of growth, as well as maintain and strengthen the progress it has made.

Farmers

The farmers in Anji should:

1. Quickly change their concept of production. They should switch from the old mode of extensive management, focused on the natural growth, to that of intensive management. By increasing inputs, participating in technical training, and mastering new technologies, raising labour input and intensifying management, they will be able to improve the output efficiency of bamboo forests and increase their own incomes.

2. Enhance their competitiveness in the market by establishing economic cooperatives. They can do this without changing the household contract responsibility system and provide themselves with various services on product sale, material supply and labour distribution.

Government

The local government should:

1. Stabilize farmers' use and property rights for bamboo forests to give them secure benefit expectations and avoid short-term profit-seeking bamboo management practices.

2. Actively spread and popularize new techniques, and organize farmers to study and master them, while providing farmers with technical advice.

3. Help establish and improve guidance to private, township and village-owned enterprises, as well as their combinations, to increase their competitiveness, and prevent resource damage and efficiency loss.

4. Begin construction and renovation of marketplaces, and assist farmers to set up an efficient system of commercial and marketing services.

Enterprises

The enterprises engaged in bamboo production and processing should:

1. Strengthen their cooperation with farmers, and establish stable supply relationships for raw materials so that risks and profits can be shared equally.

2. Enhance collaborations with scientific research institutions and improve the training of staff members.

3. Quicken the pace of establishing industrial associations and networks of information, techniques and sales.

Researchers

The researchers should:

1. Explore production practices to solve pressing production problems, and popularize their findings with appropriate governmental departments and production units.

2. Strengthen international cooperative research and information exchange to further advance the level of research.

International organizations

1. International organizations should provide training for technical personnel and carry out project research cooperation and information exchange.

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ANNEXE A1

Economic analyses of traditional and intensive bamboo management systems .

Assumptions and data for present worth analyses of production management systems include the following: land area is 1 ha; the project management period is 20 years; the plantation construction period is 3 years; daily salary is 30 yuan; trial bamboo culm harvest occurs in the 6th year; and regular bamboo harvesting occurs after the 8th year. Differences in costs and revenues include:

Traditional Management

- Initial capital investment: 8325 yuan, including seedlings (3750 yuan), soil loosening and planting (3600 yuan), contract fee (450 yuan) and management (525 yuan)
- Input costs in the 8th year and every other year thereafter: 2 500 yuan per du;
- Annual management expenses after the 7th year: 225 yuan;
- Quantity (and price) of output: culms - 12 tons/du (480 yuan/ton); shoots - 0.55 tons/du (1600 yuan/ton); and by-products - 1.5 tons/du (340 yuan/ton).

Intensive Management

- Initial capital investment: 11250 yuan, including seedlings (5 400 yuan), soil loosening and planting (4 050 yuan), fertilizer (750 yuan), contract fee (450 yuan) and management (600 yuan);
- Input costs in the 8th year and every other year thereafter: 9 150 yuan per du;
- Annual management expenses after the 7th year: 1050 yuan;
- Quantity (and price) of output: culms - 27 tons/du (480 yuan/ton); shoots - 4.5 tons/du (1600 yuan/ton); and by-products - 2.5 tons/du (340 yuan/ton).

ANNEXE A2

Present worth Calculations

NPV under traditionaland intensive management systems

Year	Discount Factor	Traditional Management			Intensive Management		
		Net benefits	NPV	NPV cumulative	Net benefits	NPV	NPV cumulative
0	1.00	(8 325.00)	(8 325.00)	(8 325.00)	(11 250.00)	(11 250.00)	(11 250.00)
1	0.91	(450.00)	(409.09)	(8 734.09)	(1 050.00)	(954.55)	(12 204.55)
2	0.83	(675.00)	(557.85)	(9 291.94)	(1 050.00)	(867.77)	(13 072.31)
3	0.75	(450.00)	(338.09)	(9 630.03)	(1 050.00)	(788.88)	(13 861.19
4	0.68	(300.00)	(204.90)	(9 834.94)	375.00	256.13	(13 605.06)
5	0.62	(450.00)	(279.41)	(10 114.35)	(1 050.00)	(651.97)	(14 257.03)
6	0.56	220.00	124.18	(9 990.17)	3 150.00	1 778.09	(12 478.94)
7	0.51	(225.00)	(115.46)	(10 105.63	(1 050.00)	(538.82)	(13 017.76)
8	0.47	4 425.00	2 064.30	(8 041.33	13 020.00	6 073.93	(6 943.83)
11	0.35	(225.00)	(78.86)	(6 509.59)	(1 050.00)	(368.02)	(2 737.38)
12	0.32	4 425.00	1 409.94	(5 099.65)	13 020.00	4 148.57	1 411.20
19	0.16	(225.00)	(36.79)	(2 375.86)	(1 050.00)	(171.68)	9 080.13
20	0.15	22 200.00	3299.89	924.03	39 000.00	5 797.10	14 877.23
Total NPV				924.03			14 877.23

Notes:

Discount rate = 10%;

Net benefits and NPVs are in yuan;

Net benefits between years 8-11 and 12-19 are not shown for simplicity as they follow the same pattern as in years 7 and 8;

Net benefits in year 20 equal sum of all future net benefits.

ANNEXE B

Economic analysis of bamboo mat production

The data below were used to calculate average production costs of a 1.95 x 1.80 m machine-made strip bamboo mat (Unit = yuan/m^2).

Enterprise	Production scale (m^2)	Raw material	Supplementary materials	Energy	Wages	Depreciation	Management	Marketing	Transportation	Interest	Total
1.	6 100	9.18	3.93	0.27	0.87	0.31	0.61	0.08	0.20	0.43	15.87
2	253 000	9.12	3.94	0.35	0.81	0.25	0.25	0.17	0.16	0.56	15.61
3	77 696	9.25	4.10	0.30	1.07	0.32	0.52	0.31	0.05	0.70	16.82
4	48 262	8.88	4.00	0.27	1.38	0.34	0.34	0.32	0.18	0.12	15.84
5	42 120	9.27	3.97	0.30	1.25	0.36	0.58	0.41	0.30	0.10	16.54
Average	85 436	9.14	3.97	0.32	0.96	0.38	0.38	0.22	0.19	0.48	15.95

Source: Case Study Survey

ANNEXE C

Economic analysis of bamboo shoot production

The data below were used to calculate average production costs of 18 kg canned bamboo shoots in water (Unit = yuan/ton).

Township	Production scale (t)	Raw material	Packing materials	Energy	Wages	Management	Marketing	Transportation	Depeciation	Interest	Total
Tianhuangping	520	2 465	810	85.5	128	71.5	75.0	14.4	61	153	3 863
Tonglixiang	500	2 635	815	92.3	135	72.1	32.9	12.2	59	148	.4 002
Zhangcun	1 200	2 683	818	67.3	146	10.5	35.0	11.3	32	158	3 961
Gankou	700	2 880	817	84.6	153	68.5	54.0	14.5	42	329	4 242
Average	2 920	2 683	816	82.4	141	55.7	49.2	13.1	48	147	4 018

Note:

Almost 90% of the production costs come from raw bamboo shoots (2 683 yuan), packing material (816 yuan, 52 tins @15 yuan/tin) and energy (82 -yuan).