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**Non-Timber Forest Products and
Rural Poverty Alleviation in Zambia**

by

Brian P. Mulenga, Robert B. Richardson, and Gelson Tembo

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EXECUTIVE SUMMARY

Forests support rural livelihoods and food security in many developing countries by providing critical sources of food, medicine, shelter, building materials, fuels, and cash income. The increasing demand for forest products has enhanced rural livelihoods and enabled the expansion of domestic markets, particularly in urban areas where woodfuel and other forest resources are scarce. Therefore, non-timber forest products may offer sources of income and opportunities for poverty alleviation in both rural and urban areas. In Zambia, most rural households residing near forests extract a range of forest products for both direct consumption and trade (including food products and wood for cooking fuel and charcoal production), and forest products are among the top sources of household income in some rural areas. Households engage in trade of non-timber forest products (NTFPs) because of low capital requirements and relatively easy entry to markets. NTFPs help bridge seasonal gaps in income for many farmers, and they provide a safety net for many rural households during years with low crop yields.

Despite the widespread trade in NTFPs by rural households in Zambia, the contribution of forest products to rural livelihoods is not well understood. NTFPs receive little attention from researchers and development practitioners because of the small scale and dispersed nature of extractive activities. Information on the contribution of NTFPs to rural household income is important for both rural development and forest management policies because of their potential role in poverty alleviation and the growing demand among both rural and urban households.

The objectives of this study were to examine the role of NTFPs in rural household welfare and the characteristics of households that rely on NTFPs for livelihoods and income. Data from a 2008 survey of rural households in Zambia were used to estimate the contribution of NTFPs to rural household income in districts where there was extensive business activity related to forest products. The survey included questions about income from business activities related to four types of NTFPs—woodfuel, ants/caterpillars, mushrooms, and wild honey—which are some of the most commonly extracted and traded NTFPs in Zambia. NTFPs contribute 33% to total household income for participating households, and woodfuel was the most common source of NTFP income, with 68% of all the households that reported participation in NTFPs having obtained income from this source.

We defined a sub-sample of households in districts where at least 10% of the households reported income from NTFP-related business activities, in order to focus the analysis on areas where NTFP activities are most prevalent; 16 of 72 districts ($n=1,257$) met this threshold, with four districts in Northwestern Province leading in terms of percentage of households deriving income from NTFPs. An analysis of the distribution of NTFP income revealed that the wealthiest quartile derives more income from NTFPs than the other three wealth quartiles in absolute terms, but the share of total income is considerably lower than the share for the other three quartiles. This implies that poorer households are relatively more dependent on income from extraction and sale of NTFPs than wealthier households. Overall, NTFPs account for about a third of total household income for participating households in the 16 districts, a finding that highlights the important role of NTFPs in rural livelihoods. While agriculture is the dominant economic activity in rural Zambia, income from NTFP-related business activities surpasses even agricultural income for the poorest 50% of the sample.

A two-stage model was used to estimate the determinants of rural households' participation in NTFP-related business activities and the contribution of these activities to household

income. Identification of these determinants is important for designing interventions aimed at improving incomes of participating households because it will enable rural development planners to understand the role of NTFPs in rural livelihoods. Information on the characteristics of participating households can help forest managers design effective conservation interventions to ensure that forest resources are managed sustainably.

The results show that age of the household head is significantly and negatively associated with both the probability and level of contribution of NTFPs to household income, which suggests that households with relatively older heads are less likely to participate in NTFP activities, and their share of NTFP income is relatively less than those headed by younger heads. Sex of the household head is positively and significantly associated with both participation in NTFPs business activities and NTFP income, suggesting that households headed by males are more likely to participate in NTFPs. Households with heads that have higher levels of education are less likely to participate in NTFPs, implying that education may afford a wider range of income-generating opportunities. Landholding size is positive and significant in explaining probability of participation in NTFPs, but negatively associated with the contribution of NTFPs to household income, implying that greater access to land reduces rural households' dependence on NTFPs' income, and could play a role in controlling extraction to ensure resource sustainability.

Distance to the nearest district town is negatively and significantly related to the likelihood of participation in NTFPs and their 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 also 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. Furthermore, the quantity of maize harvested is negatively and significantly associated with the level of NTFP contribution to household income. This may be an indication that food insecure 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.

The effect of wealth on NTFP participation and income can be estimated by the variable representing the value of household assets. The negative and significant average partial effect for the log of the value of household assets implies that households with more valuable assets rely less on NTFPs than those with less valuable assets. Using assets as a measure of overall wealth, these results imply that poorer households may be relatively more dependent upon NTFPs as a livelihood, and confirms our hypothesis of a positive relationship between poverty and dependence on natural resources such as NTFPs. The positive relationship between poverty and dependence on NTFPs underscores the importance of integrating forest management policies and rural development strategies to 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 extract NTFPs. However, careful policy considerations are required to ensure rural household welfare improvement while sustaining the forest. NTFPs can be used to build a case for forest resource conservation in rural communities by ensuring that rural households understand that the continued availability of NTFPs depends, to a large measure, on the integrity of the forests.

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ACRONYMS

CSO	Central Statistical Office
FSRP	Food Security Research Project
IAPRI	Indaba Agricultural Policy Research Institute
NTFP	Non-Timber Forest Product
PHS	Post-Harvest Survey
PPS	Probability Proportional to Size
SEA	Standard Enumeration Area
SIDA	Swedish International Development Agency
UAPE	Unconditional Average Partial Effects
USAID	United States Agency for International Development
ZMK	Zambian Kwacha

1. INTRODUCTION

Forest products play an important role in supporting rural livelihoods and food security in many developing countries. Forests provide critical sources of food, medicine, shelter, building materials, fuels, and cash income. More than 15 million people in Sub-Saharan Africa earn their income from forest-related enterprises such as firewood and charcoal sales, small-scale saw-milling, commercial hunting, and handicraft production (Kaimowitz 2003). Most research related to household use of forest resources in developing countries is concerned with forest depletion and sustainable use of natural resources.

However, the increasing demand for forest products in developing countries has enhanced rural livelihoods and enabled the expansion of domestic markets, particularly in urban areas where woodfuels and other forest resources are scarce (Arnold, Köhlin, and Persson 2006). Therefore, non-timber forest products (NTFPs) may offer sources of income generation and opportunities for poverty alleviation in both rural and urban areas. NTFPs contribute to poverty alleviation through two important avenues. First, the market for forest products provides opportunities for income generation from the collection and trade in NTFPs in rural areas and from their sale in urban areas; and second, the market for NTFPs provides urban households with a convenient and reliable source of energy for cooking, as well as inexpensive food at relatively stable prices (Richardson 2010; Arnold, Köhlin, and Persson 2006).

NTFPs include a range of forest extracts including 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 used for subsistence livelihoods including food, medicine, and bartering. 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, the NTFP share of total household income is about 20% (Shackleton and Shackleton 2006). The study revealed that 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, NTFPs constituted the highest share of incomes for the poorest households per capita than the other wealth classes. *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 (Shackleton and Shackleton 2004). 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.

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 NTFPs in the food system of developing countries, they 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, and many households subsist, in part, by collecting forest products.

In Zambia, most rural households residing near forests extract a range of forest products for both direct consumption and trade (including food products and wood for cooking fuel and charcoal production). With rural poverty rates of approximately 80% (CSO 2006), most rural households in Zambia are unable to invest in expensive timber extraction and processing technologies. Generally, only wealthier households from urban areas engage in business activities related to timber because of high barriers to entry. Many rural households engage in trade of NTFPs mainly because of low capital requirements and relatively easy access. NTFPs help bridge seasonal gaps in income for many farmers, and thus they provide a safety net for many rural households during years with low crop yields. Charcoal, mushrooms, ants, caterpillars, and wild honey are among the most commonly traded NTFPs in Zambia. Caterpillars are more common in the northern provinces of the country (i.e., Luapula, Northern, and Northwestern).

From an environmental point of view, harvesting NTFPs may be part of sustainable forest management and conservation practices, since their extraction (with the exception of woodfuel¹) does not significantly compromise the integrity of the forest as compared to timber. Intensive management of forests for NTFPs could contribute to both development and conservation objectives (Arnold and Ruiz Pérez 2001). However, the contribution of NTFPs to rural livelihoods in Zambia is not well understood, despite the widespread trade in NTFPs by rural households. NTFPs receive little attention from social science researchers and development practitioners because of the small scale and dispersed nature of extractive activities. Information on the contribution of NTFPs to rural household income is important for both rural development and forest management policies because of their potential role in poverty alleviation and the growing demand among both rural and urban households.

This study was motivated by an interest in understanding the role of NTFPs in rural household welfare and the characteristics of households that rely on NTFPs for livelihoods and household income. This study provides empirical evidence on the contribution of NTFPs to rural household incomes and identifying the characteristics of NTFP-dependent households. Such information could inform the design and implementation of effective rural development and forest management interventions. Nationally representative rural household survey data were used to estimate the contribution of NTFPs to rural household income in districts where there was extensive business activities related to forest products in order to better understand the role NTFPs play in rural livelihoods. A two-stage model was used to estimate the determinants of rural households' participation in such business activities and the contribution of these activities to household income. Identification of these determinants is important for designing interventions that will improve incomes of participating households because it will enable rural development planners understand the role of NTFPs in the livelihoods of rural households. Information on the characteristics of participating households can help forest managers design effective conservation interventions to ensure that forest resources are managed sustainably.

¹ Woodfuel in this study refers to both charcoal and firewood.

2. THEORETICAL MODEL

The objectives of this study were to examine the contribution of NTFPs in rural household welfare and the characteristics of households that participate in business activities associated with NTFPs. Household income is used here as a measure of welfare, which permits the use of statistical analysis to estimate the determinants of household participation in NTFP-related activities and the income earned from those activities. The determinants of household income typically include human capital, physical assets, locational characteristics, and other social and institutional assets (de Janvry and Sadoulet 2001). Human capital and socio-demographic variables may include household characteristics such as the age and sex of the household head, level of education, and the size of the household. Physical capital variables include total land holdings and productive assets owned (such as tractors, ploughs, wheel barrows, fishing nets, and traction animals). Social and institutional assets may include community characteristics related to population, remoteness, and access to markets. The relationship can be represented as:

$$Y = f(HC, PC, SA, LC) \quad (1)$$

where Y is income from NTFPs, HC is a vector of human capital variables, PC is a vector of physical capital variables, SA is a vector of social and institutional asset variables, and LC is a vector of locational variables. The selection of variables included in the model is guided by a review of literature on the determinants of rural household income (Barrett, Reardon, and Webb 2001; Reardon 1997), factors specific to Zambia that influence how these variables are specified, and data availability.

Since most households do not engage in business activities related to NTFPs, the dependent variable will have a value of zero for a substantial part of the sample, which results in a corner-solution outcome. Such outcomes generate biased and inconsistent parameter estimates with ordinary least squares regression, in which the dependent variable takes a zero value for a non-trivial part of the population and the values greater than zero are continuous (Gujarati 2003; Wooldridge 2008). Tobit models are often used with corner-solution outcomes, but such models estimate the determinants of the probability of participation and the magnitude of its effects simultaneously. Estimation of a single set of parameters implies an assumption that coefficients on the probability and magnitude are same, which may not always be reasonable (Lin and Schmidt 1984). Let Y_i^* be defined as a latent variable, as follows:

$$Y_i^* = \beta X_i + \varepsilon_i \sim Normal(0, \sigma^2) \quad (2)$$

where X_i is the combined vector of household and community characteristics assumed to influence the share of household income from NTFPs, β is a vector of parameters to be estimated, and ε_i is the random error term assumed to be normally distributed with zero mean and constant variance. The relationship between the observed Y_i and the latent variable Y_i^* is expressed as follows:

$$Y_i = \begin{cases} Y_i^* & \text{if } Y_i^* > 0 \\ 0 & \text{if } Y_i^* \leq 0 \end{cases} \quad (3)$$

or alternatively, $Y_i = \max(0, \beta X_i + \varepsilon_i)$.

The Cragg tobit alternative model (Cragg 1971) presents a variation of the tobit model that allows for separate estimation of the probability of participation and the value of income earned. Such two-stage models consist of both a probit and a continuous regression. In this study, the two-stage model is used to first estimate the determinants of household participation in NTFP related business activities and secondly to estimate the determinants of the level of income from those activities (which may include factors such as socio-demographics, asset base, location and institutional characteristics). We define a household as participating in NTFPs' business activities if any of its members earned income from extraction and sale of NTFPs in the 12 months prior to the survey. NTFPs contribution to household income is measured as the NTFP share of total household income.

The Cragg tobit alternative model has been used extensively in other areas, such as technology adoption studies (Teklewold et al. 2006; Burton, Dorsett, and Young 1996). However, this approach has not been used in the market participation studies of NTFPs cited in this paper. For example in their studies to determine households' dependence on forest products, Jumbe, Bwalya, and Husselman (2008) and Fisher (2004) used a tobit model to estimate household dependence and level of dependence on forest products.

In an agricultural household model, an individual is willing to participate in non-farm work when the reservation wage (w_{ri}) is less than the non-farm wage (w_{mi}), net of transaction costs (Woldehanna, Lansink, and Peerlings 2000). If D_i represents a household's decision to participate in business activities related to NTFPs, the participation decision can be expressed as a latent variable, as follows:

$$D_i^* = \gamma X_i + \mu_i$$

$$D_i = \begin{cases} 1 & \text{if } D_i^* > 0 \text{ or } (w_{ri} < w_{mi}) \\ 0 & \text{if } D_i^* < 0 \text{ or } (w_{ri} \geq w_{mi}) \end{cases} \quad (4)$$

where D_i^* is a latent variable with a value of 1 if household i participated in NTFP business activities and 0 otherwise. X_i is a vector of explanatory variables postulated to influence a household's decision to participate in NTFPs business activities, and γ is a vector of parameters associated with participation.

The relationship between the latent variable Y_i^* , the observed share of NTFP income Y_i , and the participation decision D_i can be expressed as follows:

$$Y_i = \begin{cases} 1 & \text{if } Y_i^* > 0 \text{ and } D_i = 1 \\ 0 & \text{if } Y_i^* \leq 0 \text{ and } D_i = 0 \end{cases} \quad (5)$$

The Cragg tobit alternative model allows the probability of $Y_i > 0$ and values of Y_i to be determined by separate processes, and even different explanatory variables. Unlike the tobit model, the Cragg tobit alternative model does not impose any restrictions on the elements of X_i , implying that the explanatory variables in the two equations (participation in NTFP business activities and share of NTFP income) can be the same or different and can also have different coefficient signs and magnitudes.

3. DATA AND MODEL ESTIMATION

The Cragg tobit alternative model was applied in an estimation of the determinants of the probability of a household earning income from NTFPs (participation) and the determinants of the share of NTFP income. The empirical model is specified as follows:

$$\text{Stage 1: } P(D_i = 1 | X_i) = \gamma X_i + \mu_i \quad (6)$$

$$\text{Stage 2: } Y_i = \beta X_i + \varepsilon_i \quad (7)$$

where D_i takes the value of 1 if the household participated in NTFP business activities; Y_i is the NTFP share of total income; X_i is the vector of explanatory variables postulated to influence participation and magnitude of NTFP contribution to household income, respectively, and is the same for both stages; γ is the vector of coefficients associated with X_i in the first stage; and β is the vector of coefficients associated with X_i in the second stage.

The study uses data collected in the supplemental survey of the 1999/2000 Zambia Post-Harvest Survey (PHS) of small and medium scale rural holdings conducted by the Central Statistical Office (CSO) and Food Security Research Project 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 SEAs were sorted by geographical codes to ensure that geographical distribution of the sample SEAs is also representative. The sampling frame included all rural SEAs, and a two-stage sampling scheme was adopted. At the first stage, districts in each province were selected using a Probability Proportional to Size (PPS) procedure. 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 using the PPS procedure.

The household was the second stage-sampling unit. First, all households in each sample SEA were listed and agricultural households were stratified into three categories, based on total area under crop production, quantity of specified crops and livestock, and sources of income. Households were selected from each category using systematic random sampling, with a pre-determined total of twenty sample households in each sample SEA, which resulted in a total sample size of 8,200. Due to non-responses, data were collected from 8,094 households.

The supplemental PHS collected data on four types of NTFPs, and the data collected included the type of product and values of sales and consumption. This study focused on four types of products—woodfuel, ants, caterpillars, mushrooms, and wild honey are some of the most commonly extracted and traded NTFPs in rural Zambia. The analysis proceeds in three stages. First, we present national-level descriptive statistics regarding household participation in NTFP business activities. Second, we define a sub-sample of households in districts where the average percentage of households that reported income from NTFPs was at least 10%, in order to focus the analysis on districts where NTFP activities are most prevalent. This resulted in a sample size of 1,257 households, with 216 households (17.1%) reported having obtained income from NTFP-related business activities. Third, we analyze the determinants of participation in NTFP-related business activities for this sub-sample using the two-stage model presented in equations (6) and (7) above.

We posit that there is a positive relationship between poverty and dependence on NTFPs for livelihoods. We use the value of household assets as a measure of relative wealth (and poverty) to test for the effect of asset holdings on the probability of participation in NTFP-related business activities and on the level of income earned from those activities.

Demographic factors include the age, sex, and education level of the household head; the number of prime-aged male and female household members (15-59 years old). Household asset base is measured by the value of assets owned as well as landholding size. Household location factors included distance to the district town and to the nearest main road.

4. RESULTS AND DISCUSSION

Table 1 presents descriptive results of the distribution of households that reported income from NTFPs in Zambia by province. From a total national sample of 8,094 households, 464 (about 6%) reported income from NTFP activities. Variations in number of households deriving income from NTFPs were observed across all the nine provinces. Northwestern Province had the highest share of households that reported income from NTFPs (15%) and also one of the highest absolute numbers of households earning income from NTFPs, followed by Luapula (9%), Copperbelt (8%), Southern (7%), and Western Provinces (7%).

In terms of products, woodfuel was the most common source of NTFP income with 314 households (or 68% of all the households that reported NTFP income) having obtained income from this source. This is not surprising given the increasing demand for charcoal for cooking in urban areas, which is driven in part by the increase in urban population, electricity tariffs, and few affordable alternatives. Northwestern Province is the main beekeeping and honey producing area in Zambia (Jumbe, Bwalya, and Husselman 2008). Households in that Province reported the greatest participation in the sale of wild honey as well as mushrooms, ants, and caterpillars. However, households in Northwestern Province reported negligible participation in woodfuel trade relative to other provinces.

In order to focus the analysis on districts where household participation in NTFP-related activities is greatest, we define a sub-sample of households that are located in districts where at least 10% of the households reported income from NTFPs. Table 2 provides a summary of descriptive statistics of NTFP-participating households by product for districts that met the 10% threshold. Based on the 10% threshold, NTFPs-related business activities are prevalent only in 16 out of the 72 districts in the country, with four districts in Northwestern Province leading in terms of percentage of households deriving income from NTFPs. Although NTFPs are prevalent as business activities only in a few districts, their contribution to household income in these districts is noteworthy.

Table 1. Households with Income from Non-timber Forest Products, by Province and Product

Province	Households interviewed	Households with income from NTFPs (n=464)	% of households reporting income from NTFPs			
			Woodfuel (n=314)	Ants/Caterpillars (n=101)	Mushrooms (n=67)	Wild Honey (n=30)
Central	820	49 (6%)	98	2	4	2
Copperbelt	491	41 (8%)	85	5	15	2
Eastern	1,522	24 (2%)	79	0	8	13
Luapula	988	88 (9%)	64	31	18	1
Lusaka	268	10 (4%)	100	0	0	0
Northern	1,604	31 (2%)	65	26	6	6
Northwestern	566	83 (15%)	5	75	24	19
Southern	1,018	76 (7%)	84	0	15	7
Western	817	59 (7%)	97	0	7	0

Source: Calculated from PHS data, 2008

Table 2. Households with Income from NTFPs by District and Product²

Province	District	Households interviewed (n=1257)	Households with income from NTFPs (n=216)	% of HH with income from			
				Woodfuel	Ants/ Caterpillars	Mushrooms	Wild Honey
Central	Kabwe	46	6 (13.0%)	100	0	0	17
Copperbelt	Kalulushi	44	5 (11.5%)	100	0	0	0
	Kitwe	45	7 (15.6%)	29	29	71	14
	Luanshya	40	4 (10.0%)	100	0	0	0
	Masaiti	82	11 (13.4%)	100	0	0	0
Luapula	Mansa	200	37 (18.5%)	45	55	29	0
	Milenge	45	6 (13.3%)	50	33	17	0
Northwestern	Chavuma	40	9 (22.5%)	0	78	44	11
	Kabompo	80	29 (36.3%)	3	86	10	21
	Mwinilunga	128	19 (14.8%)	5	63	42	26
	Zambezi	68	20 (29.4%)	0	95	10	15
Southern	Itezhi-tezi	60	9 (15.0%)	89	0	0	11
	Kazungula	60	7 (11.7%)	100	0	0	0
	Livingstone	40	7 (17.5%)	100	0	0	0
Western	Mongu	160	26 (16.3%)	100	0	4	0
	Senenga	119	13 (10.9%)	100	0	0	0

Source: Calculated from PHS data 2008.

In order to examine the distribution of NTFP-related income, households were divided into quartiles based on the value of assets owned. The results in Table 3 reveal that the wealthiest 25% derives more income from NTFPs than the other three wealth quartiles in absolute terms, but the share of total income (24%) is considerably lower than the share for the other three quartiles. This implies that poorer households are relatively more dependent on income from extraction and sale of NTFPs than wealthier households. Overall, NTFPs account for about a third of total household income for participating households in all the 16 districts, a finding that highlights the important role of NTFPs in rural livelihoods. While agriculture is the dominant economic activity in rural Zambia, income from NTFP-related business activities surpasses even agricultural income for the poorest 50% of the sample.

As previously stated, tobit models estimate the determinants of the probability of participation and the magnitude of the effects simultaneously, which assumes that the decision to participate and the level of income earned are influenced by the same variables. We compared the use of a tobit model against the two-stage Cragg model in the estimation of determinants of participation in NTFPs and contribution to income. The results of the formal log-likelihood ratio (LR) test between the two models confirmed the superiority of the Cragg tobit alternative model; that is, the test statistic $\Gamma=1138.01$ exceeds the critical value of the χ^2 distribution (p-value <0.01), suggesting that the decision to participate in NTFPs and the level of NTFPs' contribution to household income are governed by different processes.

² Some households in all the districts except Livingstone derived income from multiple NTFPs, thus total percentage of households with income from NTFPs across products is more than 100.

Table 3. Income Sources by Wealth Quartiles

Income source	Sub-sample of NTFP households (n=216)	Average income by wealth quartile (thousands of ZMK)			
		0-25% (n=54)	25-50% (n=53)	50-75% (n=54)	above 75% (n=54)
Total income		3,266	4,263	4,770	9,863
NTFP income	33%	1,253 (39)	1,382 (36)	1,341 (31)	2,244 (24)
Charcoal/firewood	22%	883 (29)	743 (24)	651 (20)	674 (15)
Ants/caterpillars	9%	196 (7)	436 (9)	537 (8)	877 (7)
Mushrooms	1%	85 (2)	51 (1.5)	71 (1.5)	76 (0.5)
Wild honey	1%	87 (0.8)	151 (2)	53 (0.8)	588 (2)
Agriculture income	35%	887 (31)	985 (30)	1,396 (38)	2,773 (40)
Employment income	3%	63 (3)	98 (3)	107 (1)	357 (4)
Trading income	25%	858 (21)	1,667 (26)	1,806 (26)	4,235 (28)
Remittance income	5%	205 (7)	130 (5)	120(3)	255 (4)

Source: Calculated from Supplemental PHS 2008.

Values in brackets are percentages of total household income from a particular source

Table 4 presents results of the Cragg tobit alternative model of household participation in NTFPs and the contribution of NTFP income. Stages 1 and 2 are maximum likelihood coefficients of the determinants of probability of participation in NTFPs and the contribution of NTFPs to total household income, respectively. For easier interpretation, the coefficients for the first stage are presented as the marginal effects in the fourth column; coefficients for the second stage are presented as unconditional average partial effects (UAPE) in the fifth columns. Test of significance for the average partial effects for the second stage was performed using the Delta method in Stata. The terms *marginal effect* and *partial effect* are used consistently with the literature on this technique, and share the same interpretation (see Wooldridge 2008, pp. 574-611 for treatment of UAPE). Model estimation and computation of UAPEs draw from Burke (2009), which uses the Delta method in Stata for computation of significance level for UAPEs.

The third column (Probit) in Table 4 presents marginal effects of the independent variables on a household's probability of participating in NTFPs. The fourth column (UAPE) shows the expected overall effect of each independent variable on household's share of NTFP income to total household income across all households (i.e., both participants and nonparticipants). Thus UAPE takes 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 the overall effect of each variable on the contribution of NTFPs to household income, and is therefore useful as a summary indicator of the effects of variables on income from NTFPs.

The results show that age of the household head is significantly and negatively associated with both the probability and level of contribution of NTFPs to household income, which suggests that households with relatively older heads are less likely to participate in NTFP activities, and if they do, the share of NTFP income is relatively less than for households headed by younger heads. Younger heads of households may report a higher share of income from NTFPs because of a relatively greater physical capacity for strenuous labor. Sex of the household head is positively and significantly associated with both participation in NTFPs

Table 4. Determinants of Household Probability of NTFP Participation and Income³

Variable	Marginal effects					
	Stage 1		Stage 2		Probit	UAPE
Intercept	-0.775	**	0.992	**	n/a	n/a
	(0.356)		(0.395)			
Age of household head (years)	-0.009	***	-0.000		-0.002	***
	(0.003)		(0.004)		(0.001)	(0.000)
Sex of household head	0.309	***	0.033		0.069	***
	(0.120)		(0.137)		(0.024)	(0.011)
Education level of household head	-0.046	***	-0.020		0.003	***
	(0.014)		(0.017)		(0.003)	(0.001)
Number of males aged 15-59 years	0.030		0.141	***	0.007	0.011
	(0.042)		(0.055)		(0.010)	(0.004)
Number of females aged 15-59 years	0.008		-0.129	**	0.002	-0.007
	(0.045)		(0.061)		(0.011)	(0.004)
Log of total land owned (ha)	0.069	*	-0.083	*	0.017	*
	(0.041)		(0.046)		(0.010)	(0.004)
Log of quantity of maize harvested (kg)	-0.029		-0.112	***	-0.007	-0.009
	(0.026)		(0.034)		(0.006)	(0.003)
Log of assets owned (ZMK)	-0.004		-0.042	***	-0.001	-0.003
	(0.010)		(0.012)		(0.002)	(0.001)
Distance to district town (km)	-0.006	**	-0.003		-0.001	**
	(0.002)		(0.004)		(0.001)	(0.000)
Distance to nearest main road (km)	0.010	*	0.009		0.002	*
	(0.005)		(0.007)		(0.001)	(0.000)

Number of observations=1257. *, ** and *** refer to statistical significance at 10%, 5% and 1% respectively. Standard errors are in parentheses.

business activities and the contribution of NTFPs to household income, suggesting that households headed by males are more likely to participate in NTFP than those headed by females⁴. Education of the household head is negatively associated with both the probability of participation in NTFP business activities and the contribution of NTFPs to household income. This implies that education is associated with a wider range of income-generating opportunities. Education expands the possibilities for labor and employment, whereas household heads with less education may be more economically vulnerable, and thus more likely to extract forest resources for income.

In most rural settings, both males and females are involved in the extraction and trade of NTFPs. The number of prime-age members in a household has implications for labor availability. However, it is important to disaggregate such labor by sex in order to understand the gender dynamics as it relates to NTFPs participation and contribution of NTFPs to household income. The positive relationship between number of prime-age male members and share of NTFPs suggests that having more prime-age males in a household is associated with greater contribution of NTFPs to household income. This is probably an indication that prime-age males are more commonly involved in extraction and trade of NTFPs than females. This is not surprising considering that production and trade of woodfuel (which is

³ Sixteen district dummy variables were included in the model, although they are not included in the table.

⁴ This may vary by type of NTFP, however, the analysis does not disaggregate by type of NTFP. Results represent an average across all four NTFPs.

the most common NTFP among participating households) is predominantly the work of males, as is the case with wild honey extraction. However, the number of prime-age males or females had no influence on NTFP participation, as evidenced by the lack of statistical significance of those variables in the Stage 1 and Probit columns. Landholding size is positive and significant in explaining probability of participation in NTFPs, but negatively associated with the contribution of NTFPs to household income.

The positive sign of landholding size on participation is, presumably, because most rural households with large tracts of land have more options for income diversification and may use forested land for woodfuel and other NTFPs. The Stage 2 results suggest that the NTFP share of income diminishes with greater landholding size, implying that greater access to land reduces rural households' dependence on NTFPs for income, and could play a role in controlling extraction to ensure resource sustainability.

The effect of wealth on NTFP participation and income can be estimated by the variable representing the value of household assets. The negative and significant average partial effect (UAPE) for the log of the value of household assets implies that households with more valuable assets rely less on NTFPs than those with less valuable assets. Using assets as a measure of overall wealth, these results imply that poorer households may be relatively more dependent upon NTFPs as a livelihood, and confirms our hypothesis of a positive relationship between poverty and dependence on natural resources such as NTFPs. Furthermore, the quantity of maize harvested is negatively and significantly associated with the level of NTFP contribution to household income. This may be an indication that food insecure 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.

It is common in Zambia to find traders selling NTFPs along main roads and at district market centers. Distances to the district town and to a main tarred road were used as proxies for market access. Overall, the distance from the household 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 also 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. The positive relationship between distance to main roads and both NTFP participation and income is consistent with other studies that have suggested that remote households face a lower opportunity cost of time and may be more likely to collect forest products (Pattanayak, Sills, and Kramer 2004); proximity to roads has also been found to be associated with greater deforestation and environmental degradation (Arnold, Köhlin, and Persson 2006). The scarcity of off-farm employment opportunities in remote areas is likely to compel households to engage in extraction and trade of NTFPs as a source of income.

5. CONCLUSIONS

This study examined the determinants of households' participation in NTFP-related business activities and contribution of NTFPs to rural household income in Zambia. It has shown that NTFPs contribute about 33% to household income for participating households, on average. Generally, the results show that poor households rely more on NTFPs than their wealthier counterparts, confirming the hypothesis of a positive relationship between poverty and dependence on NTFPs. This finding is consistent with other literature on the role of NTFPs in rural livelihoods (Jumbe, Bwalya, and Husselman 2008; Shackleton and Shackleton 2006; Arnold, Köhlin, and Persson 2006; Cavendish 2000). In terms of absolute value, the wealthy recorded higher income from NTFPs, indicating that wealthy households trade in larger volumes of NTFPs than the poor, or perhaps are engaged in high value NTFPs; however, poorer households reported higher levels of income from charcoal and firewood. The results also indicate that location is an important determinant of participation in NTFPs, with NTFPs being particularly important in Mansa, Kabompo, Zambezi, Itezhi-tezi, Livingstone, and Mongu districts, as indicated by the positive and significant coefficients for the aforementioned district dummy variables. Thus, interventions aimed at increasing rural incomes through extraction and sale of NTFPs would be effective if focused on these districts (while also considering the ecological implications of increased woodfuel extraction).

Human capital factors—particularly, age, sex, and educational level of the head of household—are significant determinants of household participation in NTFPs and of the contribution of NTFPs to household income. All else being equal, an increase in age and education is associated with a decline in the probability of participation in NTFP-related business activities and in the associated contribution to household income. The results also show that access to markets is critical for household participation in NTFPs.

The positive relationship between poverty and dependence on NTFPs underscores the importance of integrating forest management policies and rural development strategies to 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 extract NTFPs. However, careful policy considerations are required to ensure rural household welfare improvement while sustaining the forest.

Generally the collection and trade of most NTFPs by rural households may have negligible ecological impacts, with the exception of charcoal and firewood. Charcoal production is often associated with clearing land for crop farming, and involves cutting big trees into smaller logs and burning them in a kiln. The charcoal is primarily meant for sale rather than use, as rural households primarily use firewood for their own cooking and heating. Projections of growing demand for charcoal suggests that if left unchecked, expansion of charcoal production may compromise the integrity of forests and adversely affect ecosystem functions and the availability of other NTFPs that sustain households (Richardson 2010). 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.

Promotion and expansion of markets for other NTFPs (such as caterpillars, wild honey, and mushrooms) could help to reduce households' reliance on woodfuel as an income source. As indicated in Table 4, other NTFPs contribute substantially to household income; in the presence of appropriate interventions, these other products could contribute even more to

household incomes. Demand-side strategies (such as the promotion of improved or efficient charcoal braziers or alternative cooking stoves) should be considered for their possible role in reducing charcoal demand.

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 33% to total household income for participating households. Generally, the results of this study indicate that NTFPs play an important part in supporting rural livelihoods in the 16 districts studied. As such, NTFPs can be used to build a case for forest resource conservation in rural communities by ensuring that rural households understand that the continued availability of NTFPs depends, to a large measure, on the integrity of the forests. Caution also needs to be exercised with regard to clearing of forests for agricultural purposes as continued excessive clearing may threaten access by rural households to forests for alternative income-generating activities. 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.

In terms of research implications, the literature on non-farm/off-farm income generation often distinguishes between casual or *ad hoc* 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) (Shackleton and Shackleton 2004). Panel datasets could be used to better understand household participation over time (as opposed to a one-time snapshot).

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