



The Role of Bamboo Plantations in Rural Development: The Case of Anji County, Zhejiang, China

MANUEL RUIZ PÉREZ

Center for International Forestry Research (CIFOR), Jakarta 10065, Indonesia

ZHONG MAOGONG

*China National Forestry and Economics and Development Research Center
(FEDRC), China*

BRIAN BELCHER

Center for International Forestry Research (CIFOR), Jakarta, Indonesia

XIE CHEN

*China National Forestry and Economics and Development Research Center
(FEDRC), China*

FU MAOYI

*Research Institute of Subtropical Forestry, Chinese Academy of Forestry (RISF-CAF),
China*

and

XIE JINZHONG*

*Research Institute of Subtropical Forestry, Chinese Academy of Forestry (RISF-CAF),
China*

Summary. — Bamboos have often been viewed as inferior products, labeled as the “poor man’s timber.” Development groups have proposed bamboo production as an opportunity for increasing the wealth of the lower-income groups. This paper is a study of the household economy of 200 bamboo farmers in eight townships of Anji County in China. The authors describe the process of transformation of rural China from communes to the household responsibility system, the differentiated rate of development among farmers and the role of bamboo in that change. A multiple regression analysis was carried out to study the factors that influence farmers’ incomes and their evolution. A warning is sounded against using bamboo production to target low-income groups, as well as relying solely on aggregated data when drawing conclusions on income disparities in China. © 1998 Elsevier Science Ltd. All rights reserved.

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1. INTRODUCTION

Bamboos are one of the most versatile and widely utilized groups of plants.¹ Their uses range from basketry, weaving, mats, traditional implements and furniture to industrial ply-bamboo panels, flooring and construction materials, and from paper-making to bamboo shoots, essential oils and medicines (Ganapathy, Janssen and Sastry, 1996). It is particularly important in Asia, where it is frequently considered the "timber of the poor" (Rao, Dhanarajan and Sastry, 1987). As an example, Adkoli (1996) estimated that bamboo generates 432 million workdays in India.

Bamboo has been viewed as an inferior good mainly used by poor people as a substitute for higher quality products. This has meant that bamboo has been frequently labeled as a "minor forest product" and, as such, overlooked by official forestry policies and development projects. Despite that, perception, bamboo plays an active role in the rural economies of Asia. Over the last decade bamboo products have gained popularity both in developed countries as an attractive material for house decoration and in developing countries for its potential role in rural development. New technologies have resulted in better preservation and expanded uses of bamboo, and improved management techniques have allowed for intensification and significant yield increases in raw material production (Fu and Banik, 1996).

China has a long tradition of bamboo management and use, with strong cultural ties;² bamboo is a classical component of Chinese literature, painting and landscape. The *Chu Pu*, the first written treatise on bamboo, was compiled by Dai Kaizhi (317–420 AD). It gives a detailed account of 61 species of bamboo species and their uses in ancient China (Williams, 1941; Geng and Wang, 1994). Between 300 and 500 species of bamboo (depending on taxonomic criteria) occur naturally in all except the very high mountains and driest areas of China (Zhu, Ma and Fu, 1994). Bamboo in China is largely concentrated in mountainous and hilly regions, where it constitutes a key element of the forest landscape. The total area of bamboo is seven million ha, of which 3.2 million are natural forest and the rest bamboo plantations.³ More than 700,000 people work in the bamboo sector as farmers or industry workers, resulting in an aggregate output valued at eight billion RMB yuan (1 RMB yuan = US \$8.3), with exports amounting to US \$271.8 million in 1993 (Zhong *et al.*, 1995).

In this paper we attempt to characterize bamboo plantations in a mountainous county in Eastern China and to analyze their role in rural development. This study is a step in a long-term project originally initiated by the Chinese Academy of Forestry, the China National Forestry Economics and Development Research Center, the Center for International Forestry Research (CIFOR) and the International Network for Bamboo and Rattan (INBAR), and continued by the first three institutions.

2. THE POLICY AND ECONOMIC SETTING

In 1979 China initiated the major policy reforms that paved the way for a transition from a centrally planned to a market economy (Hu and Jiang, 1993). This change unleashed one of the largest development efforts ever undertaken, with worldwide repercussions. In less than two decades, China moved from an autarchic peasant economy to an incipient industrialized country with an export-oriented economy. Over the past 15 years the economy grew at 9.3% annually, the GNP multiplied by 2.78, and export trends are increasingly positive in recent years (World Bank, 1996; World Bank, 1997; Yatsko, 1997).⁴

The backbone of the transformation of the agricultural sector was the shift from collectively run farms based in the commune to family farms based on the "household responsibility system" (Prosterman and Hanstad, 1990). The basis of the household responsibility system is a transfer of land use rights by the commune or natural village to farmers from that village to manage the land for their own benefit.⁵ Forestry is an integral component of rural economies and land use systems in mountainous areas of China. As such, the agricultural reform also triggered a parallel reform of the forest sector. Forestry reform has been in three stages (Li, 1996; Ruiz Pérez *et al.*, 1996). The first stage, from the end of 1978 to October 1984, focused on reforming the forest management system, through implementing the household responsibility system for forest lands. The second stage, from October 1984 to the end of 1991, changed the resource allocation system, removing restrictions imposed by the traditional system on forest management by farmers, in particular the practice of monopolized purchasing. The third stage, since 1992, has concentrated on improving macroeconomic conditions and accelerating the market mechanisms. Several trading centers for timber and other forest products have been set up and the price for more than 90% of timber is now determined by the market.

This reform, however, had to face some specific challenges derived from the size of forest holdings and the nature of forest activities. Therefore, the incentives and land right arrangements for forest management frequently had to be modified from the standard arable land arrangements. These modifications included:

- (a) development of specific forest use right documents;
- (b) allowing longer term leases and the possibility to contract large areas, especially for reforestation of degraded or waste lands;
- (c) establishment and enforcement of management standards (in order to guarantee an appropriate tree cover and to prevent degradation of the resource stock); and
- (d) provision of some (albeit limited) financial incentives to induce farmers to reforest.

Within this general framework, forest policies show a high degree of variability among provinces or even among counties in the same province.

One of the observed trends has been the replacement of some older plantations⁶ that had declining production after the second or third rotation, notably the Chinese fir (*Cunninghamia lanceolata*) and some species of *Pinus*, with new types of plantations characterized by shorter rotations, more ability to respond to market demands and higher income. Bamboo is one of the most popular plantation species wherever natural conditions allow and there is a market opportunity.

A prime example of these processes can be found in Anji, a mountainous county in the province of Zhejiang. Anji County has 1,325 km² and 450,000 inhabitants, with a density of 340 people per km². Forest-related production is the dominant land use, occupying 63% of the County. Of that, bamboo is the main component, covering 57,400 ha, which qualifies Anji as one of the 10 official "bamboo counties" in China. Moso bamboo (*Phyllostachys heterocyclus*, var. *pubescens*) is the leading species, although in recent times new species have been introduced to respond to a growing demand for products, including the thriving bamboo shoot industry. Approximately 110,000 farmers grow bamboo in Anji, and another 11,000 people work in the bamboo-processing industry in the County (see Zhang, 1995; Ruiz Pérez *et al.*, 1996; and Zhong *et al.*, 1996 for a detailed description of the bamboo sector in Anji). In the following sections we analyze the role of bamboo in the economy of farmers of Anji. In particular, we attempt to answer the following questions:

How important is bamboo in the rural household economy of the county?

What is the relationship between bamboo and other farmer's incomes?

What changes have occurred in recent years?

What factors explain the different trends and speed of change in farmers' incomes? What has been the role of bamboo in this process?

3. METHODOLOGY

In order to characterize the farmers' economy and to study the role of bamboo, we designed a questionnaire that sought general household information (age, family size, number of workers, gender, education); land availability for each of the main categories (rice, other arable land, tree orchards, tea, bamboo, other forest land); legal status of the land (family plot, household responsibility contract, forest contract); income from these products as well as other farm income, income from bamboo processing and off-farm income; expenditures for each of the main products and inputs (fertilizers, pesticides, seeds, hired labor, other expenditures, as well as land rent and tax payments); and time spent on each of the main activities (on-farm, as well as off-farm). For those products such as rice, pigs or poultry that were partially self-consumed, income was estimated using the current price in the local market.

Moso bamboo is a biennial species that produces shoots in alternate years. In order to smooth yearly fluctuations and to provide a stable supply of raw material to the industry, farmers in Anji County have managed to synchronize production, so that when it is an "on" year in the east it is an "off" year in the west, and *vice versa*. Because of this biennial feature, we collected production, income and expenditure data for the last two years (1994 and 1995). In the analysis we use the aggregated 1994–95 data when appropriate.

We also requested bamboo production and income information for the period since 1989. Generally, the validity of the recalled information decreases as we move back in time. In the study area the "village group" or "natural village" (equivalent to the old commune) exerts control over allocated bamboo land and income (the base for paying rent and tax). Because of this, many farmers kept records of their income from the allocated land. This habit continued after the extension of the forest land rights to 30 years in 1988. Moreover, farmers were usually willing to share this information. We have used the 1989–90 data as the baseline information

since they can be considered reasonably accurate. It was not possible however to obtain an accurate breakdown of the rest of income and expenditure items, and so we requested that information in aggregate.

A total of 200 farmers were selected in a stratified sampling. Eight townships were selected based on their East-West location (four from each side of the basin). General township data appear in Table 1. In each township, five villages and in each village five farmers were randomly selected. The fieldwork was conducted in two stages. A general survey of county-level data plus key informant interviews provided aggregated information. Time series analysis were then used to characterize the bamboo production-to-consumption system and to illustrate that on the bamboo sector of agriculture and forest policy changes (Ruiz Pérez *et al.*, 1996). The results of this phase were used as the basis for detailed farmer interviews.⁷

4. THE ROLE OF BAMBOO IN THE FARMERS' ECONOMY

Table 2 provides some basic data about the sample of farmers interviewed in Anji County. The prototype household in the mountainous townships of Anji County is headed by a middle-aged male, contains a family of four and has 2.6 labor units or workers. The household head has reached between primary and secondary level of education. The average land managed by the family is 21.2 mu, of which 14.9 mu (70%) is allocated to bamboo plantations. The size of the family, number of workers and level of education are not significantly different between the eight townships, whereas the difference in age of the household head does show a statistically significant difference ($F = 2.39$; $p = 0.02$). There are also significant differences between townships in the areas of bamboo ($F = 5.46$; $p < 0.001$) and total land ($F = 5.66$; $p < 0.001$).

Table 1. *Basic township data*

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

Source: Anji Bureau of Statistics.

^aThe mu is a traditional land area measure that varies according to land use. The normal mu is the most common measure, and the one used in this work. There are 15 normal mu in 1 ha.

Table 2. *Basic data of the farmer sample - Anji County*

| Variable | Mean | Std. deviation | Minimum | Maximum |
|------------------------------|------|----------------|---------|---------|
| Age of h/hold head | 43.6 | 8.88 | 24 | 69 |
| Family size | 4.0 | 1.05 | 1 | 7 |
| Workers per family | 2.6 | 0.89 | 1 | 6 |
| Education level ^a | 2.1 | 0.74 | 1 | 3 |
| Arable land ^b | 2.7 | 1.83 | 0.2 | 18 |
| Cash trees ^b | 0.4 | 1.53 | 0 | 14 |
| Bamboo ^b | 14.9 | 10.05 | 1 | 70 |
| Other forest ^b | 3.5 | 10.49 | 0 | 111 |
| Total land ^b | 21.2 | 15.64 | 2.8 | 127 |

^aThe education level was divided into three categories: 1 = high school (12 years); 2 = secondary school (nine years); 3 = primary school (four years)

^bIn mu

The average annual farm household income for the period 1994–95 was 14,033 yuan, or 3,495 yuan per capita. This income was derived from four major sources: rice, livestock products (mainly pigs, chicken and ducks), bamboo and off-farm work (either as labor in the industry and construction sectors, or in business). Supplementary earnings came from other arable land (fruits and vegetables) and forest products (wood, timber and tea).⁸ The relative contribution of the different sources to household income is shown in Figure 1 (the data do not add up to 100% due to rounding).

As can be seen in the figure, bamboo is the second most important source of income after off-farm work, representing 25% of the total family income.⁹ The average annual household income from bamboo for 1994–95 was 3,551 yuan, or 886 yuan per capita. Bamboo culms contributed 84%, bamboo shoots accounted for 10% and the remaining 6% came from bamboo branches.

A key question is whether the importance of bamboo in the farmers' economy changes according to the level of income. In order to

analyze this issue, we divided the 200 farmers into quintile per capita income groups. Figure 2 represents the relative importance of bamboo for each income class. The graph shows a clearly convex shape, indicating that bamboo is relatively more important for the middle-income groups. Bamboo accounts, on average, for 29.9% of income for the middle-income group. In

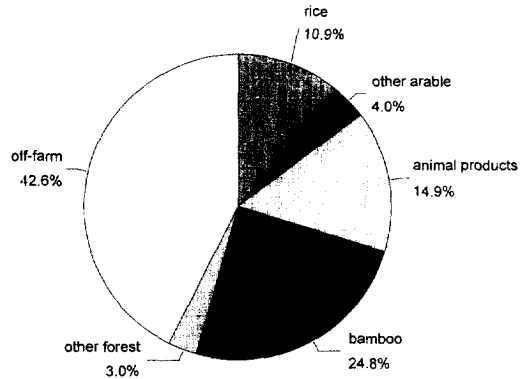
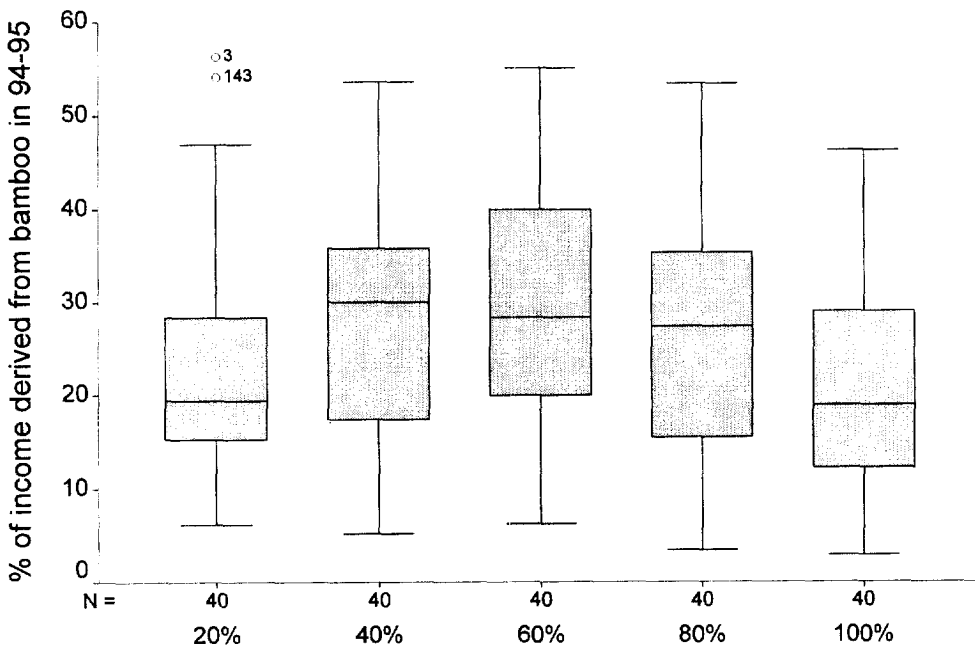


Figure 1. Sources of income for Anji farmers.

Relative importance of bamboo for each income class in 1994-1995



94-95 per capita income rank by percentils

Figure 2. Relative importance of bamboo for each income class in 1994–95.

contrast, income from bamboo contributes just 23.1% and 20.8% of income of the lowest and highest income groups, respectively. These differences in percentage of income derived from bamboo for each group are statistically significant ($F = 3.39$; $p = 0.01$).

A different pattern emerges if we compare the absolute amount of income derived from bamboo by income group. Figure 3 represents the three main categories of income (bamboo, non-bamboo farm and off-farm income) for each of the five per capita income groups. All three income components (bamboo, non-bamboo and off-farm) show a consistent increase as we move from the lowest to the highest income group. The slope of this increase however, varies between categories. For the non-bamboo farm income the increase along income groups is marginal; the ratio between the highest and lowest income groups is 1.59 and the differences among groups is significant between 0.05 and 0.01 levels ($F = 2.79$; $p = 0.03$). The income derived from bamboo shows a steeper slope along income classes, with a highest-to-lowest income ratio of 2.37 and higher significant differ-

ences among groups ($F = 9.73$; $p < 0.001$). Off-farm income displays a marked increase, with a ratio of 5.88 between the highest and lowest income groups and very high significant differences between groups ($F = 27.57$; $p < 0.0001$).

These data suggest that the three main components of the farmers' income play a differentiated role in moving from poverty to higher income ranks in the mountainous areas of Anji County. Agricultural income (other than bamboo) is a common foundation that does not vary greatly between income groups. This is consistent with the fact that a large part of this production is for self-consumption and its contribution to the cash economy is relatively small. Bamboo offers the main, farm-based income-generating opportunity, and could be considered as a good land-based capitalizing product. The best income opportunity however, comes from off-farm activities, with 43% of average income derived from off-farm sources.¹⁰ The importance of off-farm income has been found in a wide array of situations and Anji data fall within the usual range encountered (see

Main categories of income for each income class in 1994-1995

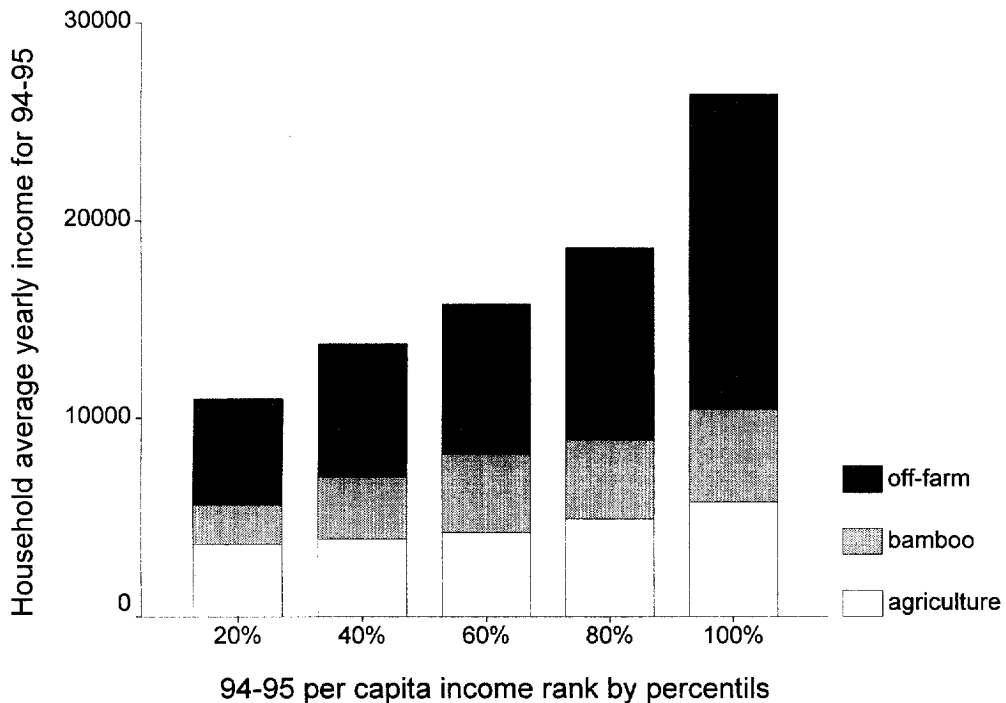


Figure 3. Main categories for each income class in 1994-95.

Haggblade and Hazell, 1989; Ranis and Stewart, 1993; Arnold, 1994). In fact, in the Chinese case the bulk of labor for township and village enterprises comes from farmers in local communities (Meng, 1990).

The data also suggest that the middle-income groups can benefit most in relative terms from the wealth generated by bamboo plantations. This is an issue of key importance since bamboo, and by extension many non-timber forest products, have been frequently targeted as the products to help the poorest segment of rural populations living near the forests (see Falconer and Arnold, 1991; FAO, 1995). We try to explore this issue in greater depth in the next section.

5. EVOLUTION OF FARMERS' INCOME

The average household income for the period between 1989-90 and 1994-95 in the mountainous areas of Anji has increased 2.35 times in current yuan and 1.37 times at constant general retail prices of 1990.¹¹ This represents an

average annual increase of 6.5%, less than the rate of growth of the Chinese economy as a whole over the same period, but higher than the average rate of growth experienced by farmers since the mid-1980s (Yazhou, 1997).

At the end of the 1980s, bamboo represented 24% of the farmers' income, and was almost the same (25%) six years later. As has been mentioned, during the survey it was only possible to separate total farmers' income of 1989-90 into two categories: that coming from bamboo, and the rest of income. Consequently, it is not possible to analyze the evolution of the main categories of income, notably those derived from non-bamboo farm activities and that from off-farm sources.

It is possible however, to study the importance of bamboo in the farmers' economy according to the level of income at that time. To do this we used a similar approach to the one mentioned above for the data of 1994-95. Farmers were divided in five per capita income groups 1989-90 income. The relative importance of bamboo at that period for each income class is shown in Figure 4. The graph maintains the convex shape

Relative importance of bamboo for each income class in 1989-1990

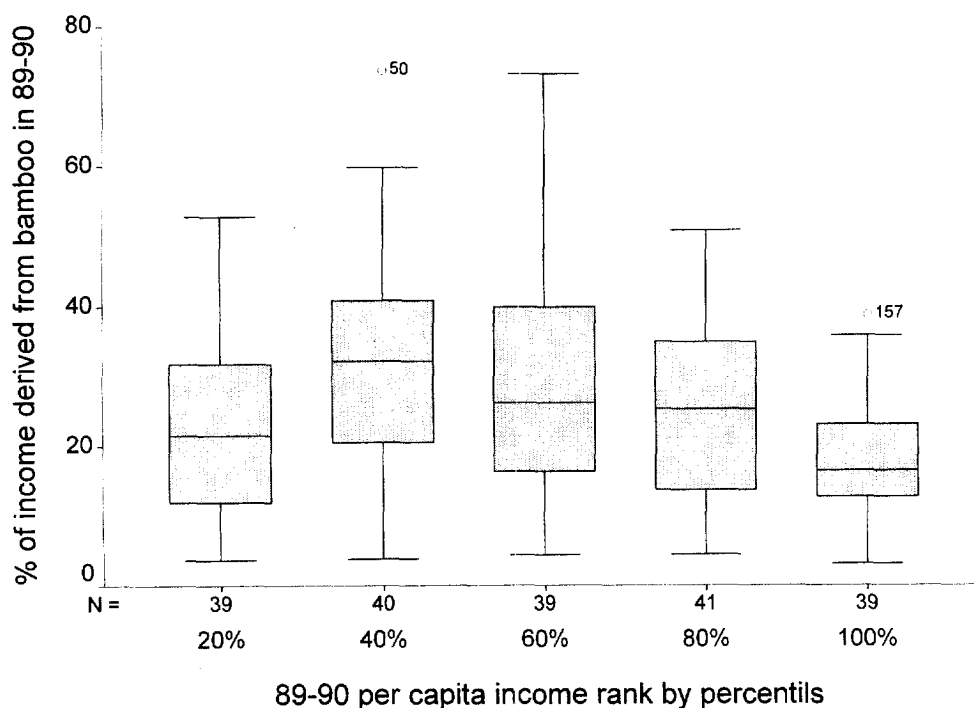


Figure 4. Relative importance of bamboo for each income class in 1989-90.

seen in the data of 1994–95, but the distribution is clearly right-skewed. The highest percentage of income derived from bamboo in 1989–90 (31.9%) occurs in the middle-to-low income group, and declines steadily as we move to higher income groups. As in the case for 1994–95, the differences in percentage of income derived from bamboo for each income group is statistically significant ($F = 5.50; p < 0.001$).

The comparison of Figures 2 and 4 seems to indicate an increasing relative importance of bamboo for the middle-income group.

As noted above, farmers have experienced an average income increase of 1.37 times since 1989–90. This increase however, has not been equal for all farmers. Using the above procedure, we divided farmers in quintile groups according to the rate of increase in income. This can then be plotted against the relative importance of bamboo (see Figure 5). The figure confirms that the strata with the lowest or highest rate of income increase correspond with the lowest importance of bamboo. The highest percentage

of income derived from bamboo is found in those farmers in the middle ranges of increase in income, in this case in the middle-to-high group (28.4% of income from bamboo). This is consistent with the above findings and confirms the role of bamboo plantations as a main land-based activity to advance from low to middle-income ranks.

6. FACTORS INFLUENCING FARMERS' INCOME

We conducted multiple regression analysis (Ordinary Least Squares) in order to study the factors that influence farmers' incomes and their evolution. Two kinds of dependent variables were used: farmers' incomes in 1994–95 and income change for the period between 1989–90 and 1994–95. Because land allocation is based on family size,¹² we have used the total household income and the per capita income. Their comparison allows for a discussion of the effects

Relative importance of bamboo for each quintile group of change in income

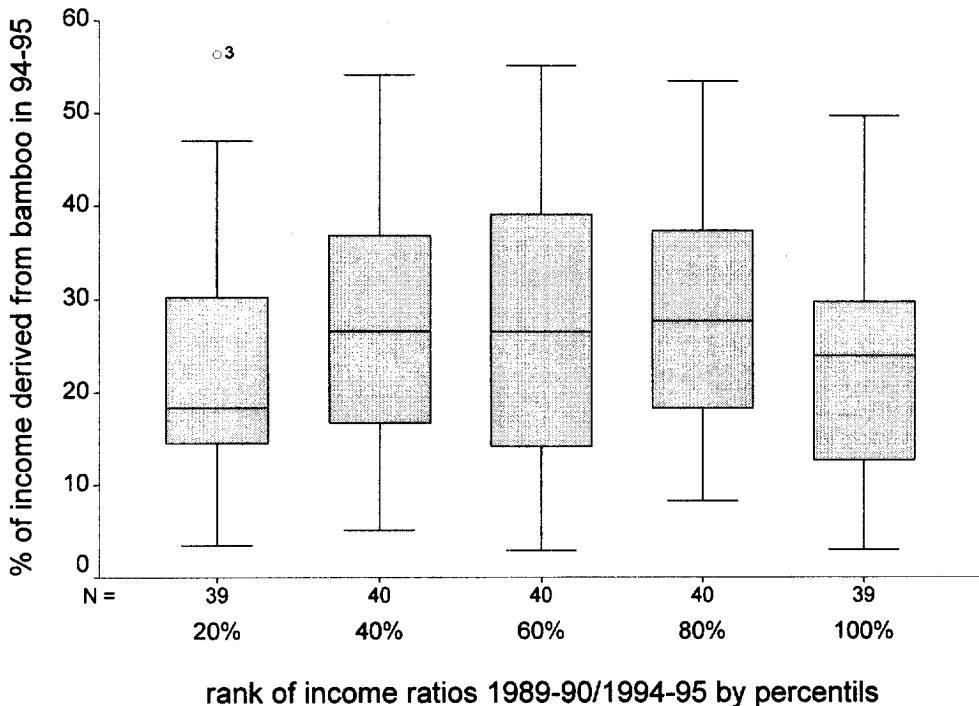


Figure 5. Relative importance of bamboo for each quintile group of change in income.

of this land allocation policy and other factors. Changes in income during the last five years have been studied using the actual change in income and the ratio between the income in 1994–95 and that in 1989–90.

After preliminary analysis, a total of 10 independent variables have been incorporated. These include age, education level, family size, female/male sex ratio, total family labor, male/total labor ratio, arable land, bamboo land, off-farm/total days of work ratio and township (measured as a rank variable based on average income per township). The total land managed by the farmer has not been used because of the high collinearity with bamboo and arable land and the lower beta coefficients and *T*-values obtained. Likewise, the amount of rice land has high collinearity with arable land and *T*-values which are generally not significant. Several family and labor composition indexes (like total male, total female, total adults or adults/total family ratio) were tried with similar problems of collinearity and low significance.

We have applied a stepwise multiple regression method using a probability < 0.05 as criteria for inclusion of variables and a probability > 0.10 as criteria for removal of variables. The

results of the multiple regression analysis for farmer's income appear in Tables 3 and 4. Both regressions have a relatively high *R* Square, good fitness and very significant *F*-values. In both analyses the bamboo land and the township have the highest beta coefficient and *T*-value, clearly indicating the importance of bamboo in the farmers' economy as well as the substantial role played by the locality in explaining the farmers' income. The amount of arable land is also retained in both regressions, though the weight of its beta coefficient is noticeably lower than that of bamboo. Likewise, the ratio off-farm/total days of work is a contributing variable to the total household and per capita income. In this case, the disproportionately low coefficient for the off-farm/total work ratio when compared with the highly significant differences in off-farm income among income groups indicates the large variability of off-farm work. This can range from a low-paid worker in a factory to a highly successful middleman.

The significance of bamboo's contribution to household income can also be derived from the income elasticity of bamboo land.¹³ Its value of 0.315 indicates that for every percentage increase in bamboo land the total income increases

Table 3. Multiple regression analysis. Dependent variable: total household income

| Variable | B-coefficient | Beta coefficient | T-value |
|---------------------------|----------------------------------|-------------------|-------------------------------|
| Family size | 3030.0 | 0.205 | 3.656 |
| Arable land | 1737.5 | 0.205 | 3.821 |
| Bamboo land | 523.3 | 0.339 | 6.245 |
| Off-farm/total work ratio | 8429.9 | 0.139 | 2.594 |
| Township | 2128.6 | 0.315 | 5.680 |
| Constant | -9815.9 | | -2.800 |
| <i>R</i> Square = 0.517 | Adjusted <i>R</i> Square = 0.504 | <i>F</i> = 41.481 | Probability <i>F</i> < 0.0001 |

Table 4. Multiple regression analysis. Dependent variable: per capita income

| Variable | B-coefficient | Beta coefficient | T-value |
|---------------------------|----------------------------------|-------------------|-------------------------------|
| Family size | -481.8 | -0.290 | -4.703 |
| Male/total labor ratio | 1479.4 | 0.132 | 2.341 |
| Arable land | 124.9 | 0.131 | 2.341 |
| Bamboo land | 64.9 | 0.374 | 6.633 |
| Off-farm/total work ratio | 1028.2 | 0.150 | 2.650 |
| Township | 270.3 | 0.356 | 6.207 |
| Constant | 1008.2 | | 3.989 |
| <i>R</i> Square = 0.488 | Adjusted <i>R</i> Square = 0.472 | <i>F</i> = 30.637 | Probability <i>F</i> < 0.0001 |

0.315% well above the 0.248 bamboo's contribution to the average household unit of income (see Figure 1).

There are two important differences between the two regressions. As expected, family size has a positive impact on total household income, reflecting the land allocation system based on family size. The size of the family however, has a negative weight in the per capita income. An ANOVA test for the five income groups shows very similar values for average family size, total family labor and ratio of labor/total family size, with small, not statistically significant differences between high, medium and low-income levels. This is consistent with the expected declining marginal effect of family size on total income, and therefore a declining absolute effect on per capita income.¹⁴ This may be exacerbated by the restrictions to family size in China, with severe economic sanctions for families with many children, whose effect would be felt in all income ranges in the study area.

This could have been partially off-set by economies of scale in use of income for larger households. In Chinese rural conditions however, taking a family of five as the norm (1.00), the effect of family size on average per capita consumption expenses ranges from 106.8 for a single person unit to 96.8 for a household of seven or more. This scale implies a much smaller impact of household size on income efficiency than in OECD countries, that assign a value of 1.0, 0.7 and 0.5 for the first adult, subsequent adults and children (Ringgen, 1991).

The other important difference relates to the male labor/total labor ratio, that presents a significant contribution in the per capita income regression. This is the only variable related to the composition of labor that has a significant contribution to the regression. It seems to indicate the importance of having male workers in the family, a fact well-known to Chinese

farmers. This may be due more to the ability of male workers to find better paid off-farm work than female workers, than to a significant difference in farm related work. In support of this, Zhong *et al.* (1996) found that male workers' salaries in the bamboo industry in Anji are, on average, 23.5% higher than those of female workers. When compounded with the male/total labor ratio, this would have a decisive influence in income differentiation given the high weight of off-farm income in total household income.

Three variables were not included in the stepwise calculation of both regressions: age, level of education and total labor, although the age has a not-negligible negative coefficient ($T = -1.518$; $p = 0.13$). The expected higher negative effect of age may have partially been offset by the extended family structure of the Chinese rural family, in which household heads close to the retirement age frequently have their young adult children working on the farm. The level of education, on the other hand, does not have a strong effect on income given the poor education facilities of most rural areas and the fact that the extension services, training courses, etc., which may have a more important impact on agricultural and off-farm output, are not included in the education index that only reflects the formal school degree. The exclusion of total labor indicates that it is the quality (including training, male labor ratio and work dedication) rather than the quantity that counts most in raising farmers' incomes in Anji County.

The results of the regression analysis for the changes in income over the five-year period appear in Tables 5 and 6. Given the effects of family size on total income discussed above we have opted to use the per capita income change as a more realistic indicator of the dynamics of the household economy. The regression of the absolute change in per capita income as the dependent variable has an acceptable *R* Square.

Table 5. Multiple regression analysis. Dependent variable: difference in per capita income over five years

| Variable | B-coefficient | Beta coefficient | T-value |
|---------------------------|----------------------------------|-------------------|-------------------------------|
| Age of h/hold head | -19.8 | -0.127 | -1.996 |
| Family size | -297.8 | -0.225 | -3.198 |
| Male/total labor ratio | 1361.6 | 0.152 | 2.244 |
| Arable land | 114.6 | 0.151 | 2.373 |
| Bamboo land | 53.9 | 0.390 | 5.997 |
| Off-farm/total work ratio | 855.2 | 0.157 | 2.420 |
| Township | 107.5 | 0.178 | 2.717 |
| Constant | 1632.8 | | 2.863 |
| <i>R</i> Square = 0.341 | Adjusted <i>R</i> Square = 0.317 | <i>F</i> = 14.178 | Probability <i>F</i> < 0.0001 |

Table 6. Multiple regression analysis. Dependent variable: ratio of per capita income change over five years

| Variable | B-coefficient | Beta coefficient | T-value |
|------------------------|---------------------------------|------------------|------------------------------|
| Age of h/hold head | -0.02 | -0.174 | -2.469 |
| Bamboo land | 0.02 | 0.198 | 2.816 |
| constant | 2.89 | | 9.793 |
| <i>R</i> Square = 0.06 | Adjusted <i>R</i> Square = 0.05 | <i>F</i> = 6.028 | Probability <i>F</i> = 0.003 |

The amount of bamboo land has the highest positive contribution to the regression, underlining again the importance of bamboo in increasing per capita income. The township of origin, off-farm to total work ratio, male to total labor ratio and amount of arable land also make significant positive contributions to the fitness of the regression. Family size has a strong negative coefficient, supporting the observation made above related to the effects of family size in general and its likely exacerbation due to family size restrictions in China. Likewise, age has a significant negative coefficient which can be understood as a decrease in dynamism with the age of the family. This regression supports the interpretations derived from the farmers' income regressions discussed above, showing the link between factors that explain actual differences in income and factors that account for differences in increase in income.

Conversely, the regression based on the ratio of per capita income change as the dependent variable has a small *R* Square although, because of the large size of the sample, the *F*-test shows a statistically significant value. Only two variables have a significant contribution, namely the amount of bamboo land (positive) and age (negative). These coincide with the highest positive and negative contributions to the former

regression. Thus, while the absolute change in income for the five-year period studied can be associated with several structural and family composition factors, the speed of that change does not show a clear pattern. It could be said that, for the period studied, a wide variety of farmer situations permits similar rates of increase in per capita income (with bamboo land and age having some positive and negative influence respectively).

The analysis of intra-county differences based on the eight townships that were sampled also shows a similar response. Thus, the average household and per-capita income, as well as the total increase in income during the study period, show statistically significant differences between townships (see Table 7). The rate of increase of income however, does not show such differences, indicating that the entire county is being affected by the huge development wave with a similar intensity, although differences in initial conditions may actually result in increasing absolute income differences.

This finding has direct relevance to the issue of income gaps among different strata of the Chinese population at a macro level (urban-rural, coastal-interior, rich-poor). As noted above, a number of studies have been conducted to assess this gap and its trends. A recommenda-

Table 7. Average annual income data by township

| Township | Household income Yuan | Per capita income yuan | Total increase income Yuan | Ratio of increase in income |
|--------------|--------------------------|---------------------------|-------------------------------|-----------------------------|
| Kuntong | 18,339 | 4,434 | 2,463 | 2.39 |
| Fenghuang | 13,663 | 3,501 | 1,905 | 2.26 |
| Gangkou | 12,816 | 3,393 | 1,996 | 2.54 |
| Tianhuang | 16,822 | 4,482 | 2,652 | 2.63 |
| Baofu | 19,739 | 4,995 | 2,721 | 2.34 |
| Zhangchun | 9,383 | 2,462 | 1,296 | 2.23 |
| Yonghe | 14,846 | 3,590 | 2,240 | 2.52 |
| Chiwu | 8,366 | 2,102 | 1,281 | 2.49 |
| <i>F</i> | 8.63 | 11.187 | 4.594 | 0.689 |
| Significance | <0.001 | <0.001 | <0.001 | 0.68 |

tion derived from the present paper is that any research aimed at studying the regional or social imbalances in China should consider this fine level of detail for the analysis, since data which are too aggregated may hide important local differences.

6. CONCLUSIONS

Anji County has a thriving economy and growth is being experienced in all sectors. Being a rural county, farm-based activities still constitute the main source of income for most people. Off-farm income however, adds a significant contribution to total family income. Bamboo could be considered a solid, farm-based income-generating activity. Its importance is highlighted by the results of the regression analysis, that consistently show the amount of bamboo land as the variable that contributes most to the regression.

The main finding of the research is that the relative importance of bamboo changes with income groups, being highest for the middle-income farmers. The evolution of income in the last five years and the change in the relative importance of bamboo during this period supports the conclusion that bamboo is having a major effect in creating a middle class of farmers in Anji County. It seems that the poor lack the resources to benefit fully from the potential development associated with bamboo plantations. They have lagged behind in the opportunity to increase their income, both in absolute and relative terms, through bamboo culms and shoots production. Rather than being the timber of the poor, bamboo in Anji represents a good alternative for those farmers already on the income-growing track. This conclusion should raise a call of warning for those forestry develop-

ment projects (especially those based on bamboo or other non-timber forest products) aimed at helping the poorest sections of rural communities.

At the other end of the spectrum, the wealthiest farmers, while enjoying the largest income from bamboo, have other complementary or even alternative primary income-generating activities off the farm. This could be the result of a push-pull effect. The land tenure system based on a fairly rigid allocation of land, limits the potential for expansion in agricultural and forestry activities. This limitation on farmland, combined with attractive and growing off-farm opportunities, leads the more dynamic farmers to divert resources to off-farm activities. Under these circumstances the relative importance of bamboo is highest among the middle-income group and become less important (relatively) among higher income groups. We believe that the current land allocation policies may have other potentially positive effects, such as preventing a high concentration of land and helping to maintain some social cohesion by reducing the differences among farmers. Its effects should be fully and clearly understood however, and the consequences acknowledged.

The rate of increase in income has been very similar for the eight townships studied. But, the absolute magnitude of the change has been significantly higher for the better-off townships, contributing to an increasing income gap between townships. The present land allocation policy and the difficulties in moving between places mean a more rigid use of labor and could contribute to perpetuation of these township-level differences. Again, this could have a number of positive effects such as preventing migration to areas still unprepared to offer job opportunities on a large scale, but the full implications warrant further research.

NOTES

1. The bamboos are generally accepted as constituting a subfamily (Bambusoideae) of the Gramineae (grasses). They can be divided into nine subgroups, about 80 genera and more than 1,000 species (Clayton and Renvoize, 1986; McClure, 1993; Dransfield and Widjaja, 1996). They are found from high mountains to lowlands in all temperate, tropical and subtropical regions of the world, with the exception of Europe and Western Asia.

2. A sentence attributed to Confucius states that "Man can live without meat, but cannot live without bamboo."

3. Of the 3.8 million ha of bamboo plantations, 2.7 million are moso bamboo (*Phyllostachys heterocycla*, var. *pubescens*), a highly versatile and productive monopodial bamboo, whose planting technique has been mastered by Chinese farmers over hundreds of years.

4. This process has not been without costs, both social and environmental. Although a detailed analysis of these issues is outside the scope of this paper, it is worth mentioning the growing concern for individual and regional disparities (see Bramall and Jones, 1993; Wang, 1995; Hak, 1996; Kai-yuen, 1996; Ke, 1996;

World Bank, 1997; Zai and White, 1997), as well as for the huge environmental problems triggered by this fast development (see Huang and Rozelle, 1995; Amsden, Dong and Xiaoming, 1996; Bradbury, Kirkby and Shen, 1996; World Bank, 1997). Both combined represent the major challenge that China will face in the near future.

5. The replacement of the commune by a family-based system was originally debated in the Third Plenary Session of the 11th Central Committee of the Communist Party held in December 1978 where major changes in rural policies were recommended. This proposal was considered excessively radical and therefore discarded. After late 1978, however, communes in some of the poorest provinces such as Anhui and Sichuan started a spontaneous process of transferring management rights and responsibilities to the households. Their success paved the way for a large-scale policy change, implemented in 1983. By 1984, more than 90% of the agricultural land was allocated under this system (Prosterman and Hanstad, 1990; Qu, Heerink and Wang, 1995; Yifu, 1995).

6. China has had a very active reforestation policy since the early stages of the Communist government, that gave high priority to tree plantations. See Westoby (1987) for a passionate presentation of the difficulties and achievements of this program.

7. In total the fieldwork lasted from April 1995 to October 1996. A preliminary, unpublished report can be found in Zhong *et al.* (1996).

8. The standard definition of forest income in China includes cash crop (mulberry and several type of fruits) trees and tea. In this paper we consider the former as part of the arable land income.

9. Some farmers semi-process bamboo raw material in their houses. This is then sold as an intermediate input to local industry. This income has been defined as off-farm income. If it is included as part of bamboo income, this category would then amount to 27% of the total household income.

10. The main reason for these off-farm income opportunities relates to the general development of the eastern provinces, with a thriving economy and high demand for situation may be quite different in more interior provinces, where the development is generally taking place at a lower speed. We are currently undertaking a comparative study along an East-West gradient.

11. We have used the official price index that appears in the Chinese Official Statistics; however, the real extent of Chinese inflation has been a subject of discussion (see The Economist, 1995).

12. The allocation of rice land in the study area is normally based on family size and age. The farmer has the right to a share of land up to a maximum of two children, but no additional land is given for more children. Working-age adults count for one whereas children and the elderly count 0.5 when distributing rice and other irrigated arable land. The allocation of bamboo is more flexible and the size of the contracted land can change to some extent according to the willingness and ability of the family to cultivate more bamboo.

13. We thank an anonymous referee for this suggestion.

14. We again thank an anonymous referee for this observation.

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