The contribution of bamboo to household income and rural livelihoods in a poor and mountainous county in Guangxi, China

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SUMMARY

Despite becoming one of China's fastest expanding and most valuable forest land uses, bamboo's role in livelihoods and rural development is poorly understood. Detailed quantitative data from 240 households were used to study the contribution of bamboo to household income and rural livelihoods in 12 remote and mountainous villages in southern China. Bamboo was a ubiquitous and highly utilised resource for a wide range of subsistence purposes in all households. Bamboo income was predominantly derived from dried bamboo shoots cultivated in small-scale household plots, and was the single most valuable source of cash. The average bamboo income share was 13.3%, ranging from 0 to 50% between villages. High income households had the highest absolute bamboo income, but low income households had the highest dependence on bamboo income. It is suggested that bamboo is an excellent pro poor resource, especially in remote, mountainous areas with limited off-farm income opportunities.

Keywords: Bamboo, southern China, forest income, NTFP, poverty

Contribution du bambou aux revenus des foyers et aux moyens d'existence ruraux dans une région pauvre et montagneuse dans le Guangxi, en Chine

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Bien qu'il soit devenu l'un des usages les plus valorisés des terres forestières, et ce, avec l'une des expansions les plus rapides, le rôle que tient le bambou dans les moyens d'existence et le développement ruraux est bien peu compris. Des données quantitatives détaillées provenant de 240 foyers ont été utilisées pour étudier la contribution du bambou aux revenus des foyers et aux moyens d'existence ruraux dans douze villages de montagne isolés en Chine du sud. Le bambou s'est révélé être une ressource à plusieurs facettes et fortement utilisée dans un éventail large de buts de subsistance dans tous les foyers. Les revenus résultaient principalement des pousses de bambou séchées cultivées dans de petites exploitation de foyers, et était la source de revenus en liquide la plus efficace. Le pourcentage de revenus provenant du bambou était de 13.3% en moyenne, allant de 0 à 50% entre les divers villages. Les foyers à revenus forts possédaient le le revenu absolu du bambou le plus important, alors que les foyers de faible revenus connaissaient la dépendance la plus élevée sur les revenus du bambou. Il est suggéré que le bambou est une excellente ressource favorable aux pauvres, particulièremnt dans les régions montagneuses isolées ne possédant que des opportunités limitées de revenus hors des fermes.

La contribución del bambú a los ingresos familiares y los medios de subsistencia rurales en un condado pobre y montañoso en Guangxi, China

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A pesar de estarse convirtiendo en uno de los usos más valiosos de los terrenos forestales y con una expansión más rápida en China, el papel del bambú en los medios de subsistencia y el desarrollo rural es poco conocido. Se utilizaron datos cuantitativos detallados de 240 hogares para estudiar la contribución del bambú a los ingresos familiares y los medios de vida rurales en 12 aldeas remotas de zonas montañosas del sur de China. Se observó que el bambú es un recurso omnipresente y ampliamente utilizado para una diversa gama de usos en todos los hogares. Los ingresos del bambú provienen principalmente de brotes de bambú secos cultivados en parcelas familiares de pequeña escala, y fueron la mayor fuente de ingresos en efectivo. El porcentaje de ingresos procedentes del bambú fue en promedio del 13,3%, con un rango de variación entre aldeas de 0 a 50%. Los hogares con ingresos más elevados fueron aquellos con mayores ingresos del bambú en términos absolutos, pero fue en las familias con menores ingresos donde se observó una mayor dependencia de los ingresos del bambú. Se sugiere que el bambú es un excelente recurso en pro del pobre, especialmente en áreas remotas y montañosas, con escasas oportunidades de ingresos fuera aparte de la finca familiar.

INTRODUCTION

Approximately 3.2% of the world's total forest area, or 37 million hectares, is made up of bamboos (*Bambusoideae*), a large subfamily of the grasses (FAO 2007). It is estimated that this unique and iconic component of the world's forests has over 1200 species (FAO 2007, Ohrnberger 1999), with a natural distribution across a broad range of environments on all continents except Europe and Antarctica (McClure 1966, Ohrnberger 1999). Bamboo has long been an important subsistence resource throughout the developing world, and especially in Asia, with an estimated two billion people worldwide using bamboo in some form on a daily basis (INBAR 1999). But in some countries, bamboo's predominant use for subsistence purposes and production of low value crafts and utensils is shifting to become an industrialised cash commodity, with production of a wide range of high-value products (FAO 2007). Indeed, bamboos are now one of the worlds most valuable and important non wood forest products (FAO 2007). Bamboo's importance as both an internationally traded commodity, and as key resource for livelihood development and poverty alleviation, is increasingly being recognised (FAO 2007).

No other country in the world has developed the potential of their bamboo resources to such an extent as that of China. Although it only makes up 2.8% of total forest land area (5.71 million ha), bamboo is one of China's fastest expanding and most valuable forest land uses (FAO 2010, Mertens *et al.* 2008). In the last two decades, China's bamboo sector was transformed from a mostly traditional, subsistence oriented cottage industry into a booming industry valued at US$14 billion in 2010 (Benton *et al.* 2011). This industrialisation process happened concurrently with transformations in both the mode of bamboo production (from predominantly wild-harvest to plantation grown) and in the ownership of the bamboo resource base (from public to private)[1]. Between 1990 and 2005, bamboo plantation area nearly doubled from c.1.07 million ha to c.2.09 million ha (FAO 2007), whilst household management (i.e. *de jure* ownership) of bamboo plantation area increased from 0% in 1990 to 39% in 2000 (FAO 2007). More than ten million Chinese farmers are estimated to be engaged in bamboo farming (Chen 2003). These figures continue to grow as smallholders and managers of government forest farms preferentially plant bamboo on their designated forest land over slower growing and less profitable timber species (Hogarth *et al.* in press, Ruiz-Pérez *et al.* 2004).

Various effects of China's rapidly changing bamboo sector on rural livelihoods have been studied, and they generally show bamboo to be an excellent natural resource for rural livelihood development (Chen 2003, Gutierrez Rodriguez *et al.* 2009, Lei 2001, Ruiz-Pérez *et al.* 2009, Wang *et al.* 2008, Zhu and Yang 2004). Much of this research is, however, geographically limited to well known 'bamboo counties'[2] located in the heart of China's economic boom zone on the eastern seaboard. The bamboo sectors in such areas developed under somewhat exceptional conditions, – greatly benefitting from exposure to early policy reforms and economic transformation, with significant government support, and easy access to the big markets of Shanghai, Hangzhou, and international markets (Ruiz-Pérez *et al.* 2009). Meanwhile, there remains an almost complete lack of information about the role of bamboo in the livelihoods of those living in the poverty stricken areas of China's south-western provinces, where over 73% of all new bamboo plantations have been established in recent years (Ruiz-Pérez *et al.* 2009).

In this paper, quantitative data collected from a poor and mountainous region in the south-western province of Guangxi are used to study the contribution of bamboo to household income and rural livelihoods. The study was motivated by three research questions: 1. what are the absolute and relative contributions of bamboo to household income and rural livelihoods? 2. who is engaged in the bamboo sector and why? 3. what lessons and recommendations for bamboo-based development and poverty alleviation can be drawn for the study area and beyond? In addressing these research questions, a detailed account of bamboo-related income and the factors affecting it is provided. Addressing these research questions will improve knowledge about the current and potential role of bamboo in household economies which is essential for guiding policies related to household allocated forest land-use, forest management in general, and bamboo-based poverty alleviation interventions in particular. But given the general lack of information on the subject, this paper will also contribute towards understanding the wider issues of plantation bamboo and forest-related development challenges in China and beyond.

THE STUDY AREA

Tianlin County is located on the eastern extension of the Yunnan Guizhou Plateau in the northwest corner of the Guangxi Zhuang Autonomous Region (24–25° N, 105–106° E). The county's population of c.240 000 is 90% rural, and composed predominantly of ethnic minorities, including Zhuang, Yao, Miao, Yi and others (Tianlin County Government 2007). With a land area of 5 170 km^2, Tianlin is the largest county in Guangxi, and has a relatively low population density compared to the provincial average (46 per km^2 compared to

[1] The Chinese system is such that land can only be state or collectively owned, but trees and forest resources can be owned by households or by other private entities. Such forests and forest lands are classified under a "private forests" category, although the land remains collectively owned (Démurger *et al.* 2009).

[2] In 1996 the State Forestry Administration designated ten counties as 'China Bamboo Hometowns' based on local economies that are dominated by the production and manufacturing of bamboo products, and a direct or indirect contribution of more than 20% GDP from bamboo (Wang *et al.* 2008).

207 per km^2). The climate is subtropical monsoonal with hot wet summers and cool, dry winters.

The people of Tianlin meet a lot of their basic needs through subsistence agriculture, and generate cash income mostly through the sale of surplus forest and agricultural products, and increasingly from off-farm activities (Hogarth *et al.* in press). Despite significant increases in household income in the last decades, the average Tianlinese farmer's income remains well below both the provincial and national average for rural households (Hogarth *et al.* in press). Tianlin has an official poverty rate of 29% (Tianlin County Government 2007), and is recognised as being one of China's 592 State Designated Poor Counties[3].

Yet Tianlin is rich in agricultural and forestry resources (Li 2004), with relatively good soils compared to many surrounding counties. More than 80% of the land area is devoted to forestry and about 17% for crops (Tianlin Forestry Bureau 2001).

Agriculture is the major income earner for the county at 53% of total industrial and agricultural output, while 32% comes from forestry (Tianlin Statistics Bureau 2003). As a State Designated Poor County, Tianlin has benefited from a range of targeted poverty alleviation programs that have supported improvements in infrastructure and education facilities, and there have also been a number of natural resource based development projects, with some centred on bamboo.

Tianlin's remote and mountainous location, high minority population and poverty status are conditions typical of China's areas of persistent rural poverty. This, in combination with its rich forest resources and emerging bamboo sector, makes Tianlin County an ideal site to study the role of forest income (with a focus on bamboo) in rural livelihoods and development.

Bamboo in Guangxi and Tianlin

In 2005 Guangxi had China's seventh largest provincial bamboo forest area, with 240 000 ha representing 1% of Guangxi's total forest area (Wang *et al.* 2008). The province was designated as one of the ten 'economic forest bases' of China in the central government's ninth Five Year Plan (1996–2000), and has been vigorously developing the bamboo industry as one of the province's pillar forest industries (Lei 2001). Bamboo has been increasing in importance as a resource in Guangxi over the last two decades; however, the growth of the sector has not kept up with the demand, as many constraints limit the potential of the sector (Maoyi unpublished).

Tianlin County is rich in bamboo resources, with many commercially important species. *Dendrocalamous latiflorus* is the most widely cultivated bamboo in the county, and planted primarily for the production of Badu bamboo shoots, which have been a famous product throughout China since the Qing dynasty. But the industrialisation of Tianlin's bamboo sector only started in the last 15 years, and resulted in a significant expansion in plantation area from 4 000 ha in 1997 to 17 357 ha in 2007 (approximately 5% of the county's total forestland area; Tianlin Forestry Bureau 2007). This expansion was the result of a bamboo-based poverty alleviation program that was implemented by the county government in partnership with the city of Guangzhou and a private company (Tianlin Poverty Alleviation Office 2004).

Between 1996 and 2000, more than 20 000 migrants were relocated to Tianlin from surrounding counties that had relatively poor soils and natural resource bases. Households were allocated between one and two hectares of bamboo land (depending on household size) for the specific purpose of producing bamboo shoots as a cash crop (Tianlin Poverty Alleviation Office 2004). The migrants had contractual relationships with both the county government (for the land), and the private company (for the bamboo shoots), whereby they could only use their land for growing bamboo and had to sell their shoots exclusively to the company (at prices set by government-private partnership). Two sample villages in this study (numbers two and four; see Table 1) were migrant villages involved in this bamboo-based poverty alleviation program.

METHODS

The study sample and data collection

The sample used in this study came from three townships (out of a total of 14 in the county) that were purposefully selected to represent the geographical and socioeconomic diversity in the county. Four villages were randomly selected from each of the three townships, with twenty households randomly selected from each of the 12 villages (using the local government's household records), for a total sample of 240 households. The average sampling intensity was 2.5% for the townships and 46% for the villages (see Table 1 for township and village names, and sampling intensity).

Primary data were collected in 2007 and 2008 using structured annual and quarterly household surveys, focus group discussions, and key informant interviews. The surveys and interviews were conducted by six local enumerators that had been trained in the survey method. Mandarin or Zhuang languages were used (as required) to conduct the surveys, with the data recorded in Mandarin, and then later translated into English by a team of translators (with crosschecking and random back-translations to ensure quality). The annual and quarterly household surveys were based on the Poverty Environment Network survey instrument (PEN 2007a), and were conducted with household heads (or another senior household member in their absence), covering the period from mid October 2006 to mid October 2007 (occasionally neighbours and relatives were present at the interviews, but

[3] State Designated Poor Counties are officially categorised as such by the central government due to their high rates of poverty, and are the subject of area-based poverty alleviation targeting in an effort to reduce inequality and persistent poverty.

TABLE 1 *Village selection and sampling intensity*

Selected township name	Admin. village name	Village No.	Total No. of households in village	No. of households selected	Sampling intensity (%)
Liulong	MenTun	1	63	20	32
		2	76	20	26
	ZhongTun	3	31	20	65
		4	52	20	38
Badu	Fuda	5	88	20	23
		6	60	20	33
	Bailiu	7	29	20	69
		8	37	20	54
Nabi	Nala	9	24	20	83
		10	58	20	34
	Liuyin	11	30	20	67
		12	78	20	26
		Mean	**626**	**240**	**46**

this was not considered to have affected the results in any significant way).

The annual surveys were conducted at the beginning and at the end of the survey period to collect general household socioeconomic data (demographics, assets and savings, land tenure) and qualitative information about forest use, prices, risks and vulnerabilities. The quarterly surveys recorded total cash and non cash income from all major sources (outlined in the next section) so that the contribution of bamboo to total household income could be contextualised. The quarterly recall periods were intended to capture seasonal variations and increase recall accuracy.

In addition to the PEN socioeconomic surveys, inventories were conducted for all 240 sample households to quantify the use, and determine the origin of, bamboo subsistence products used around the house and on the farm. Additional survey questions collected data related to the role of bamboo in their livelihoods over the last five years.

Income definitions, calculations and data analyses

The definition of income used in this paper is based on that used in the PEN global study (PEN 2007b), which defines income as the value added of labour and capital (including land). Total household income is the sum of cash plus subsistence income. Subsistence income was determined by calculating the value of products used directly by the household or given away to friends and relatives. Subsistence products were assigned cash-equivalent values based on household reported farm gate prices, which were independently cross-checked by comparing them with retail prices at local markets and by comparing average prices between sample villages. Total household income includes income from self employment (including crop and livestock production), business and wage income, income from renting out capital (including land), and transfers (e.g. remittances or pensions). For the analyses in this paper, total household income was divided into six major categories: bamboo, other forest, crop, livestock, off-farm, and fish and environmental; the definitions of which are outlined below:

Bamboo: includes income from the sale or subsistence use of bamboo products harvested from natural forests or cultivated in plantations on designated forest land.

Other forest: includes income from the sale or subsistence use of plant or animal products harvested from natural forests, or cultivated in plantations on designated forest land, plus payments for forest based environmental services (such as government payments to households involved in reforestation programs such as the Conversion of Cropland to Forests and Grasslands Program).

Crop: includes income from the sale or subsistence use of plant based annual crops grown on household land designated as agricultural land, and also includes income from fruit orchards.

Livestock: includes income from the sale or subsistence use of livestock assets in the period covered by the survey. Stock value and changes in stock values are not counted as income, but are counted as assets.

Off-farm: includes income from transfers, household business and wage income. Business income includes cash income from self employment, but does not include income from the household's own agriculture or forestry production and processing. Wage income includes cash from any kind of paid employment, including income from forest-based employment activities. Transfer income includes remittances,

cash or non-cash gifts and support from friends and relatives, pensions, agricultural subsidies from government or non-government sources, payments for renting out land, and compensation payments from government, logging or mining companies (or similar).

Fish and environmental: includes all types of cash or subsistence income obtained from the harvesting of non forest resources provided through natural processes that do not require intensive management (including wild fisheries related income).

Calculating the cash income from off-farm sources simply involved recording the amount earned in the given recall period, whereas calculating income from forest, agriculture and environmental sources, involved multiplying the recorded quantities of products and services sold, collected or purchased, by the actual sale price (for cash income) or average farm gate prices (for subsistence income). All income results presented are based on net income (gross value minus all purchased inputs including hired labour, but not household labour). Per capita income was calculated by dividing the value of the income source by the number of people in the household, regardless of their age or other factors.

Of the original 240 sample households, the analyses were conducted on the 225 households that completed all surveys, with extreme outliers removed. The contribution of bamboo income to household livelihoods and the associated socio-economic factors were analysed using SPSS 9 with ANOVA F tests, Duncan's and Dunnett's T3 post hoc tests.

RESULTS

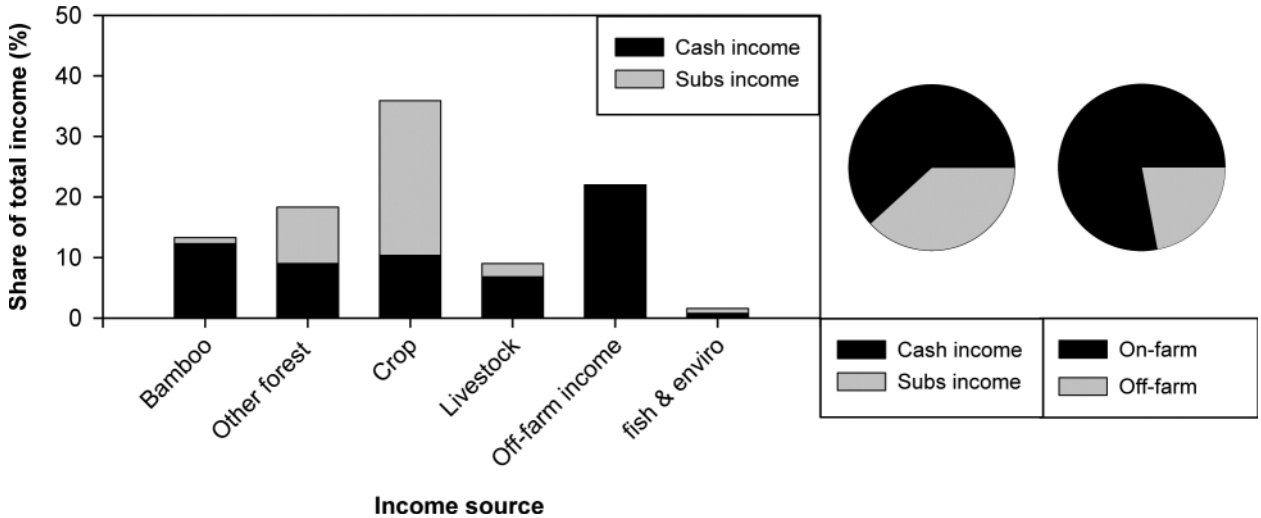
The contribution of bamboo to household income

The percentage contribution of different income sources to the mean total income for all sample households is presented in Figure 1. Cash income made up 62% of total income (although the contribution of subsistence income was still very important at 38%), whilst the contribution of on-farm income was much higher than off-farm income (78% compared to 22%). Crop income contributed the largest share to total income (36%), although this was mostly for subsistence (i.e. food security). The contribution of bamboo to total income was 13.3%, 93% of which was cash, making it the second most important source of cash after off-farm income (22%). The combined cash income from forest, livestock and crop sources (on-farm cash income) is significantly higher than off-farm income.

Almost 100% of household bamboo income comes from the sale of bamboo shoots (from *D. latiflorus*) that are cultivated in small-scale, household managed forest land that is designated for forest use. Over 98% of the harvested shoots are pre-processed on the farm (chopped, steamed, fermented and dried) and then most (92.5%) are sold to either: a) middlemen/traders of bamboo shoots who sell to factories in Guangdong that supply domestic or international markets; b) small, local, family-owned processors for the local and domestic market; or c) a large bamboo processing factory in the county which exports mostly to Japan or Taiwan via Guangdong (migrants involved in the bamboo-based poverty alleviation project are supposed to only sell their shoots in this way). The rest of the shoots are home consumed, and therefore count as subsistence income (see explanation of bamboo subsistence use in the next section).

As an individual source of income, the contribution of bamboo to the total cash component of household income is impressive. At 12.4%, the total cash contribution of bamboo to total income is substantially higher than the 9.1% from all other sources of forest-cash income combined, and also more than the 10.5% cash contribution from all crops combined (rice, corn, vegetables etc..), the 6.9% cash contribution of all livestock sources combined (cattle, pigs, chickens etc…), and the individual contributions of business (9.3%), wage (8.1%), and 'other income' (4.7%) categories that make up the off-farm income category. Therefore bamboo is the single most

FIGURE 1 *Mean annual household income contribution by source* (*n = 225*)



valuable and important cash income source of the main income categories.

Bamboo subsistence use

Two percent of the bamboo shoots harvested by the sample households are consumed unprocessed (fresh) or sold as fresh shoots, and 7.5% of the processed shoots are home consumed. In the income surveys, 63% of households reported some bamboo income, but in the separate bamboo inventory survey, 100% of households had subsistence use of bamboo products in and around their homes for a range of utility items (e.g. baskets, cooking utensils), construction material (for houses, furniture, fences, cages) and as fuel.

The subsistence role of bamboo in the sample population was, however, declining, with 67.5% of sample households reporting using less bamboo at the time of the survey than five years previous, and the rest reporting no change (only one reported an increase). More than 60% of households attributed the decreased use of bamboo to the availability of cheap substitute products (such as plastic), and all the sample households from Nabi Township (c.1/3 of the sample households) cited a decrease in bamboo availability due to overharvesting and unsustainable management.

Bamboo villages

The average contribution of bamboo income to total income reported in Figure 1 masks the significant variation in bamboo income contribution between villages, and between households within villages. Average bamboo income share in the villages actually ranges from 0% to nearly 50%. This variation in bamboo income contribution between villages is clearly shown in Figure 2, which presents the average absolute value of cash and subsistence income from all sources for the 12 sample villages. Households in half of the sample villages have virtually no bamboo income at all, whereas the other half have bamboo income contributions of more than 10% of total income (for the subsequent analysis in this paper, 'bamboo villages' and 'bamboo households' are those with more than 10% bamboo income share; see Table 2).

Previously it was stated that the contribution of bamboo to total income for all households in the sample was 13.3%; however if only bamboo households are included in such a calculation (i.e. 39% of the total sample), the average contribution to total income was 32.5%. Indeed many households specialised in bamboo production, with bamboo income shares up to nearly 80% of total income in some households (but at the expense of other income activities). This result is strongly influenced by the two migrant villages in the sample who are contractually required to grow only bamboo on their allocated forest land (see Figure 2a for a clear demonstration of this point).

Yet not all households within bamboo villages were bamboo households. Twenty three percent of households within bamboo villages derived less than 10% of their total income from bamboo, and instead specialised in off-farm income as their primary source of cash. Income from business made up these household's main component of off-farm income, with shop/trade income being the most common source, followed by transportation related business, whilst agricultural labour constituted the main type of wage income. These off-farm specialised households within bamboo villages had significantly higher income, cash share, and asset value compared to bamboo households, and they were also less likely to be migrant households compared to bamboo households.

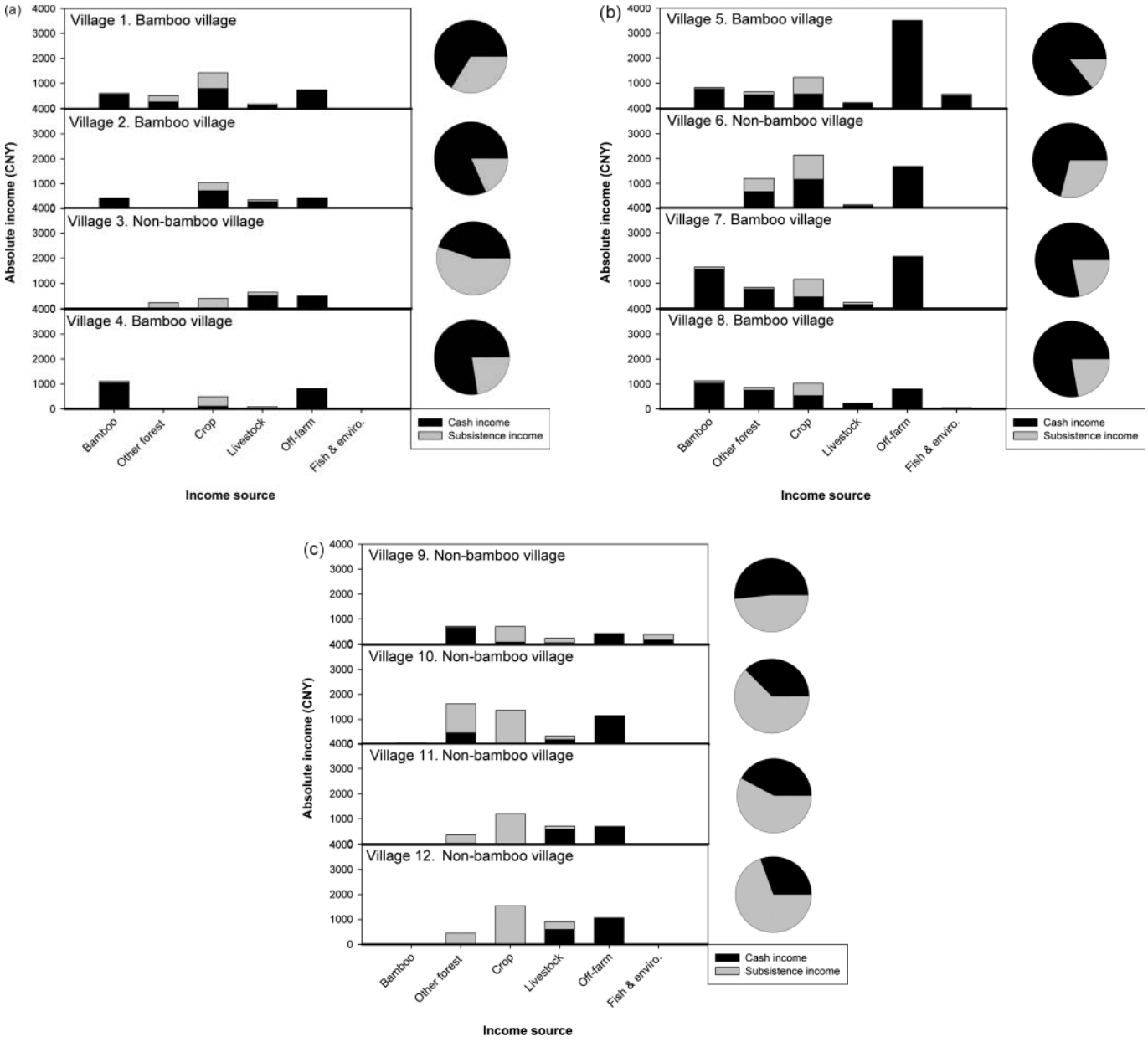
Unlike Liulong and Badu Townships, Nabi Township had not experienced any expansion of bamboo plantations and did not have an industrialised bamboo sector at the time of the study. Compared to households in other townships, those in Nabi Township had low cash income, and a heavy reliance on crop subsistence and other forest subsistence income sources (Table 2 and Figure 2c). The sample villages in Nabi had little in the way of bamboo resources (and what they did have was reportedly suffering from over harvesting and mismanagement), no bamboo market infrastructure, and no bamboo villages. Nabi's lack of engagement in the bamboo sector can partly be explained by the study households' below average forest land area (Table 2) and, compared to Liulong and Badu Townships, Nabi's villages were located the furthest distance from the county centre and markets (presumably making it more difficult to establish an industrialised bamboo sector).

The fact that villages three (in Liulong Township) and six (in Badu Township) were not bamboo villages was somewhat unexpected given that they were surrounded by bamboo villages with thriving bamboo industries, and with similar growing conditions, distances to market, and access to the bamboo market infrastructure. Village three stands out as being the poorest village in the sample (in terms of average income) with the lowest forest land area per capita (Table 2). Households in village three rely primarily on subsistence income from crop and forest sources, with livestock making the main contribution to cash, and with little off-farm income (see Figure 2a). Village six on the other hand, has above average household income (the third richest village in the sample), and slightly above average household forest land area (see Table 2). Village six households are much more cash oriented, with a focus on off-farm, crop and forest cash income (Figure 2b). Their forest income is close to average, but is unique in that nearly half comes from the production and sale of charcoal (the raw material for which is collected from natural forest), which barely registers in any of the other sample villages. This income from charcoal – plus above average cash income from corn and ginger – appears to have replaced the need for bamboo income.

Socioeconomic differentiation of bamboo income contribution

In this final results section, the analyses are focused on households in bamboo villages only. Figures three and four present the absolute and relative contribution of bamboo income to total household income differentiated by income quintiles. The high income households had significantly higher proportions of cash and off-farm income compared to the low households, with a steady gradient of change between them

FIGURE 2 *Average contributions of cash and subsistence income to total household income differentiated by sources for the 12 sample villages. Mean currency conversion rate for the year covered by the survey is 7.7CNY:1USD*



(Figure 3). Bamboo income was important to households at all income levels in terms of both absolute income (Figure 3) and relative income (Figure 4).

In absolute terms, the bamboo cash income contribution was significantly higher in high income quintile households compared to all other quintiles (Figure 3; $p = 0.004$), whereas there were no significant differences in absolute bamboo subsistence income between quintiles. There were, however, significant differences in the relative contribution of bamboo cash to total cash income between quintiles 1 and 5, and between quintiles 3 and 5 ($p < 0.05$), with low income households having significantly higher bamboo cash share compared to high income households (Figure 4; c.45% compared to c.19%; $p = 0.013$). Although not shown in any figure, the same result was found for the share of total bamboo income relative to total income, although somewhat less pronounced (c.34% to c.17%; $p = 0.045$).

DISCUSSION AND CONCLUSIONS

Bamboo's contribution to household income and rural development is clearly important in the study area, both as a major source of cash (for households in half of the villages), and for subsistence uses (for all sample households). The value of the subsistence contribution was low and reported to be declining (at all income levels, but nevertheless it remained a ubiquitous and highly utilised resource for a wide range of purposes).

TABLE 2 *Village level forest land and key income figures*

Township name	Admin. village name	Village No.	Mean forest land per capita (ha)	Mean total per capita income (CNY)	Mean off-farm income (%)	Mean per capita bamboo income (%)
Liulong	MenTun	1*	0.24	3442.6	14.3	17.7
		2*	0.36	2298.5	15.1	22.0
	ZhongTun	3	0.06	1801.3	13.6	1.4
		4*	0.41	2533.3	26.1	49.9
Badu	Fuda	5*	0.39	6921.8	45.9	13.7
		6	0.33	5116.6	26.6	0.6
	Bailiu	7*	0.54	6027.1	23.0	30.0
		8*	0.18	3638.9	16.0	19.2
Nabi	Nala	9	0.11	2436.3	11.6	0.1
		10	0.50	4554.9	22.3	1.5
	Liuyin	11	0.07	2985.0	27.3	0.0
		12	0.21	3989.8	21.2	0.0
		Mean	**0.29**	**3821.6**	**22.0**	**13.3**

** denotes bamboo villages; i.e. villages in which the mean household contribution of bamboo income to total income is greater than 10%*

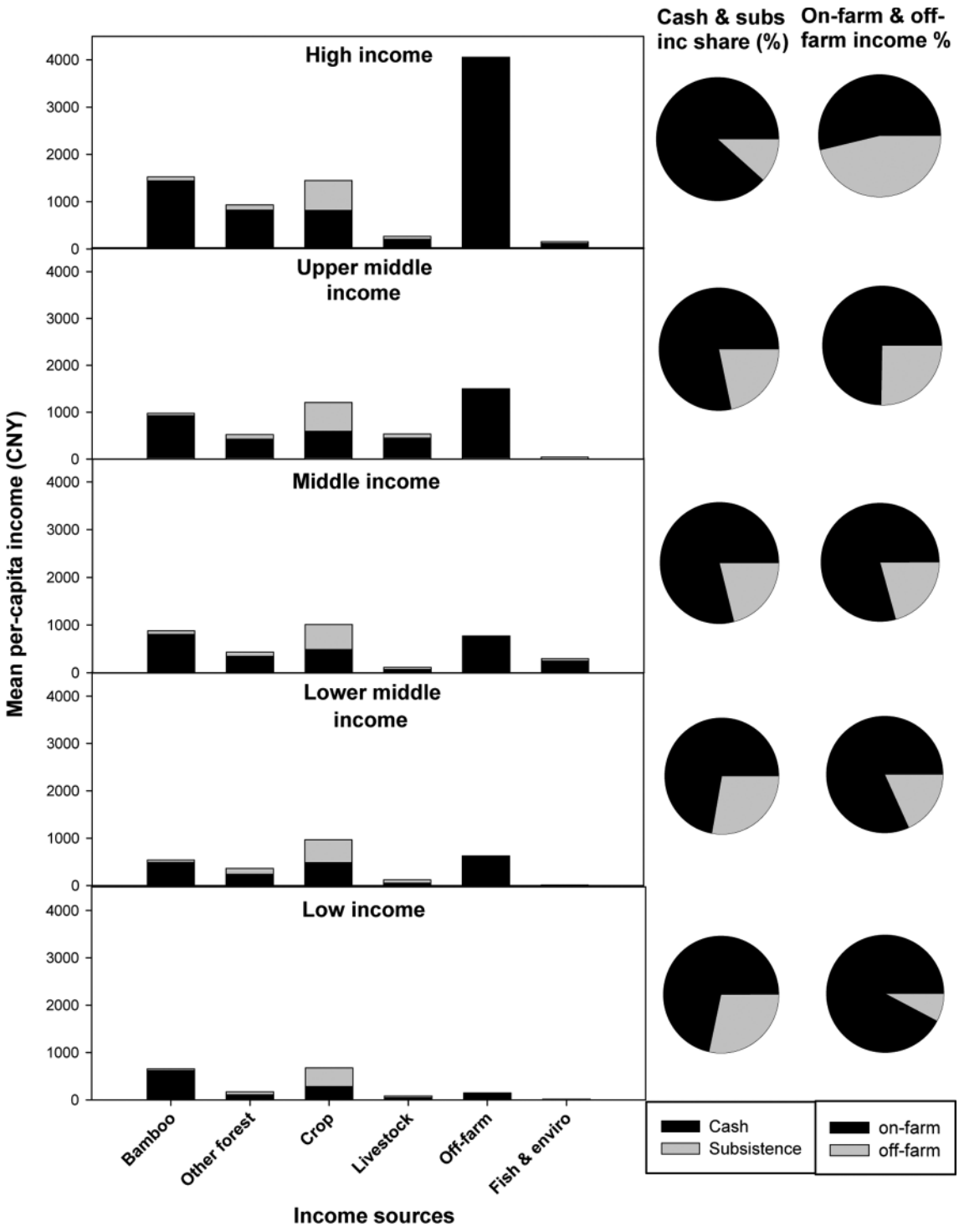
More significantly however, is bamboo's relatively new and important contribution to household cash income following the recent industrialisation of the sector. In half of the villages, bamboo was found to be the single most valuable and important source of cash income, whilst the other half of the villages either specialised in other forms of earning cash income, or languished in poverty with very low levels of cash income.

The bamboo villages that were identified in this study either had long established bamboo sectors (that began as small scale, traditional cottage industries but scaled up in recent years) with an established resource base and market chains; or, were the recent creations of the government funded bamboo based poverty alleviation project. Regardless of how or when the bamboo industrialisation process began in these villages, it is clear that bamboo was the forest based cash crop of choice at the time of the study. Within the bamboo villages, bamboo has proven to be an important resource to the majority of households at all income levels, although the specific role it played in livelihoods varied according to the socioeconomic status of the households. One of the main findings in relation to the socioeconomic determinants of bamboo income was that higher income households had higher absolute bamboo income than lower income households, but it represented a significantly smaller relative share of their total income. This kind of result has been reported in several similar studies on China's bamboo sector (Gutierrez Rodriguez *et al.* 2009, Ruiz-Pérez *et al.* 2001, 2009, Zhu and Yang 2004), and also for forest income in general (Byron and Arnold 1999, Campbell and Luckert 2002, Cavendish 2000, Hogarth *et al.* in press, Vedeld *et al.* 2007, Yemiru *et al.* 2010). This common finding is, however, simply an artefact of the higher income households having high income from other sources (especially off-farm) compared to low income households, and consequently a lower bamboo income share.

In a synthesis paper that summed up ten years of research across eight counties and three provinces in China, Ruiz-Pérez *et al.* (2009) showed that in the early, rapid stages of bamboo sector development, higher income households derive higher absolute and relative income from bamboo compared to low or middle income households, because they are better placed to take advantage of new opportunities. But as the local economy develops and the bamboo sector matures, increasing off-farm income tends to displace the relative importance of bamboo income for high income households (even as their absolute bamboo income remains steady or rises), while the relative importance of bamboo income increases for the lower and middle income households (Gutierrez Rodriguez *et al.* 2009, Ruiz-Pérez *et al.* 2001, 2009, Zhu and Yang 2004). A similar process is likely to be occurring in this study site, although determining this was beyond the scope of the data collected for this study (further studies based on time series data are required to do so).

In their study on the spatial patterns and processes of bamboo expansion in Southern China, Mertens *et al.* (2008) found that at advanced stages of bamboo development, further increases in bamboo income became limited by maximum thresholds of productivity being reached (through intensified management), and by the availability of land. There was, however, no evidence in this study that bamboo development in Tianlin had reached any such limitations of land availability or productivity. On the contrary, there is strong evidence from another study that poor management practices amongst the smallholder bamboo farmers in Tianlin has resulted in very low productivity and sub-optimal yields (Hogarth submitted). Furthermore, half of the sample villages in this study

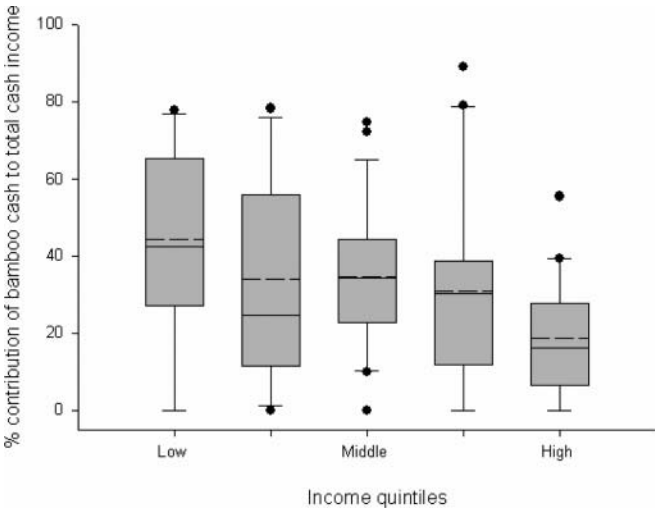
FIGURE 3 *Average values of cash and subsistence income to total household income differentiated by sources according to income quintiles (includes all households in bamboo villages only)*



had little or no bamboo resources at all, despite having ideal growing conditions and local access to bamboo stock and markets. It is therefore suggested that there is much opportunity for a continued and increasing contribution of bamboo resources to rural livelihoods in Tianlin, through an expansion of plantations and improvements in productivity with continuing favourable policies and market conditions.

Off-farm income is widely perceived to be the main route out of poverty in China's forest regions and rural areas generally (Haggblade *et al.* 2002, Lanjouw and Feder 2001). This may well be the general case, but in remote and mountainous areas such as in this study site, where persistent poverty remains stubbornly rooted and increasingly difficult to reach, forest based enterprises such as bamboo production often

FIGURE 4 *Box plot showing bamboo share of total income according to income quintiles in bamboo villages only. Dashed line is the mean, solid line is the median. n = 113; includes 87 bamboo households and 26 non-bamboo households*



represent the main, or even the only, industry and cash earning opportunities available (Katsigris *et al.* 2010, Ruiz-Pérez *et al.* 2001, 2004). Indeed, less than a quarter of the sample households in this study sample received any benefit whatsoever from off-farm income, and most of those benefitting were from high income households. On the other hand, the majority of households across all income levels derived significant benefits from bamboo and other forest related income. So, until off-farm income becomes accessible to the majority of households in remote places like Tianlin (most likely some time off), bamboo and other farm based cash crops will remain as the dominant source of smallholder income, and at least part of the solution for any poverty reduction efforts.

This paper is the first empirical based study to be published on the role of bamboo in household income and livelihoods in Guangxi, and one of few such publications for the emerging bamboo provinces of China's south west. Given the increasing value of bamboo to China's forestry sector and its potential role in poverty alleviation, much more quantitative research is needed throughout China, but especially in the emerging bamboo provinces of the south west. The current lack of understanding represents a significant barrier to policymaker and donor attempts to effectively incorporate bamboo into China's targeted poverty alleviation strategy. Despite these limitations, China's bamboo sector continues to serve as a model for other regions of the world faced with rural poverty that want to develop their bamboo sector (e.g. Marsh and Smith 2007). Research such as presented in this study could therefore provide useful information and methods for quantifying the role of bamboo income in household livelihoods throughout China and beyond.

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