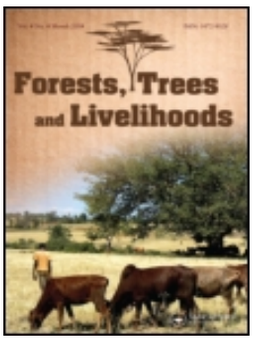

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Are miombo woodlands vital to livelihoods of rural households? Evidence from Urumwa and surrounding communities, Tabora, Tanzania

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This study investigated contribution of miombo woodland resources accrued from Urumwa Forest Reserve (UFR) to income of rural households. Data and conclusions are based on 84 randomly surveyed households in four villages adjacent to UFR. Using descriptive statistics, the analysis was guided by the sustainable livelihood framework conceptual model. Results show that the miombo woodlands of the UFR account for 42% of total household income. Further analysis reveals that woodlands contribute 28% and 59% of non-monetary and monetary income, respectively. This demonstrates a significant role played by miombo woodlands. Woodland resources contribute to household income through various livelihood activities. Accordingly the woodland resources accrued from the UFR cover human basic needs. Results from this study empirically demonstrate the vital role played by miombo woodlands in either supporting current consumption or serving as safety net. It is, therefore, recommended that current and future management strategies in the forest sector emphasize forest and livelihood dimensions for sustainability of both livelihood and forest and woodland resources.

Keywords: miombo woodlands; products and services; livelihood; household income

Introduction

Miombo woodlands constitute a large part of the African continent covering 2.4 million km^2 of southern, central and eastern Africa (Frost et al. 2003; Chidumayo & Gumbo 2010; Dewees et al. 2011). This forest formation is dominated by legume trees of the family Fabaceae (sub-family Caesalpinaceae), belonging to the genera *Brachystegia*, *Julbernardia* and/or *Isoberlinia*, with an understory dominated by C_4 grasses (White 1983). Miombo woodlands have been reported as central to the livelihoods of millions of rural and urban dwellers for providing fuel wood, building materials, medicines, food and ecosystem services (Campbell et al. 2007; Chidumayo & Gumbo 2010; Dewees et al. 2011). A comparative study of rural livelihoods in Kenya, Uganda, Malawi and Tanzania (Ellis & Freeman 2004) found that household total income was distributed almost equally between farm (crop and livestock production) and non-farm activities (wages, self-employment and remittances). However, the study did not mention the role of forests in livelihoods. Elsewhere in the region, studies have documented the role of forest-based income in total household income. Cavendish (1999) estimated that 35% of the total income of rural households in communal area originated from environmental products; Fisher (2004) reported that 30% of household income in rural Malawi was forest income; Arnold (2008) reported that forest income represented 22% of the average total household

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income (whereas the share of agriculture and livestock was 37% and that of off-farm activities was 38%); Mutamba (2007) and Mulenga et al. (2012) in Zambia reported that forest products contributed 54% and 34% to total gross income, respectively. Similar findings have been reported by Babulo et al. (2009) and Tesfaye et al. (2011) in Ethiopia.

In Tanzania, miombo woodlands are largely distributed in the southern and western part of the country. According to the national land cover and land use reconnaissance carried out in 1996, miombo woodlands covered 374,356 km^2 or about 93% of the total forest area of Tanzania (Mnangwone 1999), this represents a significant vegetation cover at country scale. Majority (80%) of Tanzanians live in rural areas (NBS 2009) and highly depend on natural resources. Moreover, the remaining population which is clustered in cities and towns highly depends on natural resources, especially for source of energy. Accordingly, nearly all miombo woodlands in Tanzania are under significant human pressure (Luoga 2000; Abdallah & Sauer 2007; Yanda 2010; Giliba et al. 2011; Mangora 2012). However, a few studies have reported the role of miombo woodlands to livelihoods in Tanzania (Lund & Treue 2008). This paper investigated the contribution of miombo woodland resources accrued from the Urumwa Forest Reserve (UFR) (Tabora Region, western Tanzania) to the livelihoods of rural households. Specifically, the study attempted to answer the following research question: Does miombo woodlands contribute significantly to household income (monetary and non-monetary)? Such information is useful in understanding fully the vital role of this ecosystem in livelihood systems as a basis for proper and effective management planning in the forestry, agriculture and development sectors in Tanzania and in the region at large.

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Study area and methods

Study area

The Tabora region is located in mid-western Tanzania on the central plateau between latitude 40–70° South and longitude 31–34° East. The maximum monthly temperature varies between 27 and 30°C, while the minimum monthly temperature varies from 15 to 18°C. Rainfall is markedly seasonal and ranges between 700 mm in the north-east and 1000 mm in the western part. The rainfall pattern is characteristically variable and unpredictable both spatially and temporarily, with a risk of long dry spells at any time during the rainy season, and incidences of long droughts are a common phenomenon (Simon 1998). The region is endowed with substantial woodland estate of nearly three and a half million hectares which are within 33 forest reserves, which altogether embrace two-thirds of the regional total area and represents more than one-quarter of the national forest resources (Wily & Monela 1999). The main socio-economic activities of people in the Tabora region include agricultural production and livestock keeping.

More specifically, the study was conducted in four (Isukamahela, Kipalapala, Masimba and Mtakuja) out of the eight villages that surround the UFR, Uyui district. The UFR is located about 15 km south of Tabora town. The miombo woodland of the UFR covers 12,800 ha, and the communities adjacent to the UFR are mostly farmers, pastoralists or agro-pastoralists. Crops being farmed include cash (tobacco, groundnut and sunflower) and subsistence (maize, paddy, millet, cassava and beans) crops. Inhabitants in the study area either belong to Nyamwezi or to Sukuma ethnic groups. Villagers in Isukamahela are mainly farmers or agro-pastoralists, whereas in Kipalapala villagers are predominantly farmers. Furthermore, Masimba and Mtakuja villages are mainly inhabited by agro-pastoralists and farmers, respectively.

The UFR is among the 'Pilot Joint Forest Management (JFM)' initiated since 1996. The Uyui district office in Tabora represents the Forest and Beekeeping Division in the management of the UFR. JFM in the UFR was adopted in response to villagers' request to be granted access to the woodland resources. Accordingly, villages surrounding the UFR were granted user rights and co-management responsibilities.

Methods

Conceptual framework of the study and model for analyses

We used a conceptual framework based on the sustainable livelihood framework model to present the relationships between various factors (capitals, shocks, trends and seasonality, structure and processes, household livelihood strategies and livelihood outcomes) and how these factors interact to bring about livelihood outcomes. We adopted the definition of livelihood given by Ellis (2000): 'livelihood comprises the assets (natural, physical, human, financial and social capitals), the activities and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household'. Figure 1 depicts the conceptual livelihood framework model. The model is adapted from Carney (1998) and Scoones (1998), with inputs to the model based on this study.

The main focus of this study was to show how miombo woodland resources contribute to livelihood outcomes through activities facilitated by institutions and policies. The livelihood outcomes considered in this study are income and vulnerability, other outcomes being beyond the scope of this study. We stratified income sources into four categories: woodland, farm, livestock and business. By income we mean both monetary and non-monetary.

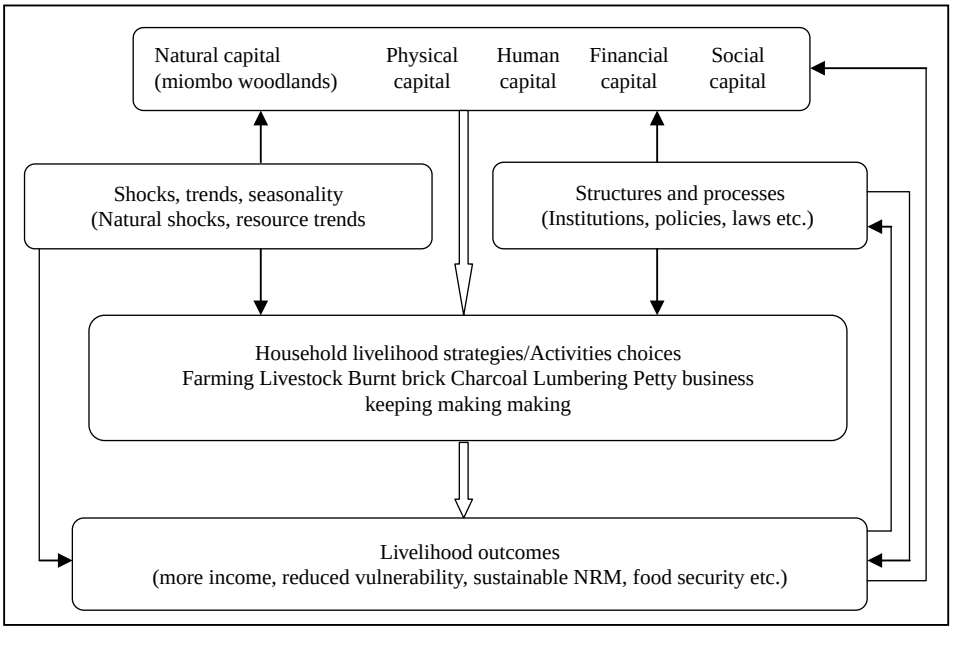

Figure 1. Sustainable livelihood conceptual framework model. *Source*: DFID's sustainable livelihoods framework (Carney 1998) and IDS's sustainable rural livelihoods framework (Scoones 1998).

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Our unit of analysis was the household which was defined here as the basic residential unit in which economic production, consumption, inheritance, child rearing and shelter are organized and carried out; it may or may not be synonymous with family. On analysing household vulnerability, we focused on the contribution of forest income to total income and on the role of the said income as either safety net, support of current consumption, a pathway out of poverty, or a combined role. The livelihood functions may be defined as follows:

> *Safety net:* forest income is used to cover unexpected income shortfall of cash needs (Angelsen & Wunder 2003; Cavendish 2003; Arnold 2008).
>
> *Support of current consumption:* forest products are important to maintain the current level of consumption and prevent the household from falling into deep poverty (Angelsen & Wunder 2003; Cavendish 2003).
>
> *Pathway out of poverty:* forest products provide a way to increase household income sustainably through either a 'stepping out' strategy (accumulation of capital to move into other activities) or a 'stepping up' strategy (intensification and specialization in existing activities (Dorward et al. 2001; Arnold 2008).

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Data collection

Data collection was carried out between August and December 2007. Four villages, located at various distances from the forest and composed mainly of either farmers or pastoralists, were purposively selected so as to capture variation across the study sites (Jagger 2012) on the role of woodland resources to rural households. Primary data collection entailed Participatory Rural Appraisal (PRA), household survey and interview with key informants.

PRA aimed to acquire general knowledge about the study area on the set-up of livelihood systems, particularly in relation to miombo woodland resources, opportunities and constraints. PRA discussion meetings were held in Isukamahela and Mtakuja: 15–20 individuals participated in PRA meetings. PRA participants included village government members, key informants and lay people, both men and women. PRA techniques used include resource mapping, matrix scoring, local histories and time lines. During the entire process, the researchers served as facilitators while insiders fully participated in the dialogue. Local language, Kiswahili, served as a means of communication. Information generated during PRA exercises was used to consolidate and triangulate the data obtained through household survey.

A total of 84 households (10% of total households in each village) were sampled for the household survey, consisting of 12 households in Isukamahela, 49 households in Kipalapala, 9 households in Masimba and 14 households in Mtakuja. Households were selected based on a random sampling procedure, with village registers used as sampling frames. The survey was carried out using a structured questionnaire aimed to capture both qualitative and quantitative information. The questionnaire was carefully designed to include all information as outlined in the study conceptual framework. The questionnaire included key issues such as livelihood activities, what do households accrue from the miombo woodland, uses/purpose, species and price/income derived from sale of woodland resources. Species identification was restricted to trees and shrubs; respondents identified species used for different purposes in their mother tongue, which in this case is Sukuma or Nyamwezi. Further translation of tree and shrub species to botanical names was done by using a master checklist of tree and shrub species for the UFR. The checklist was prepared by a renowned botanist in the country, C.K. Ruffo. Prior to full-scale data collection, questionnaires were pretested in order to check applicability, reliability and validity of

information collected. Secondary information which served as supplementary data was collected from relevant administrative institutions, library and publications.

Key informant interviews were administered to individuals with specialized or in-depth knowledge about a subject under investigation. The interviews were conducted at Isukamahela village office with 10 herbalists; 5 from Masimba and 5 from Isukamahela.

Data analyses

Data analyses were guided by the conceptual framework model (Figure 1). The study used descriptive statistical data analysis techniques. Tobacco farming is among the prominent farming activities in the study area. Once tobacco has been harvested, it needs to be cured before it can be marketed. This process heavily depends on firewood as a source of energy. Thus, if income from tobacco was entirely treated as farm income, the role of firewood would be largely underestimated because a share of firewood used in tobacco curing would not be accounted. Conversely, if income from tobacco was treated as woodland-based income, it would also be misleading. Accordingly, this necessitated partitioning income from tobacco into farming and woodland income. However, during data collection, we did not capture information (such as the monetary value of firewood used in curing tobacco) that would have helped us to disaggregate the total income from tobacco as a basis for accounting firewood used in tobacco curing into woodland-based income. Thus, on the basis of practical experience, we assumed that the wood resource used as firewood in tobacco curing represented 50% of the total income from tobacco per household. Therefore, 50% of total income from tobacco was attributed to farm income and the remaining 50% to woodland income. We report currencies in US$; the local currency is Tanzanian Shillings (TZS). The exchange rate at the time of data collection was US$ 1 = TZS 1260. All income values were further standardized to adult equivalent as described by Cavendish (2002), in order to account for differences in household composition and size. Woodland income which is referred to as environmental income by Vedeld et al. (2004) and Jagger (2012) among others was obtained by multiplying the quantity of woodland resources by the price or value of the respective woodland resources. It is argued by Jagger (2012) that the data collected on environmental income are a challenging task because environmental resources are obtained freely from the wild and that there are less or missing market prices. Accordingly, in this study, we used average prices based on reported prices of woodland resources to compute both non-monetary and monetary incomes. A similar approach was used for farm incomes, whereas livestock and business incomes are based on reported gross incomes.

Results

Contribution of miombo woodland resources to household income

This study sought to discover the role of miombo woodland resources in households' livelihood. Descriptive statistics show that households earn a mean annual income of US$ 154 per Adult Equivalent Unit (AEU) (Table 1). The household income accounts for both monetary and non-monetary values. In a descending order, farming (45.8%), miombo woodland resources (42.8%), business (9.2%) and livestock (2.2%) contribute to household income (Table 1). Based on these results, farm and woodland resources are the prominent sources of income. However, when income per AEU is disaggregated into non-monetary and monetary values, the relative importance of each income source changes. Results summarized in Table 1 show that the average non-monetary annual income per

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Table 1. Distribution of households' total income per AEU.

	N	Minimum	Maximum	Mean	SE	% Share of income
Non-monetary income (US$)						
Farm income	84	10	157	59	3.2	72.0
Woodland income	84	0	107	23	2.0	28.0
Non-monetary total income	84	16	185	82	4.3	100.0
Monetary income (US$)						
Woodland income	84	0	331	43	5.6	59.0
Business income	84	0	373	14	5.5	20.0
Farm income	84	0	101	11	1.6	16.0
Livestock income	84	0	105	3	1.4	5.0
Monetary total income	84	0	404	72	7.8	100.0
Overall income (US$)						
Farm income	84	20	185	71	3.6	45.8
Woodland income	84	0	406	66	6.5	42.8
Business income	84	0	373	14	5.5	9.2
Livestock income	84	0	105	3	1.4	2.2
Overall household income	84	31	491	154	9.7	100.0

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AEU is US$ 82, whereby farming and woodland resources, respectively, contribute 72% and 28% of this non-monetary income. Accordingly, woodland resources and farming contribute 59% and 16% of the monetary income, respectively (Table 1).

Maize, tobacco, sweet potatoes, groundnut and cassava are among the major crops grown in the study area. Accordingly, tobacco, which heavily depends on wood resources from miombo woodlands for curing, contributes 19% to the average household monetary income per AEU (Table 2). Miombo woodlands are important source of both monetary (65%) and non-monetary income (35%). Firewood which is used as a source of energy and poles used for construction purposes contribute to a large share of the non-monetary annual income, whereas the sale of charcoal and honey from miombo woodlands contributes 29% and 25%, respectively (Table 2).

Livelihood activities

Like many places in rural settings, farming received 100% response among livelihood activities practiced in the study area. As mentioned in the methodology, in this study farming excluded an account of tobacco so as to capture dependency of tobacco farming on miombo woodlands. Other livelihood activities observed in the study area include beekeeping (32%), livestock keeping (31%), business (23%), charcoal making (21%), collection of medicinal plants (15%), brick making (12%) and lumbering (10%).

Accordingly, 56% of the surveyed households claimed that their livelihood strategies have been shaped by food insecurity and hunger periods. When households were asked about livelihood strategies undertaken to cope with such challenges, 23% of the respondents claimed that they resorted to woodland resources as source of income, whereas 15% and 12%, respectively, mentioned wage labour and reducing number of meals. Other livelihood strategies mentioned include selling of livestock (8%), remittances (8%) and purchase food from others within the village or beyond (1%). During PRA exercises, it was revealed that livelihood strategies (e.g. lumbering and charcoal making) undertaken to cope with shocks are not permanent, rather households engage in such activities during periods of shocks or stress associated with food insecurity.

Table 2. Distribution of households' woodland income per AEU.

	N	Minimum	Maximum	Mean	SE	% Share of income
Non-monetary income (US$)						
Firewood	84	0	61	16	1.1	69.0
Pole	84	0	37	5	0.7	20.0
Woodland vegetable	84	0	9	1	0.2	3.0
Woodland fruits	84	0	8	1	0.2	3.0
Thatch grass	84	0	4	1	0.1	2.0
Rope	84	0	6	0	0.1	1.7
Mushroom	84	0	3	0	0.0	1.0
Edible insects	84	0	1	0	0.0	0.3
Non-monetary total income	84	0	107	23	2.0	100.0
Monetary income (US$)						
Firewood for tobacco curing	84	0	66	2	0.9	5.0
Charcoal	84	0	114	12	2.2	29.0
Timber	84	0	127	8	2.4	19.0
Honey	84	0	82	11	2.3	25.0
Brick making	84	0	73	7	1.7	17.0
Woodland medicine	84	0	26	2	0.5	5.0
Monetary total income	84	0	331	43	5.6	100.0
Overall income (US$)						
Monetary total income	84	0	331	43	5.6	64.7
Non-monetary total income	84	0	107	23	2.0	35.2
Overall woodland income	84	0	406	66	6.5	100.0

Products and services derived from miombo woodland of UFR

Table 3 summarizes characteristics of the 16 reported woodland products and services derived by households from the miombo woodland of the UFR. The reported woodland products and services cover basic household needs including firewood, charcoal, construction materials, food and medicines. Accordingly, households reported tree and shrub species used for various purposes which are categorized into 14 products (Appendix 1). Based on data in Appendix 1, 75 species are used for firewood, 72 species support beekeeping through provision of bee forage and material for beehive, 67 species are used for charcoal making and 60 species are used as medicinal plants. Accordingly, 57 species are used for making various household items such as wooden spoon, pestle and tool handle, 42 species are used for pole, 30 species are edible, 20 species offer fodder and 18 species are used for timber. Other categories used include carving (17 species), fibre (8), hedge (8), rope (4) and birdlime (2). It is observed that tree and shrub species supporting a given category ranging from 2 to 75 (mean = 34), e.g. over 70 species, are used for firewood; more than 40 species are used for pole. Similarly, each tree and shrub species supports at least two categories (range = 2–10; mean = 6). For example, *Brachystegia boehmii* supports five categories such as firewood, charcoal, beekeeping (bee forage and beehive), household items (pestle and tool handle), fibre and rope (Appendix 1).

Firewood and charcoal

In the study area, 95% of the surveyed households use firewood as the main source of energy (Table 3). Data from PRA indicated that firewood is used for cooking, brick making, local brew making, tobacco curing, warming and lighting.

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Table 3. Woodland products derived from the UFR.

Products/service	Number of species used	Mtakuja ($N = 14$)	Isukamahela ($N = 12$)	Masimba ($N = 9$)	Kipalapala ($N = 49$)	Overall use ($N = 84$)
Firewood	76	14 (100)	12 (100)	9 (100)	45 (92)	80 (95)
Charcoal	68	1 (7)	2 (17)	1 (11)	6 (12)	10 (12)
Thatching grass	NA	10 (71)	10 (83)	9 (100)	19 (39)	48 (57)
Pole	43	9 (64)	11 (92)	9 (100)	16 (33)	45 (54)
Rope	5	8 (57)	9 (75)	8 (189)	15 (31)	40 (48)
Timber	19	2 (14)	4 (33)	0 (0)	1 (2)	7 (8)
Edible wild fruit	31	6 (43)	4 (33)	8 (89)	2 (4)	20 (24)
Edible wild vegetable	NA	6 (4)	2 (17)	7 (78)	0 (0)	15 (18)
Edible mushroom	NA	3 (21)	3 (25)	9 (100)	0 (0)	15 (18)
Honey (bee forage)	73	5 (36)	8 (67)	0 (0)	2 (4)	15 (18)
Edible insect	NA	2 (14)	3 (25)	9 (100)	0 (0)	14 (17)
Wild meat	NA	0 (0)	1 (8)	2 (22)	0 (0)	3 (4)
Medicinal plant	61	6 (43)	7 (58)	9 (100)	2 (4)	24 (29)
Grazing	NA	6 (43)	7 (58)	7 (78)	0 (0)	20 (24)
Beehive (bee forage)	73	5 (36)	8 (67)	2 (22)	0 (0)	15 (18)
Beeswax (bee forage)	73	4 (29)	6 (50)	5 (56)	0 (0)	15 (18)

Note: NA denotes not applicable. Percentages in parentheses.

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Most households collect firewood on a weekly basis. Based on data from household survey, the mean gross monetary value of firewood collected annually from the woodland is US$ 66 ± 4 (SE) per AEU. Firewood is sold at US$ 0.8 ± 0.1 (SE) per head load in the study area. A head load means a pile of firewood carried on the head of men or women with an average weight of 25 kg. Species used for firewood reported by household are enumerated in Appendix 1. Data from household interviews revealed that attributes of a species preferred for firewood include medium-to high-wood density, low-moisture content, long-lasting coals, low-smoke yield, absence of thorns and absence of unusual fumes or smells.

A few (21%) households in the study area claimed to be engaged in charcoal making in the UFR (Table 3). However, this is contrary to researchers' observations, as charcoal making was observed to be a prominent livelihood activity in the UFR. Failure to admit involvement in charcoal making may be related to the illegality of such undertaking. It is, therefore, worth noting that income from charcoal has been significantly underestimated. Households in the study area hardly use charcoal, instead charcoal is sold to generate income, which supplements households' total income. Species used for charcoal making are listed in Appendix 1. Based on data from household interviews, households collect an average of 32 ± 5 (SE) bags/year annually from the UFR, which represents about US$ 50 ± 8 (SE) per annum on the AEU scale.

Construction materials

Construction materials reported by households include thatching grass (57%), pole (54%), rope (48%) and timber (8%) (Table 3). On average, households collect 3 ± 1 (SE) head loads of thatching grass, 22 ± 3 (SE) of poles, 2 ± 0.3 (SE) kg of rope and 9 ± 2 (SE) planks of timber annually. Reported price of construction materials in local markets is as follows: thatching grass US$ 0.6 ± 0.04 (SE) per head load; pole, US$ 0.8 ± 0.1 (SE) per pole; rope, US$ 0.8 ± 0.2 (SE) per kg and timber US$ 3 ± 0.3 (SE) per plank. Species used for various construction materials are annexed in Appendix 1.

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Wild food

Six types of wild food from the miombo woodland were reported in this study (Table 3). They include edible wild fruit (24%), edible wild vegetable (18%), edible mushroom (18%), honey (18%) edible insect (17%) and wild meat (4%). However, wild meat was underestimated by surveyed households because it is unlawful.

Based on data from household survey, households collect an average of 6.7 ± 1.5 (SE) kg of edible wild fruits annually. Quantities of wild fruits reported account for domestic consumption only because fruits are normally not commercialized in the study area. Children who look after herds of cattle are those most engaged in wild fruit collection/consumption. This leads to underestimation of the role of fruits at household level because it is hard to precisely quantify. Furthermore, the seemingly low quantity of collected wild fruits may be attributed to the limited sample size of surveyed households. Over 30 woodland species consumed as fruits have been identified in this study (Appendix 1). Fruits found to be common across households include *Adansonia digitata*, *Tamarindus indica*, *Parinari curatellifolia*, *Vitex doniana* and *Vitex mombassae*. Price of wild fruits could not be established because commercialization of fruits is not a common practice in the study area; however, on visit to a neighbouring urban market in Tabora town, a tin of *V. mombassae* and *V. doniana* fruits were sold at US$ 0.2, respectively, whereas a tin of fruits of *P. curatellifolia* was sold at US$ 0.4. On average a tin is about 1 l.

Households collect about 10.7 ± (SE) kg of wild vegetable annually, this entails both domestic and commercialized vegetable. Price of wild vegetable in local market in Tabora varies depending on the species; however, the mean price is US$ 0.2 ± 0.0 (SE).

In the study area, households use honey as sweetener, medicine and in brewing alcohol. As food, honey is mainly taken with sweet potatoes, cassava or used instead of sugar for porridge or tea. In the study area, honey is widely used as an ingredient in local brew making. Household survey data showed that about 171 of honey is accrued by households from UFR annually. Honey is sold at US$ 2.2 ± 0.2 (SE) per litre in the local market. The reported quantities, however, do not include honey consumed domestically because households could not quantify domestic consumption.

Medicinal plants

Over 60 species of medicinal plants have been reported in the study area (Table 3). Data from key informant interviews revealed that medicinal plants are used by households as a livelihood strategy to substitute the otherwise expensive and unreliable health services. Diseases treated by enumerated species include coughs, headache, sores, diarrhoea, hernia, asthma, snake-bite, fever, malaria, constipation and typhoid to name just a few. For example, *Combretum zeyheri* is used to treat typhoid, *Cassia abbreviata* is used for stomachache, headache, malaria and fever. According to interviewed herbalists, parts of plants utilized as medicine include roots, leaves, barks or wood stem. It was further noted that herbalists have acquired such knowledge from their ancestors.

Other products and services

Other woodland products enumerated in the study area include grazing, beehive and beeswax (Table 3). Over 20% of all respondents depend on the UFR as a grazing area for their livestock. Livestock includes cattle, goat and sheep. Results indicated that, among the study sites, Masimba village appeared to be more involved in livestock keeping than other villages because it is largely inhabited by people from the Sukuma ethnic group.

Discussion

Contribution of miombo woodland resources to household income

Results revealed that woodland income is an important part of the household income portfolio after farm income and that the difference between the two is not significant. We, therefore, argue that, because in Tanzania agriculture is among the national priority, management of forests and woodlands should be given an equal importance in development planning.

The 43% contribution of woodland to households' total income is less than the 54% contribution of forest income reported by Mutamba (2007) in Zambia, whereas significantly more than the 15% contribution of woodland products to total household income is reported in Zimbabwe by Campbell et al. (2002). Similarly Dewees et al. (2011) reported 43–49% contribution of forest products in four villages in Zambia. Results from the two studies are comparable because the scope of woodland/forest income entails both monetary/cash and non-monetary/subsistent income. Despite variation in spatial locations, differences in sampling intensity and slight differences in methods, woodland and forest incomes remain an important part of household income portfolio, contributing reasonably to both monetary and non-monetary income. Conversely, the variation in income estimates may be attributed to differences in methods (Jagger et al. 2012) as well as sample size.

When income per AEU is disaggregated into non-monetary and monetary values, the relative importance of the various income sources changes dramatically, with woodland income becoming the leading monetary income source (Table 1). The plausible reason why woodland resources contribute less than farm income may be attributed to price of key woodlands product, which in this regard is firewood. Although firewood is used in large quantity domestically, it fetches low value in local markets (and is not in high demand in neighbouring town of Tabora) than crops such as maize, particularly when sold strategically (e.g. seasons of low supply).

Among other woodland products, charcoal contributes a large share in monetary income. Plausibly this is due to high value fetched in neighbouring markets of Tabora town. Conversely, tobacco as a cash crop contributes reasonably to farm monetary income, but depends on wood resources from woodlands. Yanda (2010) and Mangora (2012) have attributed deforestation of miombo woodlands to tobacco farming. This, therefore, calls for intervention to sustainably manage miombo woodlands in order to sustain woodland-based livelihoods, which are essential in generating both monetary and non-monetary income to households.

Household income facilitated by livelihood activities may be regarded as a livelihood outcome. In the study area with the exclusion of farming and business, the rest of livelihood activities depend on miombo woodlands in one way or the other. Furthermore, it is reported that households resort to exploit miombo woodland resources in various ways in order to generate income, particularly cash income, e.g. households engaged in lumbering and charcoal making which are said to be activities undertaken when households suffer from food insecurity and prolonged hunger periods. In other words, miombo woodland resources play two important roles on households; as safety net that cushions households during hardship and as a support to current consumption/regular subsistence. Woodland resources as safety net have also been reported by Lund and Treue (2008) while studying the miombo woodland of southern Tanzania. They argued that the need to buy food and other basic requirements is the main reason for pursuing cash earnings from forest products.

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Woodland products and services

In the context of the sustainable livelihood conceptual framework, woodland products and services form the backbone of natural capital. Results based on this study presents a range of products and services which cover basic household needs. They include wood fuel (firewood and charcoal), construction materials, food, medicine and other necessities. Data on species used for various categories confirm the potential role played by miombo woodlands in livelihoods, particularly through enhancing households' resilience by offering a range of options in terms of species per category. Furthermore, the multi-utility nature of miombo woodland species explains their importance, and this calls for proper management of miombo woodlands.

Households reporting in the study area narrated qualities of firewood as a source of energy. Such qualities can be met by various species available in the UFR. Therefore, it is of paramount importance that tree and shrub species diversity in miombo woodlands is sustained. This in addition will ensure the well-being of households in rural areas through provision of diverse species for construction purposes, wild food, medicines and other necessities.

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Conclusions and policy recommendation

This study assessed the relative contribution of woodland income to total household income. Similarly the study documented a number of products and services accrued from miombo woodland of the UFR which through various livelihood activities contributed to household well-being. On the basis of descriptive statistics, we conclude that miombo woodlands of the UFR play a vital role in the livelihoods of rural communities, accounting for 42% of the total household income. Further analysis revealed that woodlands contribute 28% and 59% of non-monetary and monetary income, respectively. This demonstrates a significant role played by miombo woodlands in supporting current consumption as well as serving as safety net. Data from PRA showed that livelihood strategies such as lumbering and charcoal making are not permanent, rather households engage in such activities during periods of shocks or stress associated with food insecurity. This finding suggests that monetary income derived from miombo woodlands is used to cover unexpected income shortfall of cash needs. The woodland resources accrued from the UFR provide wood fuel, construction material, wild food, medicine and other necessities which altogether are central to the livelihood system of rural households. However, it remains unknown whether extraction of woodland resources is sustainable.

There is a growing concern in supporting and understanding the link between forest and livelihoods. This has led to policy change in Tanzania and many parts of the world in the forest sector. In Tanzania, agriculture has consistently remained a national priority due to its vital role in livelihoods. Accordingly, findings from this study demonstrate that farming is important for non-monetary income whereas woodland resources are important for both monetary and non-monetary income. On the basis of this study, we reiterate that the interface between woodlands and forests and livelihoods is strong, thus current and future management strategies in the forest sector should not underscore the said strong interface. This will not only promote livelihoods but rather ensure sustainability of natural resources, hence protecting forest and woodland dependents from falling into deeper poverty.

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Appendix 1. Use of tree and shrub species found in the UFR

Sl No.	Tree/shrub species	Product														No. of uses
		Timber	Pole	Firewood	Charcoal	Medicinal	Edible*	Fodder	Beekeeping*	HH items*	Fibre	Birdlime	Carvings	Hedge	Rope	
1	*Acacia drepanolobium* Harms ex Sjostedt			√	√				√		√					4
2	*Afzelia quanzensis* Welw.	√	√	√	√				√	√				√		7
3	*Albizia antunesiana* Harms.	√	√	√	√	√			√	√			√			8
4	*Albizia harveyi* E.Fourn.		√	√	√	√		√	√	√			√			8
5	*Annona senegalensis* Pers.		√	√	√	√	√	√	√	√						8
6	*Azanza garckeana* (F. Hoffm) Exell & Hillcoat		√	√	√		√	√	√	√			√			8
7	*Berchemia discolor* (Klotzch) Hemsl.	√	√	√	√		√		√	√			√		√	9
8	*B. boehmii* Taub.			√	√				√	√	√				√	6
9	*Brachystegia spiciformis* Benth.	√	√	√	√	√			√	√					√	8
10	*Brychystegia microphylla* Harms	√	√	√	√	√			√	√	√				√	9
11	*Brychystegia wangermeeana* De Wild.	√		√	√	√			√	√	√					7
12	*Burkea africana* Hook.	√	√	√	√				√	√						6
13	*Calotropis procera* (Aiton) W.T. Aiton			√		√										2
14	*C. abbreviata* Oliv. ssp. *abbreviata*		√	√	√	√			√	√						6
15	*Cassipourea mollis* (R.E. Fries) Alston		√	√	√	√			√	√						6
16	*Catunaregam spinosa* subsp. *taylorii* (S.Moore) Verdc.		√	√	√	√				√						5
17	*Chrysophyllum bangweolense* R.E. Fries		√	√	√	√			√	√		√				7
18	*Cissus cornifolia* (Bak.) Planch.					√	√		√							3
19	*Clerodendrum myricoides* (Hochst.) R. Br. ex Vatke			√		√							√			3
20	*Combretum adenogonium* Steud.			√	√	√			√							4
21	*Combretum collinum* subsp. *binderianum* (Kotschy) Okafor		√	√	√	√			√	√						6
22	*Combretum molle* R. Br. ex G. Don		√	√	√	√			√	√						6
23	*Combretum obovatum* F. Hoffm.			√					√	√				√		4

(*Continued*)

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Appendix – *continued*

Sl No.	Tree/shrub species	Product													No. of uses
		Timber	Pole	Firewood	Charcoal	Medicinal	Edible*	Fodder	Beekeeping*	HH items*	Fibre	Birdlime	Carvings	Hedge	Rope	
24	*C. zeyheri* Sond.			√	√	√		√	√							5
25	*Commiphora africana* (A.Rich) Engl.					√	√	√						√		4
26	*Commiphora mossambicensis* (Oliv.) Engl.						√	√						√		3
27	*Crossopteryx febrifuga* (Afzel. ex G. Don) Benth.			√	√	√				√			√			5
28	*Dalbergia melanoxylon* Guill. & Perr.	√	√	√	√	√	√	√	√	√			√			10
29	*Dalbergia nitidula* Welw. ex Baker		√	√	√	√			√	√						6
30	*Diospyros fischeri* Gürke			√	√	√				√			√			5
32	*Diplorhynchus condylocarpon* (Muel. Arg.) Pichon			√	√				√	√		√				5
33	*Ekebergia benguelensis* C. DC.			√	√	√			√	√						5
34	*Erythrophleum africanum* (Welw. ex Benth.) Harms	√	√	√	√	√			√							6
35	*Ficus sycomorus* L.			√			√	√								3
36	*Flacourtia indica* (Burm.f.) Merr.			√	√	√	√	√	√							6
37	*Friesodielsia obovata* (Benth.) Verdc.		√	√	√	√	√		√	√						7
38	*Garcinia livingstonei* T. Anderson		√	√	√	√	√		√	√						7
39	*Grewia conocarpoides* Burret		√	√	√		√	√	√	√						7
40	*Hymenocardia acida* var. *mollis* (Pax) Radcl.-Sm.			√	√	√			√	√						5
41	*Isoberlinia angolensis* (Welw. ex Benth.) Hoyle & Brenan			√	√	√			√	√						5
42	*Julbernardia globiflora* (Benth.) Troupin	√		√	√	√			√	√	√					7
43	*Kigelia africana* (Lam) Benth.			√		√	√		√							4
44	*Lannea humilis* (Oliv.) Engl.			√	√	√			√	√	√			√		7
45	*Lannea schimperi* (Hochst. ex A. Rich.) Engl.						√	√	√		√					4
46	*Lonchocarpus capassa* Rolfe		√	√	√	√		√	√	√			√			8
47	*Maerua parvifolia* Pax			√	√	√			√					√		5
48	*Manilkara mochisia* (Baker) Dubard	√	√	√	√	√			√	√			√			8

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49	*Markhamia obtusifolia* (Baker) Sprague			√	√				√	√				4
50	*Monotes adenophyllus* Gilg		√	√	√				√	√				5
51	*Mundulea sericea* (Willd.) A. Chev.		√	√	√	√			√	√				6
52	*Multidentia crassa* (Hiern) Bridson & Verdc.			√	√	√	√	√	√	√				7
53	*Oldfieldia dactylophylla* (Welw. ex Oliv.) J. Léonard		√	√	√	√	√		√	√				7
54	*Ormocarpum trachycarpum* (Taub.) Harms			√	√	√			√					4
55	*Ozoroa insignis* subsp. *reticulata* (Baker f.) J.B. Gillett			√	√	√			√	√		√		6
56	*P. curatellifolia* subsp. *mobola* (Oliv.) R.A. Graham	√	√	√	√	√	√	√	√	√				9
57	*Pavetta schumanniana* F. Hoffm. ex K. Schum.			√		√			√					3
58	*Pericopsis angolensis* (Baker) van Meeuwen	√		√	√	√			√	√		√		7
59	*Phyllanthus engleri* Pax			√	√	√	√	√	√	√				7
60	*Piliostigma thonningii* (Schumach.) Milne-Redh.		√	√	√	√	√		√	√	√			8
61	*Pseudolachnostylis maprouneifolia* Pax		√	√	√	√		√	√	√			√	8
62	*Pterocarpus angolensis* DC.	√	√	√		√			√	√		√		7
63	*Pterocarpus tinctorius* Welw.	√	√	√	√	√			√	√		√		8
64	*Schrebera trichoclada* Welw.		√	√	√	√			√	√				6
65	*Securidaca longepedunculata* Fresen.		√	√	√	√			√					5
66	*Solanum incanum* L.					√			√					2
67	*Sterculia quinqueloba* (Garke) K. Schum.	√		√			√		√					4
68	*Strychnos cocculoides* Baker		√	√	√		√		√	√				6
69	*Strychnos innocua* Delile			√	√		√		√					4
70	*Strychnos potatorum* L. f.		√	√	√	√			√					5
71	*Strychnos spinosa* Lam.		√	√	√		√		√	√				6
72	*T. indica* L.	√	√	√	√	√	√		√	√		√		9
73	*Tapiphyllum floribundum* Bullock					√	√		√					3
74	*Terminalia mollis* M.A. Lawson		√	√	√				√	√				5
75	*Terminalia sericea* Burch. ex DC.		√	√	√	√				√				5

(*Continued*)

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Appendix – *continued*

Sl No.	Tree/shrub species	Product														No. of uses
		Timber	Pole	Firewood	Charcoal	Medicinal	Edible*	Fodder	Beekeeping*	HH items*	Fibre	Birdlime	Carvings	Hedge	Rope	
76	*Vangueriopsis lanciflora* (Hiern) Robyns			√	√		√		√	√						5
77	*V. doniana* Sweet			√	√		√	√	√	√			√			7
78	*V. mombassae* Vatke			√	√	√	√	√	√							6
79	*Xeroderris stuhlmannii* (Taub.) Mendonça & E.C. Sousa	√	√	√	√	√		√	√	√			√			9
80	*Xylopia antunesii* Engl. & Diels			√	√	√			√	√						5
81	*Zanha africana* Exell		√	√	√	√	√	√	√	√						8
82	*Ziziphus mucronata* Willd.		√	√	√	√	√		√					√		7
No. of tree/shrub species used per each use category		18	42	75	67	60	30	20	72	57	8	2	17	8	4	

Note: √ indicates tree/shrub species use; *Edible = edible plant, beekeeping = beehive and bee forage, HH items = household items including storage pot, wooden spoon, pestle and tool handle.