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EXECUTIVE SUMMARY

Forest products play an important role in supporting rural livelihoods and food security in many developing countries. Pimentel et al. (1997) found that the integrity of forests is vital to world food security, mostly because of the dependence of the poor on forest resources. Studies of the role of forest products in household welfare in Zambia have found that such products are among the top sources of household income in some rural areas. This paper uses statistical analysis to examine the role of non-timber forest products (NTFPs) in rural household welfare in Zambia, with two main objectives. First, using rural household survey data, we estimate the share of NTFP income to total household income with the aim of assessing the proportion and distribution of business activities related to NTFPs. Second, we estimate the determinants of rural household participation in the extraction and trade of NTFPs, with an interest in the characteristics of households that are more dependent on forest products for income.

This analysis is based on data that were collected in the supplemental survey of the 1999/00 Post-Harvest Survey (PHS) of small and medium scale rural holdings, conducted by the Central Statistical Office (CSO) and Food Security Research Project (FSRP) in 2008. The sampling frame of primary sampling units, or Standard Enumeration Areas (SEAs), was constructed using the results from the 2000 Census of Population and Housing. The sampling frame included all rural SEAs. A sample of 410 SEAs was drawn from a total of 12,789 SEAs from the sampling frame, with the 2000 census of population and housing used as a base. The household was the second stage-sampling unit. Twenty (20) households were sampled from each Sample SEA using systematic random sampling. The total sample size was 8,200. However, due to non-responses, data were collected from 8,094 households. In addition to the agricultural data, the 2008 supplemental PHS collected data on household business activities related to NTFPs, which included the type of NTFPs sold and their respective gross sales value. Data on income from business activities related to NTFPs were used to estimate the contribution of NTFPs to total household income.

Results show that among NTFPs, charcoal/firewood is the most common source of income, with 65% of households engaged in NTFP business activities having reported income from charcoal/firewood production or sale. Following charcoal/firewood were ants/caterpillars, wild honey and mushrooms. Income from charcoal/firewood activities also represented the highest share of income (37%), followed by ants/caterpillars (19%), wild honey (12%), and mushrooms (8%). Overall, NTFPs collectively contribute about 34% to total household income amongst those households that reported income from this source. Results also revealed that households in Luapula, Northwestern, and Western Provinces were more likely to participate in NTFPs than their counterparts in other provinces, suggesting that NTFPs are important in the latter three provinces. In order to determine the relationship between poverty and dependence upon NTFPs, we categorized households into four income quartiles according to total household income. The results showed that the wealthiest (top 25%) households earned about 10 times more income in absolute terms from NTFPs than the poorest (bottom 25%). However, in terms of their contribution to household income, NTFPs constitute a higher proportion of household income for the poorest quartile (45%, compared to 29% for the richest quartile), suggesting that the rural poor are relatively more dependent upon natural resources for their livelihoods.

We used the Cragg Tobit alternative model to examine the probability of a household to derive income from NTFP business activities, and determinants of the level of contribution of

NTFPs to household income in Zambia. The results indicated that an increase in age and education level reduces the likelihood of a household to participate in NTFPs and level of NTFPs' contribution to household income. Younger household heads have the physical capacity to engage in strenuous activities involved in NTFPs extraction and trade, while education increases meaningful employment opportunities and thus, reduces the likelihood to engage in NTFPs. Households with a male household head were found to be more likely to participate in NTFP business activities. The value of assets owned by a household was found to be negatively associated with participation in NTFPs business activities, which is consistent with the notion that poor households rely more natural resources such as NTFPs than the wealthy. Square of landholding size was negatively associated with probability of NTFP participation, but positively associated with extent of NTFPs' contribution to household income (only for participating households), suggesting that further increase in landholdings lead to reduced participation, but increases NTFPs' contribution. This has implications for both national development and natural resources policies, such as measures related to land access, forest conservation, and energy. In rural areas, non-farm income is increasing in importance for household welfare, and growth in non-forest livelihood opportunities could help to reduce pressure on forests.

As expected, distance to district town (proxy for market access) was negatively and significantly related with both participation in NTFPs and the level of NTFPs' contribution to household income, implying that an increase in distance to market reduces likelihood to participation in NTFPs and contribution of NTFPs to total household income. Thus, access to markets is an important determinant of households' participation in NTFPs. Another important finding of this study is that an increase in population density is associated with higher likelihood to participate in NTFPs, presumably due to increased market for NTFPs. However, increasing population density is associated with lower contribution of NTFPs to household income, probably because more households extract NTFPs exerting more pressure on forests leading to scarcity of NTFPs. Also, high population density could lead to more forest land being cleared for settlement and agriculture leading to limited availability of NTFPs. We also found that differences in location, in terms of provinces, are important in explaining a household's participation in NTFPs and contribution of NTFPs to household income presumably because of greater forest cover in some provinces, and easier access to forests by households in some provinces.

Given the widespread demand for woodfuel and other forest products, it is likely that rural households will continue to engage in the extraction and trade of NTFPs as a business activity. It is, therefore, crucial that forest conservation policies take into account the central role NTFPs play in the livelihoods of the rural poor. Generally the extraction of NTFPs may have negligible ecological impacts with the exception of charcoal/firewood, which is sometimes associated with the clearing of land for agriculture by felling trees. Other NTFPs such as ants, caterpillars, wild honey, and mushrooms are collected and sold for consumption as food and have the potential to contribute substantially to household income. Flanked by appropriate interventions to ensure sustainability of forest resources, these other NTFPs can help reduce household reliance on charcoal as an income source and can support forest conservation objectives. It is important that poverty alleviation strategies recognize the extent of household participation in NTFP business activities and the important contribution of NTFPs to overall household welfare and income diversification.

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ACRONYMS

APE	Average Partial Effects
CAPE	Conditional Average Partial Effects
CIFOR	Centre for International Forest Research
CSO	Central Statistical Office
FSRP	Food Security Research Project
GRZ	Government of the Republic of Zambia
MENR	Ministry of Environment and Natural Resources
MTENR	Ministry of Tourism Environment and Natural Resources
NTFP	Non Timber Forest Products
PHS	Post Harvest Survey
PPS	Probability Proportional to Size
SEA	Standard Enumeration Area
UAPE	Unconditional Average Partial Effects
UNDP	United Nations Development Programme
USD	United States Dollar
ZMK	Zambian Kwacha

1. INTRODUCTION

In most parts of Sub-Saharan Africa, forests are considered important for rural livelihoods, as sources of food, medicine, shelter, building materials, fuels, and cash income. It is estimated that more than 15 million people in Sub-Saharan Africa earn their income from forest-related enterprises such as fuelwood and charcoal sales, small-scale saw-milling, commercial hunting, and handicraft production (Kaimowitz 2003). Forest products play an important role in supporting rural livelihoods and food security in many developing countries. Pimentel et al. (1997) found that the integrity of forests is vital to world food security, mostly because of the dependence of the poor on forest resources. In assessing the role of forests and non-timber forest products in the food system of developing countries, the authors categorized forest uses into groups, including food, fuel, shelter, erosion control, and water conservation. They assessed the total amount of foods produced from trees, the wild foods gathered, and animals hunted from forests, and the forest resources used in generating non-farm income and wage employment and estimated that between 60 and 70% of the population in developing countries live and work near forested areas. Many households subsist in part by collecting leaves, roots, fruits and nuts from trees and other wild plants, and by hunting wild animals, fish, and insects for consumption. Many people living in and around forest reserves harvest a range of products from forests for sale, trade, or barter, such as wood for timber, fuelwood, roof thatching materials, construction poles, honey, mushroom, caterpillars, and medicinal plants. Approximately 300 million people worldwide earn part or all of the living from harvesting food and other products from tropical forests for income generation.

Around the time of political independence in 1964, Zambia was endowed with an abundant forest resource base. However, deforestation and forest degradation remain among the most pressing environmental problems in the country, along with soil erosion and the loss of biodiversity. Population growth, economic decline, and widespread poverty have led to increased pressure on forest resources. About 34% of urban households live in poverty; approximately 80% of the rural population is poor; and 67% is extremely poor (CSO 2006). The rapidly growing urban population has led to increased demand for charcoal as a cooking fuel. Such developments resulted in escalating rates of deforestation and coupled with the inadequacy of the Forest Policy (up to 1998), are some of the major contributing factors to the degradation of the forest ecosystem (Chidumayo 2001).

Although about 66% of Zambia's land area is under some form of forest cover (Chendauka 2009), evidence of continuing deforestation is common in certain regions. Such trends compelled the Government of the Republic of Zambia (GRZ) to institute measures to invigorate the integrity of the forest estate and provide for a viable policy and legal framework for forest management. New wildlife and forestry laws enacted in 1998 and 1999 were intended to strengthen the management of natural resources and the environment. The Forest Act of 1999 conferred the responsibility of controlling and managing the forests and forest reserves on the Forest Department, under the Ministry of Tourism, Environment, and Natural Resources. These policies were meant to attract investment, create responsive corporate and public enterprises, redefine forestland ownership, and guarantee meaningful commitment from stakeholders to tree growing, protection and utilization of forest products as a means of livelihood for local communities.

There have been few studies of the role of forest products in household welfare in Zambia. Jumbe, Bwalya, and Husselman (2007) estimated the joint contribution of forest products to total household income at 20.6%, ranking between the top two sources of income in five of the eight sites studied in Central, Copperbelt, and Northern Provinces of Zambia. Bwalya

(2004) found that forest products contribute about 29.6% to total household income in Luapula, Central, and Eastern Provinces. Puustjarvy, Mickels-Kokwe, and Chakanga (2005) reported a contribution from forest products to total household income of about 50% in Luapula and Northwestern Provinces of Zambia. These studies provide useful information on the contribution of forest product to rural livelihoods. NTFPs are particularly important in support of poor households because of inexpensive extraction technology and ease of access (Jimoh 2006; Adhikari, Di Falco, and Lovett 2004; Fisher 2004).

This paper uses statistical analysis to examine the role of non-timber forest products (NTFPs) in rural household welfare in Zambia, with two main objectives. First, using rural household survey data, we estimate the share of NTFP income to total household income with the aim of assessing the proportion and distribution of business activities related to NTFPs. Second, we estimate the determinants of rural household participation in the extraction and trade of NTFPs, with an interest in the characteristics of households that are more dependent on forest products for income. Understanding the determinants of households' participation in NTFP business activities is important for designing interventions aimed at increasing incomes of those that depend on NTFPs and for designing sustainable forest management systems. The paper provides benchmark information against which appropriate forest conservation measures, food security policies, and rural development strategies can be based. This paper focuses on NTFPs not only because they are commonly extracted throughout the country, but also their exploitation is generally less ecologically destructive than timber production and, therefore, provides a sounder basis for sustainable forest management.

2. NON-TIMBER FOREST PRODUCTS

Non-timber forest products include numerous forest extracts such bark, roots, tubers, leaves, fruits, flowers, seeds, resins, honey, mushrooms, and firewood (Sunderland, Besong, and Ayeni 2003). They are collected from a wide range of ecosystems such as high forests, farm fallow and farmland, and they are widely used in a variety of ways for subsistence livelihoods, including food, medicine and bartering. Neumann and Hirsch (2000) define NTFPs as the biological materials (other than industrial round wood and derived sawn timber, wood chips, wood based panels and pulp) that may be extracted from natural ecosystems and be utilized within the household, be marketed, or have social cultural or religious significance. Jimoh (2006) extended this definition by including ecosystem services such as water purification and prevention of soil erosion. In this paper, such services are not considered.

Forest products have been identified as a source of livelihood mainly for rural households (Jumbe, Bwalya, and Husselman 2007; Jimoh 2006; Shackleton and Shackleton, 2006; Fisher 2004). Although the timber industry is often discussed in the context of its contribution to both national and local economies, but NTFPs receive little notice from social scientists and development planners (Jimoh 2006), perhaps because of the small scale and dispersed nature of extractive activities. Chikamai and Tchatat (2004) note that most non-wood forest products in Sub-Saharan Africa provide both social and economic benefits to the livelihoods of rural communities. At the subsistence level, these products normally address livelihood strategies like secure provision of food, health care needs, and concerns to reduce risk factors.

Extraction of NTFPs is mostly undertaken by poor households, as it is labor-intensive and the returns are relatively low. In Zambia there is little information on the contribution of NTFPs to rural household income nationally in terms of own consumption and sales value. Jumbe, Bwalya, and Husselman (2007) estimated that forests contribute about 20.6% of rural household income in Central, Copperbelt, and Northern Provinces, and Mutamba (2008) reported a 50% contribution of forests to household income in Kabompo and Mufulira Districts. It was also noted that most poor households engaged in NTFPs mainly because NTFP exploitation requires less capital than timber activities. Mutamba (2008) also reported that barriers to entry and market access discourage most households from engaging in timber extraction, despite its high returns. Thus, only those who are well connected to markets (usually wealthier households or those from urban areas) engage in business activities related to timber.

Still, NTFPs remain an important source of income for the rural poor throughout the developing world, especially in Sub-Saharan Africa. In a study of household use of natural resources in the Kat River Valley of South Africa, Shackleton and Shackleton (2006) note that NTFPs share of total household income was about 20%. The study revealed that households purchased significantly more NTFPs as wealth increased, and a greater proportion of wealthy households did so. On the other hand, a greater proportion of poor households were involved in the sale of one or more NTFPs, and they sold greater quantities and volumes per household, as compared to wealthy households. Detailed examination of use and value of four NTFPs (woodfuel, wild fruits, edible herbs, and grass) revealed that in all instances, the poorest households used more of the resource per capita than the other wealth classes. Even if absolute amounts used were similar between poor and rich households, the income derived from NTFPs by poor households makes a greater contribution to their welfare because it represents a higher proportion of income, relative to wealthier households. Wealthy households typically have a greater number of income streams, thus NTFPs represent a

lower, but still important, proportion of total livelihood income. This is a clear indication that the poor tend to rely more on NTFPs than wealthier households.

Shackleton and Shackleton (2003) reported that *ad hoc* trade in NTFPs is a common safety net for rural households in South Africa and other African countries (for example, as a fallback for income in the off season or during periods of weak crop yields), which in some instances becomes a permanent source of livelihood. Although the cash incomes from NTFP trade are small, they provide an important contribution that complements the diverse livelihood strategies within a household, especially for the poorer sectors of rural society.

In developing countries, most of the rural households and a large proportion of urban households depend on NTFPs to meet some parts of their nutritional, health, and raw material needs, and for income from selling these products in local markets. In some cases, NTFPs are the only source of income for local communities (Wollenberg and Septiani 1998), and they form an integral part of the rural economy. Muino (2009) observed that non-wood forest products are an important source of livelihood for rural communities in Mozambique especially during times of economic, social, or bio-physical shocks.

Jimoh (2006) reported that in Nigeria's rural areas, NTFPs contribute significantly to household income and food security and thus, play an important role in poverty reduction. He noted that income from sale of forest products constitutes a substantial amount of total household income in Nigeria. Most households in rural areas of developing countries obtain wild fruits, vegetables, and edible insects from the forests for household consumption and/or commercial purpose. In Zambia, a wide range of wild foods (e.g., fruits, tubers, mushrooms, honey, and caterpillars) is common in rural diets and they provide income through sales. In a study of the contribution of NTFPs to livelihoods in Vietnam from a commercial point of view, Quang and Anh (2006) found that in an open economy where trading is free, NTFPs support both cash income and employment. Therefore, commercialization of NTFPs in poorer communities has potential for trade expansion and is expected to increase employment opportunities as well as rural household incomes.

3. MODEL SPECIFICATION AND DATA ANALYSIS

In this study, the two stochastic processes are (1) participation in business activities related to NTFPs and (2) the share of household income generated by participating in these activities. We define a household as participating in NTFPs if any of its members earned income from business activities related to NTFPs in the last 12 months prior to the survey. In this paper, only gross income from cash and non-cash sales of NTFPs is considered; the value of NTFPs consumed within a household is not included in income due to data limitations. We model these two processes in a two-stage model.

The first stage of the two-stage model is concerned with participation in NTFP business activities, and has an equation of the following form:

$$D_i = \begin{cases} D_i * & \text{if } D_i * > 0 \\ 0 & \text{otherwise,} \end{cases}$$
$$D_i = \gamma X_1 + \mu_i \qquad (1)$$

where D_i^* is a latent variable taking a value of 1 if a household derived income from NTFPs (participated) and 0 otherwise. X_1 is a vector of explanatory variables postulated to influence a household's decision to participate in NTFPs income generating activities, γ is a vector of parameters and μ_i is the error term.

The second stage of the model is concerned with the level of income earned by participating in NTFP business activities, which is measured by the share of income derived from NTFPs to total household income (y_i), and has an equation of the following form:

$$y_i = \begin{cases} y_i^* & \text{if } y_i * > 0 \ \& \ D_i^* > 0 \\ 0 & \text{otherwise,} \end{cases}$$
$$y^*_i = \beta X_2 + \nu_i \qquad (2)$$

where y_i is the observed proportion or share of household income derived from NTFPs, X_2 is a vector of predictors that influence NTFPs income share of total household income, β is a parameter vector, and v_i is the error term.

In this paper, the Cragg (1971) Tobit alternative (two-stage) model is used in the estimation of parameters in each of the two stages. The model is a parametric generalization of the Tobit model, in which two separate stochastic processes determine both the decision to participate in an activity and the degree of participation. Cragg Tobit alternative model assumes independence between the error terms μ_i and v_i. With this assumption, the model is equivalent to a combination of univariate probit and truncated regression models.

The Cragg Tobit alternative model has extensively been used in other contexts such as employment participation and technology adoption. The approach has rarely been used in studies of household participation in particular business activities, such as the extraction and sale of forest products. In this context, Tobit models and similar approaches would assume the processes of participation in a business activity and the level of income earned are based upon the same set of determinants. The Cragg model estimates the processes separately, and its flexibility allows for a more comprehensive understanding of the role of the activity in overall household welfare, and its results may shed light on the relative dependence of rural households on NTFP for their livelihoods.

Given the advantages of Cragg Tobit alternative over the Tobit model, the former is used to estimate the probability of a household participating in NTFPs business activities and the determinants of the contribution of NTFPs income to total household income.

The Cragg Tobit alternative empirical model is specified as shown below:

$$P(D_i=1 \mid X_1) = \gamma X_i + \mu_i \qquad \textit{(Stage 1)} \qquad (3)$$

$$Y_i = \beta X_2 + v_i \qquad \textit{(Stage 2)} \qquad (4)$$

where D_i is the participation decision variable, which takes the value 1 if the household decides to participate in NTFPs income generating activities. Y_i is the ratio of NTFPs' income to total household income; X_1 and X_2 are the vectors of factors postulated to influence participation and level of NTFPs' contribution to household income, respectively; γ is the vector of coefficients associated with X_1in the first tier (participation equation); β is the vector of coefficients associated with X_2in the second tier (level of contribution of NTFPs to household income); and u_i and v_i are the error terms for each of the empirical equations.

This paper uses data collected in the supplemental survey of the 1999/00 Post-Harvest Survey of small and medium scale rural holdings, conducted by the Central Statistical Office and the Food Security Research Project in 2008. The sampling frame of primary sampling units (Standard Enumeration Areas, or SEAs) was constructed using the results from the 2000 Census of Population and Housing. The SEAs were sorted by geographical codes to ensure that geographical distribution of the sample SEAs was representative. The sampling frame included all rural SEAs. A two-stage sampling scheme was adopted. At the first stage, Probability Proportional to Size (PPS) selection procedure was used to select districts in each province. The measure of size was the number of agricultural households (as listed in the Census) in each SEA. A sample of 410 SEAs was drawn from a total of 12,789 SEAs from the sampling frame, with the 2000 census of population and housing used as a base.

The household was the second-stage sampling unit. All households in each sample SEA were listed and agricultural households were identified. Households were selected using systematic random sampling, with a total of twenty (20) households in each sample SEA, resulting in a total sample size of 8,200. However, due to non-responses, data were collected from 8,094 households.

In addition to the agricultural data, the 2008 supplemental PHS collected data on participation in various business activities, including the extraction and sale of NTFPs. Data on income from business activities related to NTFPs were used to estimate the contribution of NTFPs to total household income. The paper focuses on participation in business activities related to four NTFPs: firewood/charcoal, wild honey, ants/caterpillars, and mushrooms. It is also important to note that these are among the common NTFPs extracted and traded by rural households (Mutamba 2008; Jumbe, Bwalya, and Husselman 2007). The use of national data captures differences in local market conditions, transaction costs, and availability of alternative household income generating activities that may exist in different parts of the country, an aspect that was not captured by the other studies.

The Cragg Tobit alternative model does not restrict the elements of the vectors, X_1 and X_2, and in our case, both vectors have the same variables. The names and brief description of the variables are presented in Table 1.

Table 1. Variables used in the Cragg Tobit Alternative Model

Variable name	Variable description
age_head	Age of the household head (years)
sexhead	Sex of household head (1 if male, 0 otherwise)
educ_H	Education level of household head (years of schooling)
hhsize08	Household size (adult equivalent)
totland	Landholding size (hectares [Ha])
totlandsqd	Square of landholding size (Ha)
assetall08	Value of assets owned (Zambian Kwacha [ZMK])
popdens	Population density
disttown	Distance from homestead to district town (km)
cent_prov	Central Province dummy (1 if yes, 0 otherwise)
cop_prov	Copperbelt Province dummy (1 if yes, 0 otherwise)
east_prov	Eastern Province dummy (1 if yes, 0 otherwise)
luap_prov	Luapula Province dummy (1 if yes, 0 otherwise)
north_prov	Northern Province dummy (1 if yes, 0 otherwise)
nwstn_prov	Northwestern Province dummy (1 if yes, 0 otherwise)
south_prov	Southern Province dummy (1 if yes, 0 otherwise)
west_prov	Western Province dummy (1 if yes, 0 otherwise)

4. RESULTS AND DISCUSSION

Table 2 presents descriptive survey results of the distribution of households that reported income from NTFPs in Zambia by province. From a total national sample of 8094 households, 478 households derived income from the four NTFPs, representing about 6%. Variations in number of households deriving income from NTFPs were observed across all the nine provinces. The Northwestern Province had the highest number of households deriving income from NTFPs (about 19.7% of the total number of households reporting NTFP income) followed by Luapula (18.4%) and Southern (16.5%) provinces.

Eastern and Lusaka Provinces had less than the national sample average in terms of the share of households deriving income from NTFPs, and the Northern Province share was relatively lower than the others. Low participation in these activities in Eastern and Northern Provinces is likely due to the rural and remote nature of those areas, which limit the scope of potential markets for distribution and sale. Low participation in the Lusaka Province is likely because of higher population density and urban land use, where distance from forests limits the ability of households to engage in the extraction of NTFPs. Moreover, Lusaka households are more likely to be net buyers of NTFPs that were extracted from other provinces, and it is thus more of a market for, than a source of NTFPs.

The most commonly reported source of NTFP income was charcoal/firewood. Out of 478 households that had income from NTFPs, 314 households, representing 65%, derived income from charcoal/firewood. This is not surprising, given that fuelwood is the most important source of cooking energy in the rural and urban areas. In urban areas charcoal is a very close

Table 2. Households with Income from Non-Timber Forest Products by Province and Product in Zambia[1]

Province	Households interviewed	Households with income from NTFPs	Firewood/ Charcoal	Ants and Caterpillars	Mushrooms	Wild Honey
Central	820	49 (10.2%)	48	1	2	1
Copperbelt	491	41 (8.6%)	35	2	6	1
Eastern	1522	27 (5.6%)	19	0	2	3
Luapula	988	88 (18.4%)	57	28	16	1
Lusaka	268	10 (2.1%)	10	0	0	0
Northern	1604	31 (6.5%)	20	8	2	2
Northwestern	566	94 (19.7%)	4	64	20	16
Southern	1018	79 (16.5%)	64	0	11	5
Western	817	59 (12.3%)	57	0	4	0
Total	8094	478 (100.0%)	314	103	63	29

Source: Calculated from data from the third supplemental survey to the 1999/00 PHS, 2008.

[1]Some households derived income from more than one NTFP, thus the total number of households in each NTFP category (509) is greater than the total number of households deriving income from NTFPs (478)

substitute for electricity for cooking and space heating, whereas in the rural areas firewood is the main source of cooking energy and space heating. Thus, the demand for charcoal and firewood in both rural and urban areas is high. Some variations were also observed in the percentages of households deriving income from charcoal/firewood across provinces. Luapula, Southern and Western Provinces had the greatest number of households reporting income from business activities related to charcoal and firewood, and together they comprised more than half of the total number of households reporting income from this source. Charcoal/firewood was the only NTFP that households in Lusaka Province reported having derived income, presumably because of sales in urban markets where demand is high.

Following charcoal/firewood, edible insects (mainly ants/caterpillars) are the second most common NTFPs, providing income for 103 out of 478 households (Table 2), and representing about 22% of all the households that had income from NTFPs. The gathering of ants/caterpillars is a seasonal activity, as these products are usually collected in November and December and restricted to certain areas (Jumbe, Bwalya, and Husselman 2007). Given the restricted nature of ants/caterpillars to certain areas, it is not surprising that some provinces (Eastern, Lusaka, Southern and Western) had no household deriving income from this source. It is clear that ants/caterpillars were most common in Northwestern, followed by Luapula, Copperbelt, Northern, and to a lesser extent Central Provinces. Collecting ants/caterpillars is one of the main economic activities in these provinces. After collection, most traders take their products to large urban markets, for example Lusaka, or sell them along roadsides to capture motorists and travellers along the road. Northwestern Province had highest percentage (11%) of NTFPs-dependent households deriving income from ants/caterpillars.

Other wild foods, such as mushrooms, leafy vegetables, tubers, and wild fruits are some of the common NTFPs extracted by rural households residing in and around forest environments in Zambia. These products supplement the diets of most rural households, especially at the start of the rainy season, a time when most rural households are experiencing low food stocks (Chileshe 2005). Not only do these products contribute to household diet, but also household cash income through trade. Mushrooms in particular are an important source of cash income for rural households. In Zambia, about 25 species of mushrooms have been documented (Pegler and Pearce 1980 in Jumbe, Bwalya, and Husselman 2007). All but Lusaka Province had households with income derived from collecting and selling mushrooms, but participation varied widely. Households in the Northwestern Province represented nearly one third of the total households reporting income from mushrooms.

Northwestern Province is the main beekeeping and honey production area in Zambia and it is estimated that 70% of the country's beekeepers live in this province (ITC/DTCC in Jumbe, Bwalya, and Husselman 2007). They produce between 90 and 95% of locally traded and 100% of the exported honey. Beekeepers earn approximately US$100 per year per household from this activity (Mickels-Kokwe 2006). It is clear from that Northwestern Province has the highest number of households deriving income from wild honey (nearly half), compared to other provinces.

Table 3 gives a summary of sample characteristics and makes comparisons on selected variables between households that reported income from NTFPs and those that did not. The sample observations were weighted using a population weight variable in order to correct for the imbalance between the sample and the population (since sampling was not random). From a total sample of 8,094 households, only 478 (about 6%) reported income from NTFPs. Comparison results suggest significant differences between the two sub-samples with regard

to demographic, income and assets and settlement characteristics. Using a t-test, comparison results suggest significant differences between the two sub-samples with regard to demographic, income and assets and settlement characteristics. Statistically significant differences were observed with respect to household size, gender of household head, age of the household head, maximum education attained by adult in the prime age, income from salaries and wages, value of assets owned, and distance from the homestead to the main tarred road. Significant differences were also observed in terms of total land owned. There was a clear difference regarding two of the three settlement variables (distance to the main tarred road and to the nearest district town).

The results indicate a significant variation in household size with those that reported income from NTFPs having larger (6.1) household sizes than their counterparts who had an average household size of 5.7. Variation in gender of household head was significant with households that reported income from NTFPs having a higher proportion of male-headed households than their counterparts. Amongst the households that derive income from NTFPs, 83% of the respondents were male headed compared to 76% male headed amongst those that did not derive income from NTFPs. The observed variation in age of the household head between the two groups indicates that households with NTFP income had relatively younger (45 years)

Table 3. Sample Variable Means, Weighted

Attribute	Full sample	Households with income from NTFPs	Households with no income from NTFPs	Sig.
Number of Households	8,094	478	7,616	
Demographics				
Household size	5.8 (0.04)	6.1 (0.16)	5.7 (0.04)	*
Number of prime aged adults	2.9 (0.02)	2.92 (0.08)	2.9 (0.02)	
Gender of household head (=1 if male, 0 otherwise)	0.76 (0.005)	0.83 (0.018)	0.76 (0.006)	***
Age of household head	48.3 (0.193)	45. (0.723)	48.5 (0.2)	***
Education of household head (years)	5.9 (0.052)	5.7 (0.172)	5.9 (0.055)	
Maximum education attained by adult in the prime age	7.5 (0.048)	7 (0.15)	7.6 (0.05)	***
Income and assets				
Salary/wage income (000 ZMK)	1007 (58)	319 (142)	1049 (61)	***
Value of assets owned (000 ZMK)	979 (98)	360 (37)	1018 (104)	***
Value of productive assets (000 ZMK)	3885(153)	1788 (281)	4011(161)	***
Total land owned (Ha)	2.84 (0.11)	3.08 (0.24)	2.82 (0.12)	
Maize harvested (kg)	2428(70.61)	1399(143.24)	2489(74.21)	***
Settlement				
Population density (per sq km)	22.3 (0.49)	23.5 (2.13)	22.2 (0.51)	
Distance to tarmarc road (Km)	25.1 (0.46)	15.56 (1.02)	25.70 (0.48)	***
Distance to nearest district town (km)	34.36 (0.30)	31.53 (1.22)	34.53 (0.31)	***

*, ** and *** refer to statistical significance at 10%, 5% and 1% levels, respectively.
Values in parenthesis are standard errors.
Source: Calculated from data from the third supplemental survey to the 1999/00 PHS, 2008.

household heads compared to their counterparts whose head on average was 48.5 years old. This was against the sample average of 48.3.

In terms of income from salaries/wages, the NTFPs-participant households had significantly less income from this source than their counterpart, perhaps an indication that NTFP-participant households engage in low paying employment activities or have few employment opportunities and thus, turn to NTFPs to supplement off-farm income. With regard to value of assets owned, households with income from NTFPs had significantly less valuable assets (ZMK 360, 000) compared to those with none (ZMK 1,018,000) (*USD 1= ZMK 3,800 in 2008*), and a similar pattern was observed in terms of productive assets owned. Also, households with income from NTFPs had significantly low maize production in 2008 relative to those with none (see Table 3). These attributes underscore the overall economic vulnerability of forest-dependent households.

With regard to settlement, distance from the homestead to the main tarred road differed significantly between the two groups, with those that reported income from NTFPs being relatively closer (15.56km) to the road than their counterparts (25.7km). A similar pattern was observed with respect to distance to the nearest district town. This is an important attribute considering that most of the NTFPs traders sell their products along the main roadside and district town. These two variables are a good proxy for market access and it is clear that most households that are closer to markets engage in NTFPs business activities.

Rural households earn income from a variety of sources, including NTFPs, agricultural production, and wage employment. Table 4 presents the mean contribution of the primary income sources to total household income, by quartiles of household income, for those households reporting income from NTFPs.

The results reveal that the highest income quartile (wealthiest 25%) derives more income from NTFPs than the other three quartiles in absolute terms, but its share total income (29%) is relatively less than for the poorest households in the lowest income quartile (45%). This implies that poorer households are relatively more dependent on income from extraction and sale of natural resources such as NTFPs than wealthier households.

Table 4. **Income Sources by Income Quartiles for NTFP Households (000s of Kwacha)**

Income source	Sub-sample of NTFP Households	Household income quartile			
		0-25%	25-50%	50-75%	above 75%
Total income per capita (Kwacha)		627	1627	3346	11300
NTFP income per capita	34.3%	282 (45%)	535 (34%)	1128 (36%)	2891 (30%)
Agriculture income per capita	35.7%	219 (36%)	697 (38%)	1271 (39%)	3397 (29%)
Employment income per capita	3.7%	12 (2%)	60 (4%)	72 (2%)	789 (6%)
Trading income per capita	20.8%	63 (9%)	213 (16%)	720 (19%)	3882 (32%)
Remittance income per capita	5.5%	51 (9%)	123 (8%)	156 (5%)	309 (3%)

Values in parentheses represent mean contribution to household income from a particular source.
Source: Calculated from data from the third supplemental survey to the 1999/00 PHS, 2008.

Table 5. Average Contribution of NTFPs to Total Household Income by Product for Participating Households

NTFPs	Average share of total household income
Charcoal/firewood	37%
Ants/Caterpillars	19%
Wild honey	12%
Mushroom	8%

Source: Calculated from data from the third supplemental survey to the 1999/00 PHS, 2008.

Agricultural income represents the second highest contribution to total household income for the lowest income quartile (poorest 25%), but it is the highest contributor for the second and third quartiles. The wealthiest quartile earns more income from wage employment. However, agriculture is the leading contributor, overall, indicating that agriculture is still the dominant economic activity in rural areas. It is important to note that share of trading income increases from the lowest income quartile all the way to the highest, perhaps an indication that participation in other business activities increases with household income, presumably due to availability of capital. Employment and remittances ranked lowly in terms of contribution to total household income in all the quartiles. Employment contribution ranges from 2-6% with the highest (6%) being for the highest income quartile.

Table 5 presents the mean contribution of each NTFP to household income for households that reported income from NTFPs. The results indicate that charcoal/firewood is the highest contributor (37%) followed by ants/caterpillars (19%). Following ants/caterpillars is wild honey with a contribution of 12% while mushroom is the least contributor accounting for 8% of total household income. In order to reduce households' reliance on charcoal/firewood as an income source, there is need to promote the extraction of other NTFPs such as wild honey, ants/caterpillars, and mushroom, which have negligible ecological impacts, as these have the potential to contribute substantially towards household income.

The first step of the analysis in estimating determinants of participation in NTFPs and their contribution to household income consisted of testing the Tobit model against the two-stage Cragg Tobit alternative model. The results of the formal log-likelihood ratio (LR) test between the Tobit and the Cragg (1971) two-stage model confirm the superiority of the Cragg model and the rejection of the Tobit model; that is, the test statistic Γ=1138.01 exceeds the critical value of the χ^2 distribution (p-value <0.01). This suggests that the decision to participate in NTFPs and the level of NTFPs' contribution to household income may be governed by different processes.

Table 6 presents results of the Cragg Tobit alternative model of household participation in NTFPs. Tiers 1 and 2 are maximum likelihood coefficients of the determinants of probability of engagement in NTFPs and the contribution of NTFPs to total household income, respectively. For easier interpretation, the coefficients for the first tier are presented as the marginal effects in the fourth column; coefficients for the second tier are presented as average partial effects (APE) in the last two columns. Test of significance for the average partial effects for the second tier was done using the bootstrap method in Stata with 50 replications.

Table 6. Determinants of Household Probability of NTFP Participation and Share of NTFP Income[2]

					Marginal Effects					
Variable	**Tier 1**	**Sig.**	**Tier 2**	**Sig.**	**Probit**	**Sig.**	**CAPE**	**Sig.**	**UAPE**	**Sig.**
Intercept	0.3837		1.3188	***	n/a		n/a		n/a	
Age of household head (years)	-0.0081	***	0.0018		-0.0007	***	-0.0007	***	-0.0002	**
Sex of household head (1=male)	0.1522		-0.0244		0.0117		-0.0087		0.0037	
Education of household head (years)	-0.0296	***	-0.0078		-0.0026	***	-0.0028		-0.0011	
Household size (adult equivalent)	-0.0010		-0.0358	*	-0.0001		-0.0127		-0.0010	
Landholding size (ha)	0.0015		-0.0005		0.0001		-0.0002		3.2E-5	
Square of landholding size (ha)	-0.0470	***	0.0389	**	-0.0041	***	0.0138	**	-0.0005	
Log of value of assets owned (ZMK)	-0.1244	***	-0.0976	***	-0.0106	***	-0.0347	***	-0.0056	***
Population density (persons/sq km)	0.0015	***	-0.0014	***	0.0001	***	-0.0005		0.00001	
Distance to district town (Km)	-0.0059	***	-0.0001		-0.0005	***	-0.0004	***	-0.0002	***

Number of obs= 5071, Log likelihood = -854.4152; *, ** and *** refer to statistical significance at 10%, 5% and 1%, respectiv*ely.*

The fourth column (Probit) in Table 6 presents marginal effects of the independent variables on a household's likelihood (probability) of participating in NTFPs. The fifth column, conditional average partial effects (CAPE), indicates the effect of each independent variable on a household's share of NTFPs income in total household income (level of contribution), but only for the subsample comprising households that reported income from NTFPs. The sixth column, unconditional average partial effects (UAPE) shows the expected overall effect of each independent variable on household's share of NTFP income in total household income, taking into account both the probability of participating in NTFPs and the share of NTFPs income to total household income, for those that depend on NTFPs. This column is of particular importance for policy interpretation as it provides information on overall effect of each variable on the contribution of NTFPs to household participation and income.

The regression results show that age of the household head is negatively associated with both the probability and level of contribution of NTFPs to household income. This suggests that households with older heads are negatively associated with both the probability of engaging in NTFP business activities and with the share of income from NTFPs. Younger heads of households may obtain a higher share of their household income from NTFP activities because of their relatively greater physical capacity for strenuous labor.

Educational level of the household head has a negative effect on the probability of participation in NTFP business activities. Households with higher levels of educational attainment are less likely to participate in NTFPs, implying that higher levels of education are associated with a lower likelihood of dependence on forest products for rural livelihoods. Education expands the possibilities for labor and employment, whereas households with lower levels of education may be more economically vulnerable, and thus, more likely to extract forest resources for income. Education has no significant effect on the share of income from NTFPs.

The effects of wealth on NTFP participation and income can be estimated by examining the value of household assets. The negative and significant APEs for the log of the value of household assets (columns five and six), implies that households with more valuable assets

[2] Eight province dummy variables were included in the model, although they are not included in the table above.

are less likely to participate in NTFPs and for those who do participate, assets are negatively associated with NTFPs' contribution to household income. If assets are used as a measure of overall wealth, these results imply that poorer households may be relatively more dependent upon NTFPs as a livelihood, and reinforce previous assertions of the association between poverty and NTFP participation. This may be an indication that poorer households turn to NTFPs to cushion their vulnerability to economic shocks and crop variability, and as such NTFP participation may be seen as safety nets, especially for poor, rural households.

In terms of access to markets, rural areas are mostly characterized by sparse population and the relatively weak purchasing power of rural households, which may limit the scope of rural markets for forest products. The regression results indicate that population density is positively and significantly associated with participation in NTFP business activities, suggesting that households residing in areas of relatively higher population density are more likely to engage in NTFPs. This is possibly because higher populations provide greater market opportunities for trade in NTFPs.

The square of land holding size is negatively and statistically significant in explaining the probability of participation in NTFPs. On the other hand, square of landholding size is positively and significantly associated with extent of NTFPs' contribution to household income for those that are already engaged in NTFPs. The negative sign of square of landholding size (column four) suggest that initially, an increase in landholding size leads to increased probability of participation in NTFPs; however, further increase in landholding size is associated with a lower likelihood of participation. This has implications for policy as measures that would ease access to land for rural households could reduce participation in NTFP business activities and could be used to control extraction of NTFPs to ensure sustainability of the resources. For those already engaged in NTFPs, an increase in landholding size is positively and significantly associated with higher share of NTFPs income. Distance to district town was used as a proxy for market access. Overall, the distance from the homestead to the district town is negatively and significantly related with likelihood of participation in NTFPs and extent of NTFPs' contribution to household income. This implies that the farther away a household is from the market, the lower the likelihood to participate in NTFPs and the less dependent a household is on income from NTFPs. This underscores the relevance of improving market access in order to encourage rural smallholder households to diversify into NTFP business activities and increase their income.

In order to capture the effect of difference in location on NTFP participation and NTFPs' contribution to household income in the model, we used a location dummy variable (represented by provinces). This was postulated to capture the effects of variations in local market conditions, availability of alternative household income generating activities, inter-provincial abundance and distribution of forests, and any other spatial differences across the nine provinces. The location dummy was found to be jointly significant in explaining both participation in, and contribution of, NTFPs (p-value = 0.000) following a joint F-test. Thus, differences in location, in terms of provinces, are important in explaining a household's participation in NTFPs and contribution of NTFPs to household income presumably because of greater forest cover in some provinces, and easier access to forests by households in some provinces. With Lusaka Province as the benchmark, the results indicated that being in Luapula, Northwestern, or Western Provinces is positively and significantly associated with participation in NTFP business activities, while being in Eastern or Northern Province is negatively and significantly associated with participation in NTFP business activities. The other provincial location dummy variables (Central, Copperbelt, and Southern) had insignificant coefficients. NTFPs thus, appear to be important in only Luapula, Northwestern,

and Western Provinces. This finding corresponds with that of Puustjarvy, Mickels-Kokwe, and Chakanga (2005), who established that forest products are an important income source for rural residents in Luapula and Northwestern Province.

5. CONCLUSIONS AND POLICY IMPLICATIONS

This study examined the characteristics of rural households that participate in business activities related to non-timber forest products in Zambia. We estimated the contribution of NTFPs to rural household income and determinants of households' participation in NTFPs in rural Zambia. The study has shown that NTFPs contribute 34% to household income, on average. Generally, the results show that poor households rely more on NTFPs than the wealthy as indicated by NTFPs contribution (45%) to the incomes of the poorest and 29% for the wealthiest. The significant and negative relationship between value of assets owned (a proxy for wealth) and participation in NTFPs also reinforces the finding that the poor tend to be more reliant on NTFPs than the rich. In terms of absolute value of income earned from NTFPs, the wealthy recorded higher incomes indicating that the wealthy households extract larger volumes of NTFPs than the poor, or maybe they sell their products at higher prices than the poor. The results also indicate that location is an important determinant of participation in NTFPs, with NTFPs being important in Luapula, Northwestern, and Western Provinces. Thus, interventions aimed at improving rural incomes through extraction and sell of NTFPs (except charcoal) should be focused on these provinces.

Human capital factors, particularly, age and educational level of the head of household are significant determinants of households' participation in NTFPs and the level of NTFPs' contribution to household income. All else being equal, an increase in these variables is associated with a decline in household participation in NTFPs and their contribution to household income. This result is consistent with that of similar studies that found age of the household head to be negatively related with a household's likelihood of utilizing forest products (Jumbe, Bwalya, and Husselman 2007; Fisher 2004). The results also show that access to markets is crucial for households' participation in NTFPs. Another important finding of this study is that an increase in population density leads to increased likelihood of households to participate in NTFPs; however, increasing population density leads to declining contribution of NTFPs to household income for participating households. Increased population density may also lead to overexploitation of forest resources, which highlights the need to ensure sustainable harvesting of NTFPs while also considering the important role of NTFPs in rural household income.

The findings of this study suggest that there is a positive relationship between poverty and reliance on NTFPs and this is in line with most literature on natural resource dependence and poverty (Jumbe, Bwalya, and Husselman 2007; Shackleton and Shackleton 2006; Fisher 2004; and Cavendish 2000). It is, therefore, crucial that both forest management policies and rural development strategies take into account the central role NTFPs play in the livelihoods of the rural poor, because of the economic vulnerability that drive poorer households to NTFP extraction. Improving rural infrastructure, such as feeder roads, could ease access to marketing points and increase the contribution of NTFPs to incomes of the rural poor that rely on them. However, careful policy considerations are required to strike a balance between rural household welfare improvement and forest resource sustainability. Programs that build capacity for alternative livelihoods or offer incentives for the conservation of forest resources could be effective at reducing pressure on ecological systems. Additionally, the results suggest that improving rural households' access to adequate land could help diversify sources of rural household income and maintain the integrity of forest systems.

Generally the extraction and trade of NTFPs by rural households may have negligible ecological impacts, with the exception of charcoal and firewood. The production process of charcoal occasionally involves the felling of whole trees, which, if left unchecked, may

compromise the integrity of forests and adversely affect ecosystem functions and the availability of other NTFPs. The demand for charcoal is often driven by urban household consumption, and as such, urban population growth is likely to increase the pressure on rural households to engage in charcoal production as an income earner. Since the main thrust for households' involvement in charcoal production is income, it would help to exploit supply side strategies such as promotion and expansion of markets for other NTFPs, such as caterpillars, wild honey, and mushrooms, in order to reduce households' reliance on charcoal and firewood as income sources. As indicated in Table 5, other NTFPs contribute quite substantially to household income, and if flanked by appropriate interventions, these other products could contribute even more to household incomes. Demand side strategies that could reduce the dependence on charcoal and firewood as an energy source, such as the promotion of improved/efficient charcoal braziers, should be explored. With regard to demand for firewood as an energy source in rural areas, strategies such as rural electrification may reduce rural household demand for firewood.

The opportunity to gather open access resources such as NTFPs, and convert them into marketable products provides a source of income and safety net for rural households in Zambia, as indicated by the results, where NTFPs contribute 34% of total household income for participating households. It is, therefore, evident that rural households will continue to rely on NTFPs for a long time to come. Since NTFPs seem to play an important part in supporting rural household livelihoods, rural residents should be made to understand that the continued availability of NTFPs depends largely, on the integrity of the forests. NTFPs can, therefore, act as incentives for more sustainable use of forest resources. Caution also needs to be exercised with regard to clearing of forest land for agricultural purposes as continued excessive clearing may threaten access by rural households to forests for alternative income-generating activities.

In terms of research implications, the literature on non-farm/off-farm income generation often distinguishes between casual participation (for example, those who participate in NTFP harvest and sale as a safety net in the off season or during periods of weak crop yields) from entrepreneurial participation (for example, commercial charcoal producers or others who engage in such activities regularly as a business) (Paumgarten 2005; Shackleton and Shackleton 2003). Panel data could be used to better understand household participation over time (as opposed to a one-time snapshot.)

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