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The Role of Forest-Related Income in Household Economies and Rural Livelihoods in the Border-Region of Southern China

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Summary. — Quarterly socioeconomic data from 240 households are used to study the links between forest-related income and rural livelihoods in southern China. Results show average forest-related income shares of 31.5%, which was predominantly derived from cultivated non-timber sources. Forest-related income was important to households at all income levels, although lower income households were more dependent due to a lack of other sources. Higher income households monopolized off-farm income and had more land than low income households. Forest-related income could be increased by making forest land more accessible to the poor, improving productivity, and removing constraints to smallholder engagement in timber marketing.

Key words — Asia, China, poverty alleviation, off-farm income, NTFP, environmental income

1. INTRODUCTION

In the last decade the role of forest-related income in household economies and rural development has received increasing attention from the international community. This is largely in recognition of the significant relationship between forest areas and poverty (Sunderlin *et al.*, 2008; World Bank, 2001a,b, 2004), and the emerging imperative that forests could, and should, have a far greater role in meeting the Millennium Development Goal's poverty alleviation targets (FAO, 2005; World Bank, 2001a). Hence governments, international donors, and NGOs are increasingly looking to the forestry sector for solutions to reduce poverty (Arnold, 2001), but progress is hampered by a distinct lack of empirically based knowledge about forest-related income in household economies and rural development (FAO, 2006, 2008; Oksanen, Pajari, & Tuomasjukka, 2003; RECOFTC, 2009). Systemic institutional failure to collect forest-related income data across the developing world has led to a significant underestimation of the forest sector's importance to rural livelihoods and economic development (FAO, 2008). The real value of forest goods and services is generally underestimated, wrongly attributed to other sectors, or entirely omitted (FAO, 2008; Vedeld, Angelsen, Bojöd, Sjaastad, & Kobugabe, 2004; PROFOR, 2008). This lack of quantitative data and readily available information is considered a major constraint to mainstreaming the use of forests in poverty alleviation, and therefore the potential of forests to alleviate poverty is largely unrealized (World Bank, 2008).

China makes for an interesting case study in this context. Since the post-Mao era economic reforms began in 1979, China's forest cover has rapidly increased due to large-scale conservation and afforestation efforts (FAO, 2010a), and at the same time a staggering half billion people were lifted from

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poverty (World Bank, 2009). Yet China still has hundreds of millions of people living below the poverty line (World Bank, 2009), a large concentration of which is located in mountainous, forested areas (ADB, 2008; Katsigris, Xu, White, Yang, & Qian, 2010; Li, 2004; World Bank, 2009). To tackle this persistent poverty the central government introduced a National Plan for Poverty Reduction in 1994 (the "8-7 Plan"), which among other things involved area-based targeting in officially designated "poor" counties [1] and the promotion of forest-based cash crops through supportive policies and other incentives (Ruiz-Pérez *et al*., 1996; Wang, Li, & Ren, 2004; World Bank, 2009). Furthermore, some clear links to poverty reduction were included in the nationwide Priority Forestry Programs introduced in 1998; including the Conversion of Cropland to Forests and Grasslands Program (CCFGP; an afforestation project involving 32 million rural households; Bennett, 2009; Liu *et al*., 2011). Despite China's efforts to integrate forests into the national poverty plan and poverty into the national forestry plan, the role of forest-related income in household economies and rural development remains poorly understood due to a distinct lack of empirical data on the subject (ADB, 2008; Katsigris *et al*., 2010; World Bank, 2005). This gap in the knowledge represents a significant barrier to policymaker and donor attempts to effectively incorporate forestry into China's targeted poverty alleviation strategy (World Bank, 2005).

In this paper, data from a targeted poor county in the Guangxi Zhuang Autonomous Region are used to study the role of forest-related income in household economies and rural livelihoods. The study is motivated by three research questions: (1) what are the livelihood strategies of the sample population in terms of income sources? (2) What is the specific role of forest-related income within the context of their wider livelihood strategy?, and (3) How do socioeconomic and policy factors influence forest-related income contributions? In addressing these research questions, a detailed account of forest-related income and the factors affecting it is provided. Such information is essential for guiding policies related to land-use, forest management, and forest-related poverty interventions. Addressing these research questions will improve our understanding of the current and potential role of forest-related income in reducing poverty; especially for remote, mountainous and impoverished areas such as the target areas of China's poverty alleviation programs. But given the dearth of information on the subject in general, this paper will also contribute toward understanding the wider issues of forest-related development challenges in China and beyond.

(a) *Studies on the role of forest-related income in rural livelihoods*

In recent years, research into the role of forest-related income in rural livelihoods has been gaining momentum. For example, a 24-country comparative study called the Poverty Environment Network (PEN, 2007a) is currently under way; focusing on household income generation from forest and environmental sources (data from this China case study are included). There are also a suite of recently published case-studies that investigate a range of forest-livelihood interactions, and show forest-related income contributions ranging from 6% to 45%; (Ambrose-Oji, 2003; Appiah *et al*., 2009; Babulo *et al*., 2008; Campbell & Luckert, 2002; Cavendish, 2000; Fisher, 2004; Illukpitiya & Yanagida, 2008; Mamo, Sjaastad, & Vedeld, 2007; McElwee, 2008; Shackleton, Shackleton, Buiten, & Bird, 2007; Takasaki, Barham, & Coomes, 2001; Tieguhong & Nkamgnia, 2012; Vedeld *et al*., 2004; Yemiru, Roos, Campbell, & Bohlin, 2010) levels that in some cases are equal to, or exceed the contributions from agriculture. The majority of such studies are, however, located in sub-Saharan African countries, and most are focused on forest-related income derived from natural forests only (i.e., environmental income). China makes for a special case study in this regard, having very little accessible natural forests and the world's largest plantation forest area (FAO, 2010c); hence the dynamics of forest income in rural livelihoods in China is very different to the above mentioned studies.

The previously mentioned lack of empirical data on the role of forest-related income in household economies and rural development in China is not due to a lack of published literature on the subject. Indeed Katsigris *et al*. (2010) did a literature review of 55 publications on the subject, but found that a substantial portion of the literature was qualitative and theoretical in nature. The majority of the reviewed literature was also published only in Chinese, and therefore effectively inaccessible to the international audience. Much of the literature that is accessible to the international audience is limited in focus to measuring the impacts of specific forest-related policies and projects on livelihoods (e.g., ADB, 2008; Bennett, 2008; Liu, Jinzhi, & Runsheng, 2010; Uchida, Xu, Xu, & Rozelle, 2007; World Bank, 2005; Xie *et al*., 2005; Zhang, 2000). Katsigris *et al*.'s 2010 study provides the only comprehensive overview of forests and livelihoods in China, which in addition to the literature review, is based on the available government data and an analysis of data from their own eight-province, 276-village household survey. Their key findings are that: (a) forests make a significant contribution to household income in China's forest areas, including those in poor areas; (b) average forest-related income contributions are in the range of 10–20% (although in a minority of study sites forest income contributes the major share of household income); and (c) the forest-related income share of "a very significant proportion of locales" was increasing (Katsigris *et al*., 2010, p. 3). Although very useful information for a general overview of the situation, by the author's own admission, the findings were limited to village averages (i.e., no household level analysis), had no clear analysis of the socioeconomic determinants of forest use, and did not disaggregate the types of forest products and services that make up total forest-related income.

Although limited to only one county, this study provides a new method for systematically quantifying the contribution of household level forest income in rural livelihoods in China. The data are broken down and analyzed according to income groups in order to provide an insight into the specific role of forest income to different socioeconomic groups. Forest-related income is disaggregated according to income groups to provide an insight into the types of forest products and services that contribute to incomes and livelihoods, and the policies that affect them. Furthermore, this study represents a unique contribution to the international literature on the subject, being focused on forest income that is predominantly derived from smallholder non-timber forest plantations.

2. STUDY SITE

The study site is in Tianlin County, which is located in the northwest corner of the Guangxi Zhuang Autonomous Region in southern China. Tianlin is wedged between Guizhou and Yunnan Provinces, and is part of the Greater Mekong sub-region, about 150 km north of the border with Vietnam. The climate is subtropical-monsoonal with hot-wet summers (seasonal flooding and landslides are common) and cool–dry

winters (seasonal droughts are common). The topography is characterized by low mountains (345–863 m altitude) and narrow river valleys. Tianlin is relatively rich in agricultural and forestry resources compared to many surrounding counties. More than 80% of Tianlin's land area of 5170 km^2 is devoted to forestry and about 17% for crops (Tianlin Forestry Bureau, 2001). Agriculture contributes 53% of total industrial and agricultural output, while 32% is from forestry (Tianlin Statistics Bureau, 2003).

The county population of c.240,000 is predominantly composed of ethnic minorities including the Zhuang, Yao, Miao, Yi and other ethnic groups, with the balance made up of ethnic Han (Tianlin County Government, 2007). Tianlin has a relatively low population density at 46 people per km^2 (compared to the provincial average of 207 per km^2) and very little urbanization, with 90% of the population living in rural areas (Tianlin County Government, 2007). The villages in our study are situated in relatively remote upland areas with poor roads, health and education facilities, limited arable land and weak agriculture and forest extension services. Living conditions can be harsh, with access to clean drinking water and education limited in many locations. The people in our sample were rural dwellers, almost exclusively smallholder peasant farmers with small allocations of agricultural and forest land, and low cash incomes.

3. METHODS

Tianlin County is divided into administrative units made up of 14 townships, with 1346 natural villages that are grouped together to make 168 administrative villages.

For this study sample, three townships were selected that represented the geographical and socioeconomic diversity of the county. Two administrative villages were randomly selected from each of the three townships, with two natural villages randomly selected from each of the six administrative villages. Twenty households from each of the 12 natural villages were randomly selected using the local government's household records, making a total sample of 240 households (80 households per township, 40 per administrative village, and 20 per natural village). The average sampling intensity was 46% for the natural villages, 16% for the administrative villages, and 2.5% for the townships. We collected primary data using structured village and household level surveys based on the Poverty Environment Network survey instrument (PEN, 2007a), as well as focus group discussions, key informant interviews, and collection of local government data. Six local enumerators were hired and trained to conduct the surveys (one for each village) that were conducted over an 18 month period starting in January 2007.

(a) *Questionnaire design and data collection*

Village surveys were conducted in small groups (with village leaders and a cross section of citizens) at the beginning and end of the survey period to collect data common to all households (e.g., geographic and climate variables, village level demographics, infrastructure, forest cover and land use, risks, wages and prices, and forest services). The village survey conducted at the beginning of the survey period provided background information about the villages while the one at the end provided comparable information for the 12 month period covered by quarterly surveys.

Throughout 2007, two kinds of household surveys were conducted with household heads (or another senior household member in their absence) covering the period from mid-October 2006 to mid-October 2007. Annual surveys were done 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 vulnerability. Four quarterly surveys recorded the cash and non-cash income from all major sources so that the specific contribution of forest income could be contextualized. Income data from wage, business, forest and environmental sources were based on a recall period of one month, whereas data for crop, livestock and other sources of income were based on three month recall periods. The quarterly timing of the survey and the short recall periods were designed to capture seasonal variations and increase accuracy.

While cash income from wage and business sources simply involved recording the amount earned, cash and subsistence income from forest, agricultural, and environmental sources were calculated using the recorded quantities of products and services (sold, collected, or purchased) multiplied by local prices. Subsistence products or services were assigned cash-equivalent values based on each household's own-reported values (local 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.

(b) *Definitions of forest, forest land, and forest products*

The Chinese definition of what constitutes forest and forest land (and thereby forest-products) is very broad by international standards. Forest includes natural forests, plantation grown timber, protection forests (including planted forests for environmental services), economic forest (includes cultivated non-timber tree crops such as tea-oil, tung-oil, star anise, cinnamon, nut and fruit orchards), bamboo forests (natural and plantation), shrub land, farm and coastal shelter belts, and trees planted around villages, rivers, roads, and houses (Rozelle, Huang, & Benziger, 2003). Forest land includes land with a minimum area of 1 mu (i.e., 0.067 ha, compared to 0.5 ha in the FAO definition), a width of 10 m (compared to 20 m in the FAO definition), tree crown cover of 20% (compared to 10% in the FAO definition), and a minimum tree height of 2 m (compared to 5 m in the FAO definition) (FAO, 2010b). These definitions must be taken into account when using or referring to the official Chinese data related to forests, and when considering the forest policies and forest-related poverty alleviation strategies (as is done in throughout this paper). The definitions of forest and forest products used in this study are based on the official Chinese definition of forest and forest land, with the exception that land used for fruit production was assigned to the crop category.

In terms of smallholder land use, there is a clear distinction made in China between household allocations of agricultural land (allocated under the Household Responsibility System) and separate allocations of forest land (allocated mostly under the Contract Responsibility System). Agricultural land is generally better quality land that is more conducive to higher input and annual production, while forest land is often located on marginal, sloping land used for production of perennial forest crops. These land allocations are generally held on separate plots, and there are separate laws and policies that apply to their use (agricultural policy or forest policy).

(c) *Income calculations*

The definition of income used in this paper is based on that outlined in the PEN technical guidelines (PEN, 2007b), and is defined as the return to the labor and capital that a household

owns, used in own production and income-generating activities (self-employment or business) or sold in a market (e.g., wage labor). Transfers—in the form of remittances, pensions, or other government payments—are also included in the income definition. Total household income is the sum of cash income and subsistence income (subsistence income is defined as the value of products consumed directly by the household or given away to friends and relatives).

For the livelihoods analyses in this paper, total household income was divided into seven major categories based on those used in the survey instrument (PEN, 2007a). They are: crop, forest-related, business, livestock, wage, other, fish and non-forest environmental (two separate categories combined for this study). Definitions of these categories are outlined below:

Crop income includes income from the sale or consumption of plant-based annual crops grown on household managed land designated as agricultural land, and income from perennial fruit crops grown on what is considered as forestry land according to the Chinese classification system (note that there was very little fruit production recorded in the study site).

Forest-related income includes income from the sale or consumption 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 afforestation programs such as the CCFGP).

Business income includes cash income from self employment, but does not include income from the household's own agriculture or forestry production and processing.

Livestock income only includes income from the sale or consumption of livestock assets. Changes in stock values are not counted as income.

Wage income includes cash from any kind of paid employment, including income from forest-based employment activities.

Other income includes remittances; cash or non-cash gifts/support from friends and relatives; pensions; support such as agricultural subsidies from government, NGO, or similar; payment for renting out land; and compensation from government, logging or mining companies (or similar).

Fish and non-forest environmental income 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).

All income results presented are net income, which is the gross income value minus all purchased inputs including hired labor. Per capita income was used in all analyses and results, and was calculated by dividing the various income variables by the number of people in the household, regardless of their age or other factors.

(d) *Data analyses*

Income quintiles were determined within the six administrative villages by ranking households according to their total income and then dividing them into five groups from highest income (quintile 5) to lowest (quintile 1). Quintile groups from all six villages were then aggregated to make five complete quintile groups, as shown in Table 1.

Out of the original 240 sample households, the analyses were conducted on 225 households that completed all surveys, and with some extreme outliers removed (the highest and lowest incomes). Patterns of forest income and socioeconomic factors were analyzed using SPSS 9 with ANOVA *F*-tests, Duncan's and Dunnett's T3 *post hoc* tests, and multiple regression analyses.

4. RESULTS AND DISCUSSION

(a) *Basic socioeconomic characteristics of the sample population*

Three ethnic groups were represented in the sample population, with 61.5% Zhuang, 26% Han, and 12.5% Yao (although there is some integration, they mostly live in ethnically homogenous natural villages). The sample included two villages that were composed predominantly of Yao migrants from other counties that were part of a bamboo-based poverty alleviation project that started in 1996; which largely explains why 24% of the total sample population were migrants. The average household size was 4.65, but households in the highest income quintile had a significantly smaller household size (4.24) compared to households in the lowest three income quintiles ($p < 0.05$). Household heads were 92% male with an average age of 41.5, and in terms of age composition, 22% of the sample population were in the 0–14 age bracket, 72% in the 15–64 age bracket (working age), and 6% in were in the 65+ age bracket. Only a small percentage of household heads were illiterate, with most having completed at least primary school level education. The average number of schooling years of household heads was 5.8, although on average the number of schooling years decreased as the age of the household head increased, and high income households had significantly more schooling (6.7 years) compared to households in the low—middle income quintiles (5–5.4 years, $p < 0.05$).

Cash savings, livestock, and household assets constituted the main household asset endowment. Relatively high cash savings were reported in all income quintiles (with no significant difference between income groups), with average savings of 3700 CNY reported. The mean reported value of livestock assets (mainly pigs, cattle, buffalo, some horses and mules) was 6113 CNY, although households in the higher income quintile had significantly higher livestock asset value than those in the lowest income category (7064 CNY compared to 3934 CNY, $p < 0.05$). The average household asset value was 6182 CNY, and included things like furniture, motorbikes, electrical equipment, farm tools, and machinery. Household asset value was strongly correlated with income, to the extent that household asset value in the highest income quintile was worth more than three times that of households in the lowest income quintile.

(b) *Income characteristics and poverty levels of the sample population*

The average annual per capita net cash income calculated in this study for 2007 was 2629 CNY (i.e., c.US$341), which is comparable to the official government income statistics for the county (presented in Figure 1). Thirteen percent of households reported crises or unexpected expenditures during the year. Of these, nearly half were related to crop failure (mostly moderate, with some severe cases), around 30% were related to illness and death, and the remaining 22% were related to the loss of livestock and other assets. The total income figures calculated in this study were 18% below the provincial average, and 36% below the national average for rural households (CNBS, 2008). Moreover, the total average income in this study was more than 80% less than the national average per capita income of urban households (CNBS, 2008), a clear demonstration of the income disparity between rural and urban China.

Although Tianlin's rural household income increased fourfold from 1995 to 2007 (Figure 1), the impressive increase

Table 1. *Quintile determination matrix*

Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Village 1 poorest 20%	etc.	etc.	etc.	Village 1 richest 20%
Village 2 poorest 20%				Village 2 richest 20%
Village 3 poorest 20%				Village 3 richest 20%
Village 4 poorest 20%				Village 4 richest 20%
Village 5 poorest 20%				Village 5 richest 20%
Village 6 poorest 20%				Village 6 richest 20%

was not unique, indeed all elements of the Chinese population experienced significant gains in average income in the previous 30 years (Luo & Zhu, 2008). Even with the fourfold increase in income, the county poverty rate in 2007—according to the official Chinese poverty measure at the time[2]—was 29% (Tianlin County Government, 2007); while the rate calculated for our sample population using our data was 24% (if subsistence income is included our calculated poverty rate is reduced to 4.5%). The official Chinese poverty measure at the time was one of the lowest national poverty line measures in the world, set at 785 CNY per person per year for 2007, or $0.57 per person per day in 2005 PPP dollars (World Bank, 2009). If the standard international poverty line of $1.25 a day was applied to our sample, the poverty rate would be c.47%.

It is due to these high levels of poverty that Tianlin County is categorized as a "State Designated Poor County", and was therefore targeted by central and provincial government poverty alleviation programs. Benefits from these targeted poverty alleviation programs included the construction of new roads, dams, electrification, improvements in education facilities, and communication infrastructure, as well as a focus on forest-based development projects. China's economic boom—which was concentrated in the eastern and coastal provinces—also led to some improvements in Tianlin via the "trickle down effect", with increasing opportunities to engage in the cash economy, expanding markets for agricultural and forestry products, increased off-farm income opportunities, and cash remittances from family members working as migrant laborers in the cities. According to our study, 75% of the sample households considered themselves better off at the time of the survey compared to their situation five years previously, with off-farm employment cited as being the main reason for their improved status, followed by higher prices for agricultural and forestry products.

(c) *Land "ownership" characteristics of the sample population*

The average household forest land in the sample population was 1.25 ha, while cropland was 0.63 ha. However, these aggregate figures mask the variation in household land allocations found between income quintiles, with higher income households having significantly larger allocations of both forest and crop land compared to lower income households ($p < 0.05$; Table 2). In theory, both forest and crop land should have been originally allocated to households in an egalitarian fashion based on household numbers, with larger households entitled to proportionally larger allocations (Lohmar & Somwaru, 2002). However, as previously reported in Section 4(a), households in the highest income quintile had significantly smaller household sizes than households in the lowest three income quintiles, hence they have disproportionately large land areas. In order to further demonstrate this inequality of land distribution, the per capita forest and crop land areas of each income quintile are presented in Table 2.

High income households had significantly higher absolute and relative forest land area per capita compared to low income households, with forest land ranging from 0.18 ha per capita in low income households (48.5% of total land area) up to 0.5 ha per capita in high income households (62.9% of total land area, $p < 0.05$). High income households also had

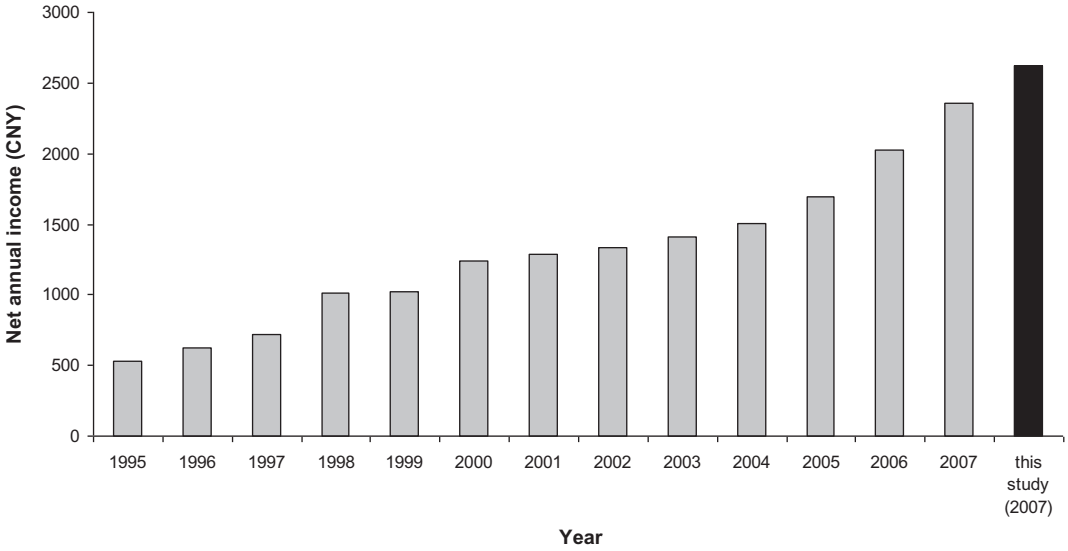

Figure 1. *Average annual net per capita income of Tianlinese farmer's from 1995 to 2007. Gray bars represent Tianlin Statistics Bureau data (Tianlin Statistics Bureau, 1995–2007) and the black bar represents the income calculated in this study for 2007. Mean conversion rate for the year covered by the survey is 7.7CNY:1USD.*

Table 2. *Land area "ownership" characteristics arranged by household income classes*

Land area variables	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	Mean	ANOVA *F* value
Mean forest land area per household (ha)	0.82[a]	0.92[a]	1.01[ab]	1.47[ab]	2.00[b]	1.25	5.18**
Mean forest land area per capita (ha)	0.18[a]	0.21[a]	0.21[a]	0.32[ab]	0.50[b]	0.29	6.41**
Mean% forest land area per household	48.5[a]	50.9[a]	50.0[a]	58.0[ab]	62.9[b]	54.1	2.48**
Forest land productivity (CNY per ha per capita)	1595.2[a]	1749.2[a]	2119.6[a]	1632.1[a]	1908.2[a]	1806.6	0.36
Mean crop land area per household (ha)	0.43[a]	0.60[ab]	0.65[ab]	0.69[b]	0.79[b]	0.63	2.65**
Mean crop land area per capita (ha)	0.09[a]	0.13[ab]	0.13[ab]	0.16[b]	0.19[b]	0.14	3.86**
Mean% crop land area per household	47.2[a]	45.6[a]	46.7[a]	39.0[ab]	34.5[b]	42.6	2.22*
Crop land productivity (CNY per ha per capita)	1614.8[a]	2044.6[ab]	2118.7[ab]	2236.2[ab]	2747.8[b]	2150.4	2.49**

One-way ANOVA *F*-test was used for all variables.
* Significant at the 10% level.
** Significant at the 5% level. For post hoc tests Dunnett's T3 test or Duncan's test was applied depending on the variable's homogeneity of variance. Means with the same superscripts are not significantly different from one another ($p < 0.05$). $N = 225$.

significantly higher average per capita crop land area compared to low income households (0.19 ha compared to 0.09 ha), but lower income households had a significantly higher proportion of their total land area as crop land (47.2% compared to 34.5%, $p < 0.05$). In terms of forest land productivity, there were no statistically significant differences between quintiles, although higher income households had significantly higher crop land productivity than lower income households ($p < 0.05$).

These results clearly show that household forest and crop land distribution is not egalitarian in this study sample, with benefits (financial and non-financial) being captured by the better-off segments of the population. This may, however, not just be another case of elite capture, as it is feasible that households with more land (for whatever reason) only recently became better-off as a result of targeted poverty alleviation programs. We do not have sufficient data to determine the causality, but it is an important question with respect to the role of small-scale forestry in poverty alleviation. Regardless, this case illustrates the importance of land resources (and what is produced on them) in rural livelihoods, and points to potential opportunities for increasing the benefits for those low income households that are missing out.

Furthermore, it is possible that households engaged in substantial off-farm income earning activities were able to use accumulated capital to legally (or illegally) acquire more land (in addition to their administrative allocation) via land-right transfers between households (Orlik & Rozelle, 2008) or by purchasing long-term utilization and management rights of additional land in wasteland auctions (Lu, Landell-Mills, Liu, Xu, & Liu, 2002). The inequality of household land areas revealed in these results could also be related to any number of complexities and irregularities related to the land allocation procedures, such as the difficult procedure of updating land allocations to match the constantly changing household demographics; an especially difficult task for forest land because of the long term nature of the land contracts and the associated investments (Gutiérrez Rodríguez *et al.*, 2012; Lohmar & Somwaru, 2002). Getting a definitive explanation for this inequitable household land area discrepancy is, however, beyond the scope of the data collected for this study.

(d) *Household income sources*

The average income contributions from different sources and the percentage of the sample engaged in the related income activities are presented in Figure 2. Crop and forest-related income were clearly the most important sources, together contributing c.70% to total income. Business, livestock, and wage contribute c.9% each to total income, followed by other income (c.5%), with fish and non-forest environmental income being the least important (c.1.5%). Forest-related income was the second most important income source (31.5%) after crop income (36%), and the most important source of cash income (21.5%), worth more than the combined contribution of crop and livestock income (i.e., agricultural cash income). Income from on-farm sources (crop, forest, and livestock) made up c.75% of total household income, and importantly, almost all sample households were engaged in these income earning activities (97–99%), while far fewer households were engaged in off-farm income earning activities (23–67%; Figure 2).

Figure 3 shows how the absolute contribution of cash and subsistence income from different sources varies with income levels. Almost 90% of the lowest income household's total income was derived from on-farm sources (mostly crop and forest-related), and over half their total income was subsistence derived. Higher income households, on the other hand, had more diverse and balanced income portfolios, with only c.60% of their total income derived from on-farm sources, and more than 75% of their total income in cash. These high proportions of off-farm income and cash are key factors differentiating the high from low income households in this study. Such results are consistent with findings in other parts of China whereby middle and high income farmers tend to maximize off-farm income earning opportunities, while low-income farmers tend to be limited to traditional on-farm enterprises (Haggblade, Hazell, & Reardon, 2002; Lanjouw & Feder, 2001; Ruíz-Pérez, Belcher, Fu, & Yang, 2004).

(e) *The contribution of forest-related income to household economies*

The average total forest-related income share reported in Figure 2 (31.5%) is lower than the 40.7% average recently reported by Gutierrez Rodriguez *et al.* (2009) in a similar study, higher than the 10–20% average recently reported by Katsigris *et al.* (2010), and very high compared to the 2007 national average of 1.4% for rural Chinese households (China National Bureau of Statistics (CNBS), 2008). These studies, however, used different methods of data collection, different definitions, and different calculations of forest income than this study, and are therefore only roughly comparable.

Figure 3 demonstrates how the contribution of forest-related cash and subsistence income compares to other income sources broken into income quintiles. Forest-related income is the second most important income source after crop income in all but the highest quintile, in which forest-related

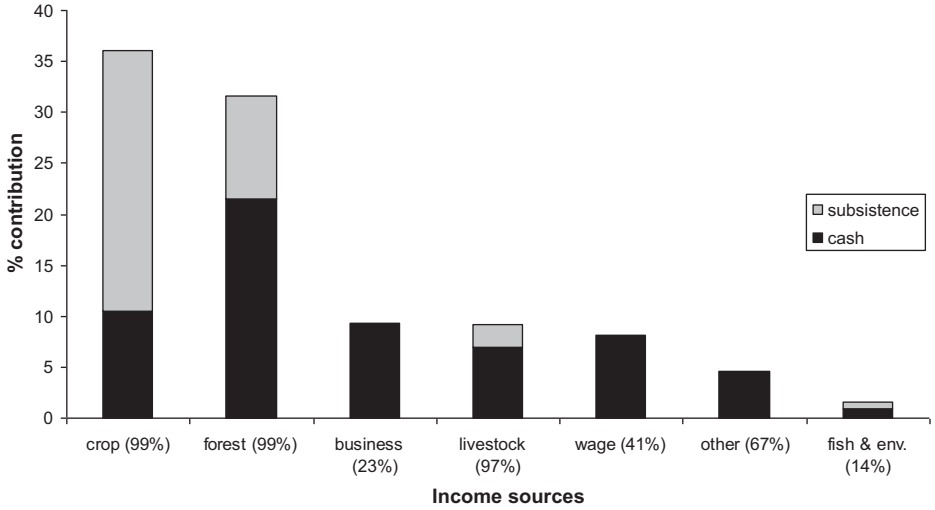

Figure 2. *Mean annual per-capita income percentage contribution by source. N = 225. The figure in brackets next to the income source on the X-axis represents the percentage of the sample households that gained income from that source.*

income is the most important. The cash component of forest-related income is significantly higher than the cash component of crop income in all quintiles, and is the single most important source of cash in the bottom three income quintiles. In contrast to crop income, the cash contribution of forest-related income is significantly higher than the subsistence contribution in all quintiles. Crop subsistence income is much more important than forest subsistence income, and is a major source of household income and food security for households at all income levels (it is especially important for households in the low to middle income quintiles that have negligible income from other sources). Crop subsistence income contributes an average of c.24% to total income and c.66% to total subsistence income, whereas forest subsistence income contributes c.10% to total income and c.25% to total subsistence income. This frequently uncounted contribution of forest subsistence income to household livelihoods (the "hidden harvest") has been demonstrated to be of much greater importance in other case studies where natural forests are more prominent than in this study site (e.g., Cavendish, 2000; Vedeld *et al*., 2004). In fact, less than 5% of forest-related income in this study came from natural forests, with the majority being derived from cultivated non-timber forest products.

Figure 4 presents a breakdown of the five most important sources of forest-related income according to income quintiles, which highlights the specificity of forest-related income sources in the region.

Cash income from the cultivation and sale of bamboo shoots (*Dendrocalamus latiflorus*) was the main source of forest-related income for households in all income quintiles, with over 60% of households engaged in the activity. Bamboo was also an important subsistence product, with the shoots contributing to household diets and food security, and the culms used for a wide range of utilitarian applications (e.g., baskets, cooking utensils), construction material (for houses, furniture, fences, and cages) and as fuel (see Hogarth & Belcher, 2013, for a detailed analysis of the specific role of bamboo in the sample population's livelihoods). The second most valuable forest-related income (and the most valuable subsistence forest income) came from tea oil that is extracted from the seeds of *Camellia oleifera*. Tea oil trees are cultivated by 57% of households, and the home-processed oil is used primarily for subsistence purposes as cooking oil across all quintile groups, with a small proportion also sold for cash.

Firewood, collected as dead or fallen branches from timber plantations or natural forest, was the third most important source of forest-related income, and the second most valuable subsistence forest product. Firewood was used by 82% of households almost equally across all income groups. Tung oil seeds were the next most important source of forest-related income, and were harvested annually from the cultivated Tung tree (*Vernicia fordii,* syn. *Aleurites fordii* Hemsl.), and sold to a local factory that produced tung oil for use in various products including varnishes, resins, inks, paints, and coatings. Although households in all income quintiles were involved, the production of tung oil seeds was a relatively specialized enterprise, with only c.40% of households engaged. Payments for Forest Services (PFS) were the third most important source of forest-related cash income, with 57% of households receiving cash payments from government programs such as the CCFGP and related programs. The "other" forest-related income came from timber and charcoal, wild harvested mushrooms, medicinal plants and fodder, which all contributed about 2% each or less to total cash income, with only a small percentage of specialized households involved.

Figure 5 presents some detail about the absolute and relative contributions of forest-related income to households in different income quintiles. These results are typical of the commonly reported trend whereby higher income households use greater amounts of forest products (and have higher absolute forest income) than lower income households, which have lower absolute forest income but a higher relative forest income (as a proportion of their total income; Byron & Arnold, 1999; Campbell & Luckert, 2002; Cavendish, 2000; Tieguhong & Nkamgnia, 2012; Vedeld, Angelsen, Bojö, Sjaastad, & Berg, 2007; Yemiru *et al*., 2010). This is because higher income households have high levels of cash income from other sources (especially off-farm sources), while lower income households have fewer income sources (see Figure 3), thus making their forest income proportionally more important. Despite significant differences between quintile groups in absolute forest subsistence income, there are no statistical differences in the relative contributions of forest subsistence income to total subsistence income between quintiles.

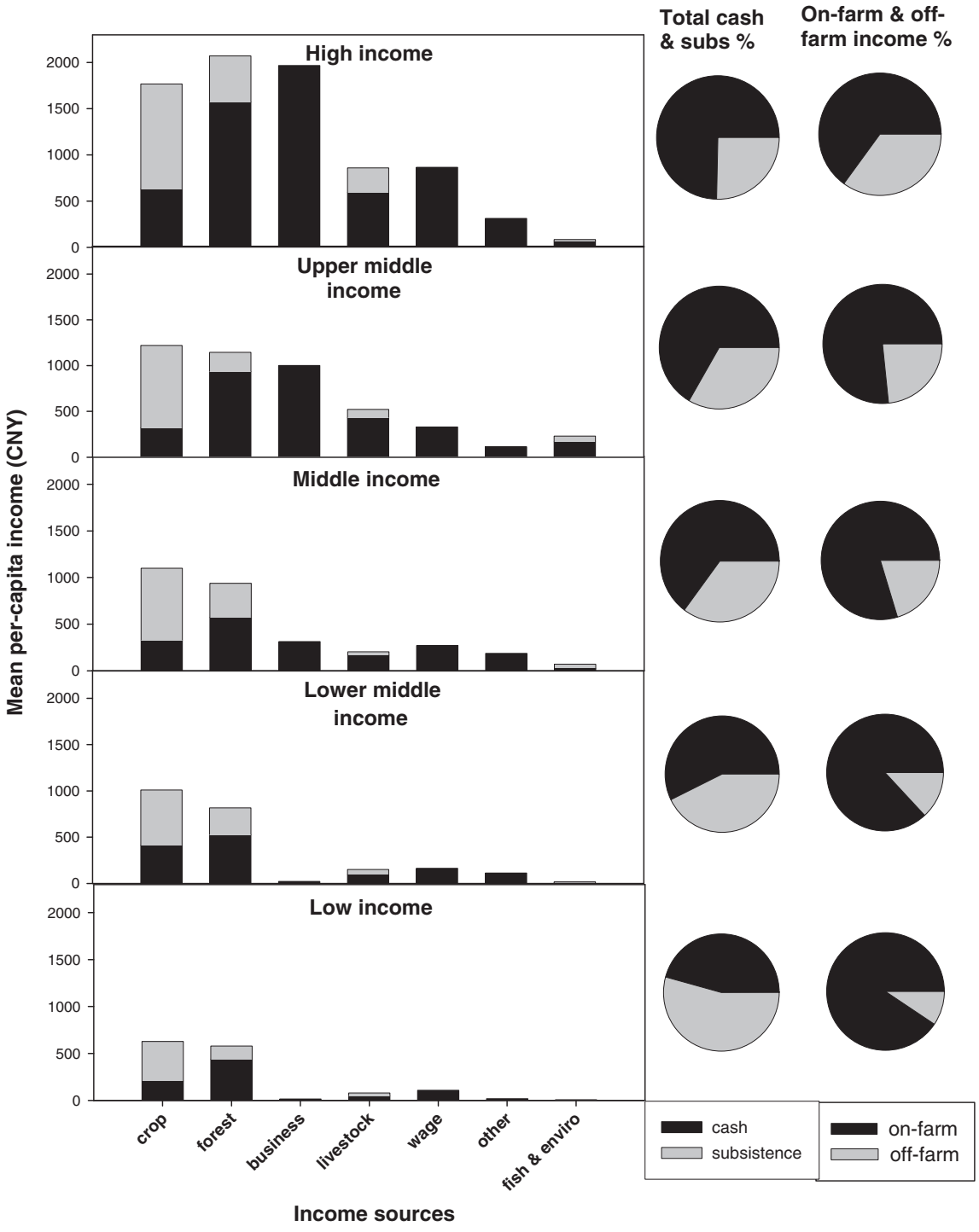

Figure 3. *Contribution of cash and subsistence income to total household income differentiated by sources according to income quintiles. N = 225. Mean conversion rate for the year covered by the survey is 7.7CNY:1USD.*

Many of the case studies that focus on forest and environmental income from natural forests suggest that forest products play a role in filling seasonal income gaps and as safety nets in times of crises (Byron & Arnold, 1999; Fisher & Shively, 2005; McSweeney, 2004; Pattanayak & Sills, 2001; Paumgarten, 2005; Shackleton *et al.*, 2007; Sunderlin *et al.*, 2005), however neither was the case in this study. This is because most of the forest-related income is derived from cultivated non-timber forest products that have annual harvest cycles that coincide with the seasonal agricultural harvest (i.e., bamboo shoots, tea, and tung oil seeds). Some of the key forest products such as bamboo shoots did, however, contribute to income smoothing due to a time lag between the harvesting and selling of the end product (due to a long processing time that involves fermentation and drying). In terms of a safety net function in times of crises, "*doing nothing*' or '*getting assistance from friends and relatives*" were cited as being the most important coping strategies during the

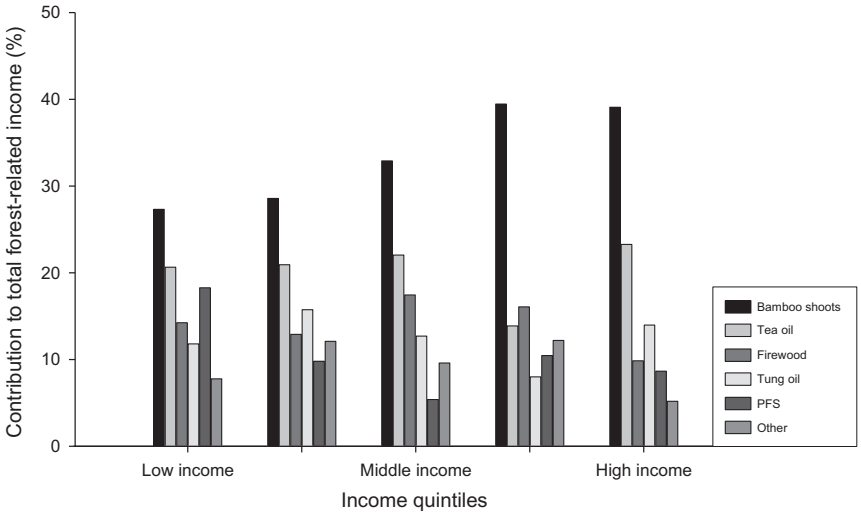

Figure 4. *Contribution of forest-related income sources to total forest income according to income quintiles. N = 225. PFS = Payments for Forest Services.*

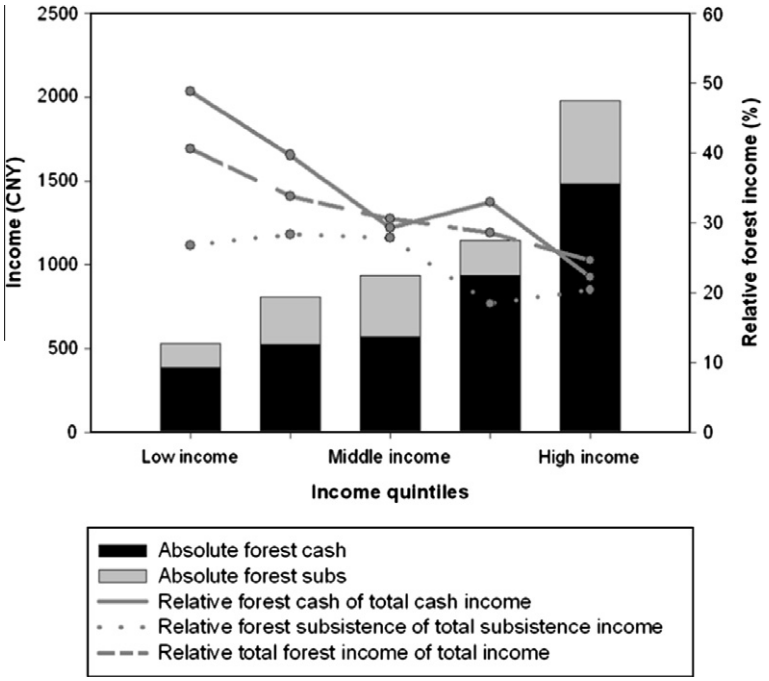

Figure 5. *Absolute and relative forest cash and subsistence income arranged by income classes. N = 225. Mean conversion rate for the year covered by the survey is 7.7CNY:1USD.*

fieldwork period, with no households citing forest-based coping strategies.

(f) *Socioeconomic determinants of forest-related income and poverty*

We used regression analyses to assess which socioeconomic factors had greatest influence on per capita income (as a proxy for wealth status) and forest-related income (Table 3). Forest and crop land area both had significant positive relationships with total income at the 5% level, while the age of the household head had a significant negative relationship at the 5% level. Forest land area unsurprisingly had a significant, positive relationship with forest-related income at the 5% level, while crop land area had a significant negative relationship with forest-related income at the 10% level. This negative relationship between crop land and forest-related income is largely attributable to a degree of specialization among some households that focus their energy and resources on crop production at the expense of forestry activities and visa versa. Furthermore, this relationship is influenced by 17% of the sample households involved in the bamboo-migrant project that have relatively small (and lesser quality) crop land areas and high forest-related income. Livestock assets had a significant, positive relationship with forest-related income at the 5% level, indicating that high forest-income households may be investing proceeds into livestock. These results show very clearly that household allocations of forest and crop land are key

Table 3. *WLS Regression results of socioeconomic factors on total per capita income and total per capita forest income*

	Coefficient	Standard error	*t*	Sig.	
Total income					
Constant	2.489	1.586	1.570	0.118	$N = 219$
Forest land area per capita	2.724	0.356	7.655	0.000	$F = 18.403$
Crop land area per capita	4.292	1.099	3.905	0.000	Prob > $F = 0.000$
Livestock assets	−0.005	0.024	−0.225	0.822	$R^2 = 0.342$ adjusted
Age of household head	−0.657	0.199	−3.305	0.001	$R^2 = 0.324$
Education level of household head	−0.015	0.110	−0.137	0.891	
Crop land area productivity	0.020	0.039	0.521	0.603	
Total forest income					
Constant	2.601	3.599	0.723	0.471	$N = 219$
Forest land area per capita	5.774	0.825	6.998	0.000	$F = 7.462$
Crop land area per capita	−4.206	2.491	−1.688	0.093	Prob > $F = 0.000$
Livestock assets	0.179	0.053	3.380	0.001	$R^2 = 0.221$ adjusted
Age of household head	−0.133	0.461	−0.290	0.772	$R^2 = 0.192$
Education level of household head	0.084	0.248	0.339	0.735	
Business income	−5.523E−5	0.000	−1.463	0.145	
Wage income	−0.014	0.034	−0.394	0.694	
Crop land area productivity	0.090	0.089	1.014	0.312	

Weighted by value of household assets. Data is log transformed.

determinants of total income in this relatively remote, mountainous, and under-developed study site that has limited off-farm income opportunities.

(g) *Policy factors influencing forest-related income contributions*

Forest-related income in this study sample is characterized by having the majority of both cash and subsistence income coming from cultivated non-timber forest products, with only very minor contributions from timber production and natural forests. As previously mentioned, the lack of timber and other wild-harvested products from natural forests is due to a lack of accessible natural forest in the study site, and not to restrictive forest protection policies such as the Natural Forest Protection Program (Guangxi is one of the few provinces in China that is not affected by it; Liu, Li, Ouyang, Tam, & Chen, 2008).

There are a range of polices and regulations at both the national and local level that simultaneously discourage household engagement in the timber sector, while encouraging engagement in the economic forest sector. When given the option, smallholders throughout China generally prefer to plant economic forest and bamboo on their designated forest land because they are considered more profitable than conventional timber plantations (Ruíz-Pérez *et al.*, 2004; Zhang, 2000). This is certainly the case in Tianlin, despite the strong domestic demand (White, Sun, Canby, Xu, & Barr, 2006) and good growing conditions for various timber species. Consequently most of the significant timber production in Tianlin comes from large scale state-owned forest farms. Cultivating economic forest products is relatively more attractive to the rural poor compared to timber due to the low barriers to entry, less policy constraints and regulations, and the ability to generate annual income from their limited forest land (unlike the long harvest cycle for timber trees). The long term investment in timber is still considered by many farmers to be risky due to ongoing land tenure insecurity issues (Jacoby, Gui, & Rozelle, 2002). There are also high taxes and fees, restrictive cutting permits, strict quotas, and expensive transport permits imposed on privately-owned plantation timber (Hyde, Belcher, & Xu, 2003), making smallholder engagement uneconomical or encouraging black market trade. Furthermore, it has been suggested that timber companies and/or the government maintain artificially low purchase prices (Liu, 2005), further discouraging smallholder engagement in the sector. A number of studies have recommended changes to these policies and regulations to allow forestry to better contribute to poverty alleviation (Katsigris *et al.*, 2010; Li, 2004; Liu, 2005).

At the same time there are both national and local level policies and factors that encourage household engagement in the cultivation of economic forest products. At the national level, the government has actively encouraged the inclusion of non-timber forest species as part of the CCFGP. The CCFGP has had significant influence on rural livelihoods and forestry activities nation-wide, and was considered an attractive program by most farmers and the local government in our study area. While there are a wide range of often contradictory assessments regarding the impact of the program on household income (due to the environmental and socioeconomic variation in the program sites studied), participation in the program has generally resulted in a positive impact on livelihoods (ADB, 2003; Katsigris *et al.*, 2010; Li, 2004; Liu, 2005). Furthermore, when rural households convert their cropland, they free-up labor that can be used in the off-farm sector or elsewhere. In addition to cash payments, households participating in the CCFGP are entitled to retain all the profits derived from the harvest and sale from what they planted (depending on their individual contract arrangement). In this study 17% of households reported timber species as being the primary crop grown on their forest land, but only 1% of households reported any timber income (mainly because timber trees planted as part of the CCFGP had not reached harvest age at the time of the study). So despite the discouraging policies related to the timber sector, there is potential for more timber related income in the future for those who planted timber trees on their land involved in the program.

At the county level, the previously mentioned bamboo-based poverty alleviation project brought significant government and private investment to Tianlin's bamboo sector, which facilitated the expansion of an already well-established bamboo industry (see Hogarth, in press, for a detailed study related to this bamboo-based poverty alleviation project).

The bamboo shoot production from the two sample villages involved in this project—combined with the significant production from other sample villages not involved in the project—accounts for bamboo's prominence as the main source of forest cash, and its importance in total income. Although timber-oriented forest types still occupy the largest share of China's forest land, economic forest and bamboo plantations have been expanding at much faster rates (FAO, 2010a; Mertens *et al*., 2008), thriving under the prevailing policy and economic conditions. This trend toward more economic forests and bamboo has also caused changes in the structure of rural markets, and has provided farmers good opportunities to increase their income and reduce poverty (Lei, 1999; Ruiz-Pérez, Fu, Belcher, & Yang, 2000).

5. CONCLUSIONS

Although Tianlin has benefited from targeted poverty alleviation programs and the "trickle down effect" from the economic boom, this study clearly shows that many households were left behind. A large proportion of households in this study were living below the poverty line, and in many ways are representative of the persistent poor that the central government's targeted poverty alleviation programs are trying to reach. Some author's criticize the central government's targeted poverty alleviation programs, saying they are not targeted enough, that many of the benefits of investments in target villages are not reaching those who need them most (i.e., the poorest within the villages), and that further gains from such area-based targeting cannot be made (Katsigris *et al*., 2010; World Bank, 2009). The results in this study support these concerns somewhat, for although the causality is not clear; the group of higher income households was clearly dominating the off-farm opportunities almost to the complete exclusion of the lower income households, while at the same time they also dominated the trade in forest and crop production due to their disproportionately high land areas. Poverty alleviation targeting based on household-level criteria could potentially discourage elite capture of land resources, and avoid different levels of engagement in off-farm activities that can lead to problematic within-village inequality (Benjamin, Brandt, & Giles, 2004), while at the same time directing benefits to low income households such as those identified in this study.

Off-farm income has played a key role in China's falling poverty rates (De Janvry, Sadoulet, & Zhu, 2005; World Bank, 2009), and is widely perceived as the main route out of poverty in China's forest regions and rural areas generally (Haggblade *et al*., 2002; Lanjouw & Feder, 2001). In this study, however, only high income households received any significant benefit from off-farm income, whereas the majority of households across all income levels derived significant benefits from forest-related income. Therefore, we believe that forest-related enterprises can and will continue to play an important role in household livelihoods and poverty alleviation for some time to come (especially in remote mountainous areas such as this study site, where off-farm income opportunities are limited). In terms of improving household livelihoods and alleviating poverty in the study site, enhancing off-farm employment opportunities for lower income households should certainly be encouraged as part of an overall strategy, but we would suggest that efforts should also focus on improving the income of the traditional income base of agriculture and forestry enterprises.

Based on our results, it is clear that access to more land would significantly improve the income and livelihoods of the lower income households identified in this study. We do not, however, advocate another redistribution of land (especially without knowing how the current, unequal distribution occurred), but we do suggest that targeted poverty alleviation strategies should aim to improve land access for households below the poverty line, or at least ensure that they are getting their fair entitlement of forest and crop land as the original egalitarian theory intended. Alternatively, there are examples of compensation schemes in China whereby households with disproportionately large per capita forest land areas (due to a decrease in household members) compensate households with smaller per capita endowments due to expanding household size (Gutiérrez Rodríguez *et al*., 2012). This scheme resulted in a significant increase in land productivity, and proved to be an effective instrument to fairly deal with unequal land allocations without resorting to potentially unsustainable forest land reallocations (Gutiérrez Rodríguez *et al*., 2012).

We suggest that there is substantial potential to improve household income and livelihoods using the current household land holdings through things like increasing productivity, prevention of post-harvest losses, and improved market effectiveness for their cultivated non-timber forest products. For example, some recent research conducted in Tianlin demonstrated that basic improvements in smallholder bamboo management practices could potentially more than double the average bamboo productivity and the household's associated income (Hogarth, in press). Such improvements in productivity may well apply to other non-timber forest crops, and also to crops and livestock, but further investigation is needed. Finally, we echo other author's suggestion that policy changes are needed to encourage more smallholder investment in longer-term and higher value timber crops. Such measures would not only increase the domestic production of timber that is so desperately needed, but would also create new opportunities to diversify farm income and free up labor for other income earning activities.

NOTES

1. Five hundred and ninety-two counties throughout China were identified by the government as being "poor", and became the subject of area-based poverty alleviation targeting in an effort to reduce inequality and persistent poverty.

2. At the end of 2011 China redefined the level at which people in rural areas are considered poor to include everyone earning less than US$1 a day. While the revised poverty line is still below the standard international poverty line of $1.25 a day, the change brings China's official poverty statistics much closer to international standards.

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