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The contribution of non-timber forest products (NTFPs) to rural household revenues in two villages in south-eastern Burkina Faso

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Abstract Non-timber forest product (NTFP) providing species constitute substantial components of West African agroforestry systems and contribute considerably to local livelihoods. The aim of our study was to measure the annual economic contribution of NTFPs to local livelihoods in two villages of south-eastern Burkina Faso, focusing on the following specific questions: What is the average share of NTFPs in local household income? Which socio-economic variables affect total household income and NTFP dependency? How does NTFP income vary between (i) villages, (ii) ethnic groups and (iii) different income groups? Does NTFP income have an equalising effect on income inequality?

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Applying structured household surveys, we investigated the economic contribution of NTFPs household revenues among 155 households. NTFPs accounted for the second largest income share (45 %) of total household income compared to other income sources, i.e. crop production, livestock breeding and off-farm activities. We found that poorer households depend more on income from NTFPs than wealthier households, even though the latter earned more from NTFPs in absolute terms. In general, income from NTFPs had an equalising effect on income inequality. Furthermore, we discovered significant differences in NTFP dependency between the two investigated villages and across the three main ethnic groups (Gourmantché, Mossi, Fulani) reflecting different species compositions in their surroundings as well as different traditional uses and harvesting practices. Thus, we argue that management recommendations for agroforestry systems and poverty alleviation need to consider local differences with regard to site-specific species composition as well as ethnic-specific NTFP use patterns and habits.

Keywords Household income · Non-timber forest products · NTFP dependency · Rural livelihood · Socio-economics · West Africa

Introduction

Non-timber forest product (NTFP) providing species contribute considerably to local livelihoods for

subsistence as well as for cash income in Africa and elsewhere in developing countries (Agrawal et al. 2013). It is estimated that forests and trees directly or indirectly contribute to livelihoods and income of about one to 1.6 billion people worldwide (Agrawal et al. 2013; World Bank 2008). NTFPs are open or semi-open access resources and do not require expensive or elaborate equipment (Angelsen and Wunder 2003), which make them highly attractive particularly for the very poor in rural areas.

In studies on NTFPs, they are often differently defined. In our study, we define NTFPs according to Belcher (2003) as organic matter except timber derived from forests, woodlands and agroforestry systems for human use. Gathered fruits, nuts, vegetables, fish, game, medicinal plants, bark, gum, leaves, grasses and, unlike non-wood forest products (NWFP), small wood products like firewood and chew-sticks are considered NTFPs (Belcher 2003; CIFOR 2011).

Providing subsistence (direct consumption) and cash income from sales, NTFPs play a considerable role in poverty alleviation and can reduce risks as well as serve as safety net in times of shocks and stresses (e.g., natural catastrophes, crop shortfall and illnesses) through diversifying local livelihood strategies (cf. Malleon et al. 2014; Shackleton and Pandey 2014; Sunderland et al. 2013). Moreover, cash flow gaps during non-agricultural seasons can be buffered by NTFPs (cf. Malleon et al. 2014; Marshall et al. 2006). Securing local livelihoods, these diverse functions of NTFPs concurrently affect national economies, particularly the overall food security of the countries and the availability of additional cash income (cf. Shackleton and Pandey 2014).

A range of recent studies have focused on the economic importance of NTFPs in rural sub-Saharan Africa. In southern Ethiopia, forest income constitutes on average 35 % of household revenues (Worku et al. 2014) and 47 % in the mountain forests of south-western Ethiopia (Melaku et al. 2014). Schaafsma et al. (2014) showed that in a rural mountain area of Tanzania NTFP income contributes with 20 % to total household income. In the Miombo woodlands of Zambia NTFPs provide about 44 % of the households' incomes (Kalaba et al. 2013). A global comparative analysis of NTFP income shares for rural households suggested an average income share of 21.4 % in the African sites (Angelsen et al. 2014).

In West Africa, a number of recent studies focused on the importance of savanna species for rural people in general and addressed the increasing conflict between biodiversity conservation and woodland extraction (Haarmeyer et al. 2013; Kaboré et al. 2014; Schumann et al. 2012). Though, studies on the economic contribution of NTFPs to local livelihoods still remain scarce in West Africa, and particularly in the North Sudanien vegetation zone. The only corresponding study in the North Sudanien zone by Faye et al. (2010) showed that in Mali income from NTFP sales contribute from 26 to 73 % to rural household revenues. Three studies in the South Sudanien zone reported corresponding data. Ouédraogo et al. (2013) found that wild plants contribute 12 % to the total household income in south-west Burkina Faso, whereas Pouliot and Treue (2013) found 35 % contribution in the same area and 30 % in south Ghana. A study in northern Benin revealed that 39 % of local household income is generated by NTFPs (Heubach et al. 2011).

These studies indicate divergent economic importance of NTFPs, but different methodological approaches could influence the results. One example in this regard is the controversy whether to include or exclude fodder in NTFP accounting and the different valuation methods of it. In some studies, fodder is considered being livestock input and therefore livestock income. In others, it is considered being environmental (NTFP) income calculated considering the contribution livestock makes to household economies using different approaches (Cavendish 2002). Since livestock is the major consumer of NTFPs, we decided to include fodder as NTFP income to show the value of the freely accessible browse and graze of a savanna, which contributes substantially to households since usually no other fodder input is added (Cavendish 2002). Moreover, in some studies, only marketed NTFPs are considered in the calculation of NTFP income, giving a distorted picture of the importance of NTFPs to rural household incomes since in many communities NTFPs are not sold on markets and instead directly used and consumed (Delang 2006). These examples indicate that comparisons of studies using different approaches are delicate. In order to achieve best comparability with other studies from West Africa we, thus, applied our study in south-west Burkina Faso according to a recent investigation of Heubach et al. (2011) in northern Benin

allowing direct comparisons between two vegetation zones.

Economic studies on NTFPs are important to understand the preferences of local communities regarding plant products and the contribution of their extraction to the daily life, to investigate protection needs for nature conservation as well as to improve rural livelihoods (Heubach et al. 2011, 2013; Lykke et al. 2004; Ouédraogo et al. 2014; Schumann et al. 2012). In recent years, several ethnobotanical studies on NTFP-providing plant species in West Africa found use preferences and the valuation of species to be linked to geographic location and ethnicity (Avouhou et al. 2012; Leßmeister et al. 2015; Segnon and Achigan-Dako 2014; Sop et al. 2012). Though, in economic studies, the influence of location and ethnicity has rarely been investigated. Therefore, in our study, we investigate the influence of location and ethnicity on the economic importance of NTFPs to local livelihoods in the North Sudanien zone and compare our results to the results of Heubach et al. (2011) from the South Sudanien zone.

In sub-Saharan countries poor households depend more directly on NTFP extraction from forests than wealthier households, even though the latter often gain higher cash income from forest resources (Babulo et al. 2009; Cavendish 2000; Heubach et al. 2011; Pouliot et al. 2012). Moreover, NTFP income tends to have an equalising effect on income of economies (Coulibaly-Lingani et al. 2009; Heubach et al. 2011; Vedeld et al. 2007).

In this study, we aim to augment existing ethnobotanical knowledge on species importance and economic value in Burkina Faso which is one of the poorest countries in the world. The Human Development Index ranks Burkina Faso 181st, out of 187 countries (UNDP 2014). Forty-three percent of the urban population and 94 percent of the rural population are considered poor. Therefore, the economic contribution of NTFPs to rural livelihoods is important.

Our overall objective is to measure the economic contribution of NTFP income to local livelihoods in rural villages of south-east Burkina Faso, focusing on the following specific questions: What is the average share of NTFPs in local household income? Which socio-economic variables affect total household income and NTFP dependency? How does NTFP income vary between (i) villages, (ii) ethnic groups

and (iii) different income groups? Does NTFP income have an equalising effect on income inequality?

Methods

Study villages

The study was conducted in the North Sudanian zone in south-east Burkina Faso. We have selected two study villages for comparative analysis. The two study villages Nagré and Kompienbiga (Fig. 1) were chosen according to their similarity in terms of population size (around 1000–1300 households), distance to the next urban center (30 km to Fada N’Gourma, and 10 km to Pama) and the constitution of main ethnic groups. Both villages have a school, hospital, piped water, host a small local market every 3 days but lack electricity.

Nagé is situated in the province Gourma. Kompienbiga is located 70 km south of Nagré in the province Koupéhi, at the boundary to the South Sudanien zone and is therefore slightly more humid. The natural vegetation consists of savanna woodlands and tree and shrub savanna. Agroforestry systems with alternating cycles of cultivation and fallow periods, which are managed by subsistence farmers, are typical in the region. Useful tree species on fields (serving as NTFP providers) are spared from clearing which creates the typical West African parkland savanna. Traditionally the use of fallow trees was communal in the study region but nowadays landowners reserve all rights (Lamien et al. 1996). Crop cultivation is combined with extensive animal production (e.g., cattle, goat, sheep and chicken).

Ethnic groups

The three main ethnic groups of the study area are the Gourmantché, the Mossi and the Fulani. The Gourmantché are the dominant and autochthon people in the study area (and in the entire region of eastern Burkina Faso). At the country level, the Mossi are the most dominant ethnic group (40–50 % of total population) originally living in the centre of Burkina Faso and having migrated to the study area (CIA 2009). The Fulani migrated to the area from the northern part of the country. The Gourmantché and the Mossi are both agriculturalists, whereas originally the Fulani are semi-nomadic cattle pastoralists. Nowadays, a

Fig. 1 Location of the study villages in south-east Burkina Faso

majority of the Fulani have settled and combine livestock breeding with crop production as a main livelihood activity. But the Fulani generally live outside the village centre and the access to cropland is more restricted to them than to the agriculturalists. Additionally, the agriculturalists have the access to the NTFP-providing parkland trees on their fields. However, grass is an NTFP strongly used by the Fulani as fodder for their livestock herd.

Data collection

To ensure comparability our study followed the approach and methods as implemented in northern Benin by Heubach et al. (2011), who calculated the NTFP income in two similar villages for the five main ethnic groups in the area.

We conducted 155 structured household surveys using both closed and open questions between November 2012 and April 2013. In both villages, the three main ethnic groups were considered with a minimum of 25

interviews. Households were chosen by stratified random methods, stratified according to ethnicity. Interviews were conducted separately with the household head (always men) and his first wife (households are often polygamous, see Table 1). Due to strong gender roles in the rural areas of West Africa, women and men were posed different questions. Men provided general information of the household (age and education of household head, number of household members, religion and polygamy) and different sources of income (cash and subsistence), including off-farm income, crop production and livestock breeding. Women provided information on the collection and consumption of firewood, wild foods and medicinal plants. For harvested and collected income sources, quantities were recorded as well as the amounts consumed, sold, exchanged and given away as a gift. Respondents were asked to recall annual quantities usually given in local measure units (bowl, sac etc.) and product prices of the respective year. The interviews were conducted in local languages with a local interpreter.

Table 1 Household characteristics in the two studied villages for their main three ethnic groups

	Nagré						Kompienbiga					
	Gourmantché		Mossi		Fulani		Gourmantché		Mossi		Fulani	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Household size (head count)	9.36	3.84	7.56	2.88	6.96	2.33	7.17	2.79	9.27	4.97	7.45	3.21
Age of household head (years)	47.16	10.26	43.76	9.02	42.09	8.9	41.63	7.52	43.3	9.91	39.72	7.02
Education (years)	1.19	2.15	0.14	0.73	0	0	1.02	2.41	0.60	2.05	0.20	0.75
Polygamy (%)	28		24		32		28		32		31	
Household income in Euro (per aeu)	572	175	412	137	455	94	357	115	344	107	305	105
NTFP income in Euro (per aeu)	189	67	152	49	272	79	150	72	132	46	188	84
Farmland size (hectare)	7.21	3.79	5.03	1.08	3.33	1.15	4.57	1.18	4.78	2.29	2.72	1.03
Number of cattle	2.97	1.65	1.95	1.91	6.65	3.69	2.36	2.51	2.76	2.79	5.44	5.18

aeu Adult equivalent unit (explanation see “Income accounting and adjusting” section), *SD* Standard deviation

In addition to the household interviews, we conducted market surveys at the village markets to obtain prices of products, to double check the recalled prices and to fill gaps in the interviews. Products with no market value (mainly wild fruits) were estimated through replacement values of similar products with similar physical properties (substitutes) (Boxall and Beckley 2002). For all products, the averages of the product prices provided in household interviews and on markets were used. To ensure representative average prices considering inflation rates of products due to seasonality, market interviews were conducted on a regular basis in each village during a period of one year.

Data analysis

Income accounting and adjusting

To calculate annual net income for the year 2012, we referred to the methodology as conducted by Cavendish (2002). For total household income, incomes from all income activities were summed up (income from crop farming, livestock, off-farm activities and extraction of NTFPs). Net income was calculated without reducing own labour costs from household income because of thin labour markets in rural West Africa, i.e. negligible opportunity costs of labour, and for better comparability with other rural household studies that usually do not calculate own labour costs (cf., Heubach et al. 2011; Kamanga et al. 2009).

Net income from crop farming includes income from sale and estimated value of subsistence consumption reduced by production costs, such as salaries for workers and fertilizer.

Net livestock income equals the value of annual livestock sale reduced by production costs, such as veterinary supplies. Subsistence income from livestock (own household consumption) is not counted as livestock income. Since fodder for livestock is considered NTFP income, subsistence income from livestock is calculated as fodder income. In savannas, browse and graze are freely accessible to the livestock and usually no other fodder input is provided. The fodder value is therefore substantial and is counted as a NTFP income (Cavendish 2002).

NTFP income is composed of different NTFP uses for cash and subsistence such as wild foods, firewood, chew-sticks, fodder for livestock and medicinal plants.

Income from wild foods was calculated using means of market prices or own-reported prices of the respondents for the local measure units multiplied with the reported annual amount collected.

Annual income from firewood and chew-sticks was calculated using daily consumption amounts reported by respondents multiplied by market prices.

To calculate the annual income from fodder for livestock, we followed an estimation method by Cavendish (1997). Own reported and market livestock prices are used to calculate years income stream (y_0) that equal the value of all fodder inputs. Under the assumption of a frictionless livestock production

technology food inputs convert into biomass outputs at 100 per cent efficiency without value added. The equation is as follows: $y_0 = P_0 \left(\frac{r}{r - (\frac{1}{1+r})^T + 1} \right)$, where T represents the lifespan of the livestock unit measured from the current date, r is the proportional discount rate and P_0 is the current price of the livestock unit based on own-reported values or current market prices (Cavendish 2002).

The calculation of income from medicinal plants is difficult. Since profound knowledge on medicinal plants is subject to traditional plant healers we only calculated medicinal plant income for household that reported to gain cash from healing activities.

Income from non-agricultural and non-woodland activities is considered as off-farm income such as from commercial activities as retail dealer, labour wages or formal employment. It is directly reported by the interviewees for the respective year.

Different sizes and compositions of households lead to different needs of households. Therefore, an income adjustment aims at ensuring a comparability of households of different sizes and of different compositions concerning sex and number of adults and children. Alike Heubach et al. (2011), we applied an OECD-modified equivalence scale considering the type of household member (adult, children) and therefore the nutrition need as well as the number of household members (household size) (Deaton 1982). The result is an adjusted income per adult equivalent unit (aeu) allowing a comparability. Additionally, all values were converted into Euros using the conversion factor of 655.975 CFA Francs (OANDA 2015).

Effect of socio-economic variables on total household income and on NTFP dependency

In order to test the effect of different variables (village, ethnicity, age of household head, education of household head, number of women in household, farmland size, number of cattle and off-farm income) on total household income, we applied an analysis of covariance (ANCOVA). Additionally, we calculated the relative NTFP income to investigate NTFP dependency, which is the households NTFP income per total household income. To investigate the influence of the same socio-economic variables on NTFP dependency, we conducted another analysis of covariance

(ANCOVA). Requirements (normality of residuals, homoscedasticity) for ANCOVA were met. To detect difference among ethnic groups we applied a Tukey post-hoc test.

The variables were selected according to the following different assumptions:

Village The two villages have many similarities. However, the savanna woodland types differ slightly since the climate in Kompienbiga is slightly more humid than in Nagré. Since all other characteristics are very similar, we hypothesize that location has neither an effect on total household income nor on NTFP dependency.

Ethnicity We hypothesize that ethnicity has a considerable effect on total household income as well as on NTFP dependency due to different traditions, main source of livelihood as agriculturalists/pastoralists as well as different regional provenance (autochthon/migrated) of the investigated ethnic groups.

Age of household head We presume that age is linked to greater knowledge about plant resource uses as well as of a higher NTFP extraction expertise. Thus, we hypothesize that NTFP dependency increases with higher age of the household head. For total household income, we presume that age has no effect.

Education of household head In accordance with Mamo et al. (2007), we hypothesize that with a higher education level of the household head the NTFP dependency decreases due to higher alternative income opportunities. For total household income, we therefore assume an increase with higher education levels.

Number of women in household Since most NTFPs are collected by women, our hypothesis is that NTFP dependency increases with a greater number of women in a household. In contrast, we assume that it does not have an effect on total household income.

Farmland size With higher availability of farmland, crop income increases. We therefore hypothesize that increasing farmland size leads to increasing total household income and decreasing NTFP dependency.

Number of cattle Since we considered fodder in our NTFP calculation, the number of cattle is likely to increase NTFP income. Our hypothesis therefore is

that NTFP dependency as well as total household income increase with a higher number of cattle.

Off-farm income Off-farm income represents an income alternative to NTFP extraction; hence, we hypothesize that increasing off-farm income is linked to decreasing NTFP dependency and increasing total household income.

Comparison of income shares and income from different NTFP use-categories between ethnicities and villages

In order to investigate the effect of ethnicity and provenance (village) on income from different income sources, a Principal Component Analysis (PCA) was performed. The PCA was based on a main matrix with 155 informants by four income shares (crop, NTFP, off-farm, livestock) and NTFP incomes split into its four NTFP use-categories (income from firewood, wild foods, fodder, chew-sticks) and a second matrix with the three ethnic groups, the two villages as well as farmland size and number of cattle as explanatory variables. Multivariate analysis was carried out in PCORD (McCune and Mefford 2011).

Comparison between different income groups

Total income per income source for different income groups was tested using a one-way ANOVA. For this purpose, the samples were split in three income terciles (low, medium and above medium income) of almost the same size (52, 52 and 51 households).

Measurement of income inequality

In order to investigate if NTFP income has an equalizing effect on the income distribution of the study area, we calculated Gini coefficients including and excluding NTFP incomes according to Deaton (1997). The Gini coefficient measures the inequality among values of a frequency distribution and is commonly used as a measure of inequality of income or wealth within the investigated sample. A Gini coefficient of zero refers to perfect equality (where everyone has the same income), whereas a Gini coefficient of one expresses maximal inequality among values (one person has all the income, when the rest has none).

Results

Respondents profile

Household heads, on average, were in their early to mid-forties (42.8 ± 9.2) and households comprised about eight members (7.8 ± 3.6). The education level was very low (school attendance of a year or less) and lowest for the Fulani. The Fulani owned more cattle and less farmland than the agriculturalists (Gourmantché and Mossi) (Table 1). In terms of total household income, it becomes apparent that income was higher in the village Nagré for all ethnic groups compared to Kompienbiga (also compare Fig. 3). The autochthonous Gourmantché in Nagré showed to have the highest total income. A Post-hoc test confirmed that NTFP income was significantly higher for the Fulani compared to the Gourmantché and Mossi. Between the two farmer societies there were no differences.

Income share of NTFPs to rural households' economies

NTFPs accounted for the second largest income share with an average income share of 45 %, whereas crops accounted for the largest income share representing about half of the total household income (48 %). Off farm (5 %) and livestock income (1 %) only contributed with a small share to total household income (Table 2).

All interviewed households reported to be engaged in NTFP collection and subsistence use. The NTFP use-categories wild fruits, chew-sticks and fodder were solely collected and/or consumed on a subsistence basis. In other words, no cash income was generated by their collection. Firewood was collected for sale in two of the investigated households, whereas all other households collected firewood solely on a subsistence basis. No additional purchase of wild foods, fodder, firewood and chew-sticks was reported. However, no medicine or healing activities were reported to be sold/payed for in any of the investigated household.

Effect of different socio-economic variables on total household income

The ANCOVA showed that the tested variables ethnicity, village, farmland size, number of cattle

Table 2 Average household income per income source for all respondents (N = 155) per aeu in Euro

Source of income	Total income	Mean income	SD	Income shares (%)
NTFPs	27,877.36	179.85	80.99	45
Crops	29,667.39	191.40	105.4	48
Livestock	648.15	4.18	14.73	1
Off-farm	3275.67	21.13	34.92	5
Total	61,468.00	396.57		

aeu Adult equivalent unit (explanation see “[Income accounting and adjusting](#)” section), *SD* Standard deviation

and off farm income had a highly significant influence on total household income (Table 3). The autochthon Gourmantché had significantly higher income compared to the migrated societies (Table 1). In Nagré, household income was significantly higher than in Kompienbiga. More farmland had an effect on higher income generation, whereas a higher amount of cattle had the contrary effect. With increasing off-farm income, also total household income increased. Number of women in a household, education and age of the household head showed no effect on total household income.

Comparison of income shares between ethnic groups

The Principal Component Analysis (PCA) gives an overview of similarities and differences among informants based on their income patterns. In this case, the ethnic groups are highlighted (Fig. 2). The Fulani are

grouped and relatively isolated from the rather inter-mixed Gourmantché and Mossi in the PCA diagram. The farmer societies Gourmantché and Mossi possessed greater farmland and therefore earned considerably more from crop production than the pastoralist Fulani, whereas the latter earned more from livestock because they sold considerably more cattle than the farmer societies (though still little). In addition, farmers earned more from off-farm activities than pastoralists, whereas the Fulani earned more from NTFPs than the farmer societies (Fig. 2; Table 4).

The income generation from different NTFP use-categories differed for different ethnic groups. The Fulani generated more NTFP income from fodder than the agriculturalists (Fig. 2). We found that in quantitative terms fodder income was about twice as much for the Fulani (189 €) compared to the two other ethnic groups (Gourmantché: 90 €; Mossi: 80 €). In contrast, the farmer societies earned more income from fire-wood than the pastoralists (Fig. 2). There was no

Table 3 Influence of socio-economic variables and household characteristics on total household income (ANCOVA)

Source	Type I sum of squares	df	Mean square	F
Corrected model	2,373,027.37 ^a	6	395,504.56	48.36***
Intercept	23,716,448.65	1	23,716,448.65	2899.74***
Ethnicity	195,852.29	2	97,926.15	11.97***
Village	1,060,303.95	1	1,060,303.95	129.64***
Farmland size	194,169.80	1	194,169.80	23.74***
Number of cattle	414,215.33	1	414,215.33	50.65***
Off farm income	508,486.01	1	508,486.01	62.17***
Error	1,194,105.97	146	8178.81	
Total	27,283,582.00	153		
Corrected total	3,567,133.35	152		

^a R squared = .665 (Adjusted R squared = .651)

All non-significant explanatory variables were removed (number of women in household, age and education of the household head)

*** $p < 0.001$

Fig. 2 Principle Component Analysis (PCA) of different household incomes (NTFP, off-farm, livestock, crops) and of the individual components of the NTFP income (firewood, wild foods, fodder, chew-sticks) from the first matrix compared

among three ethnic groups (second matrix). The vectors cattle and farmland represent quantitative explanatory variables from the second matrix

Table 4 Comparison of income shares (in %) among villages and ethnic groups

	Nagré				Kompianbiga			
	Gourmantché	Mossi	Fulani	Total	Gourmantché	Mossi	Fulani	Total
NTFP	33	37	60	43	44	41	64	49
Crops	59	60	34	51	49	51	31	44
Off farm	8	3	4	5	6	7	4	5
Livestock	0	1	3	1	1	1	1	1
NTFP use-category								
Firewood	34	39	24	31	35	29	17	26
Chew-sticks	1	5	3	3	5	5	4	4
Wild food	15	4	2	6	3	5	3	4
Fodder	50	52	72	60	57	60	76	65
Medicine	0	0	0	0	0	0	0	0

difference for the income category wild foods and chew sticks between the ethnic groups.

For all ethnic groups, fodder accounted for the largest NTFP income share followed by firewood. Wild foods and chew-sticks contributed little to NTFP income for all ethnic groups except for wild food income of the Gourmantché in Nagré (Table 4). Medicine or healing activities were not reported to be sold/payed for in any of the investigated household.

Comparison of income shares between villages

In our second PCA diagram the two studied villages separated clearly with regard to the composition of

household income (Fig. 3). Households in Nagré earned considerably more from crop produce (51 %) than households in Kompienbiga (44 %)—due to greater land holdings of households in the former village, whereas income from NTFP collection was higher in Kompienbiga (Nagré 43 %, Kompienbiga 49 %, Table 4). Off-farm and livestock income was low and did not show differences between the two villages. Some NTFP use-categories also differed between villages. Households in Nagré earned more from firewood, whereas in Kompienbiga income from fodder contributed more to the household income. Income from wild foods and chew-sticks was very low and did not differ considerably between the two villages.

Fig. 3 Principle Component Analysis (PCA) of different household incomes (NTFP, off-farm, livestock, crops) and of the individual components of the NTFP income (firewood, wild foods, fodder, chew-sticks) from the first matrix compared

among two studied villages (second matrix). The vectors cattle and farmland represent quantitative explanatory variables from the second matrix

Table 5 Influence of socio-economic and household variables on relative NTFP income (ANCOVA)

Source	Type I sum of squares	df	Mean square	F
Corrected model	2.06 ^a	5	.41	66.04***
Intercept	32.98	1	32.98	5291.27***
Village	.10	1	.10	16.04***
Ethnicity	1.55	2	.78	124.45***
Farmland size	.06	1	.06	10.21***
Number of cattle	.34	1	.34	55.08***
Error	.92	147	.01	
Total	35.95	153		
Corrected total	2.97	152		

^a R squared = .692 (Adjusted R squared = .681)

All non-significant explanatory variables were removed (number of women in household, off-farm income, age and education of the household head)

*** $p < 0.001$

NTFP dependency

The results of the ANCOVA (Table 5) showed that out of all tested variables, the four variables village, ethnicity, farmland size and number of cattle had a highly significant effect on NTFP dependency.

ANOVA and mean comparisons showed that households in Kompienbiga were significantly more dependent on NTFPs (48 % NTFP dependency) than households in Nagré (43 % NTFP dependency) and a Tukey post hoc test showed that the pastoralist Fulani (60 % dependency) were significantly more dependent on NTFP income than the agriculturalist societies Gourmantché and Mossi (both with 39 % NTFP dependency). Parameter estimates showed that NTFP dependency significantly decreased with increasing farmland size, whereas it increased with an increasing number of cattle in a household. However, all other tested variables (age of household head, education, number of women in household and off-farm income) showed no significant impact on NTFP dependency.

Income groups

The ANOVA showed a highly significant difference of mean income from NTFPs ($F = 52.9$, $p < 0.001$), crops ($F = 49.76$, $p < 0.001$) and off-farm ($F = 10.91$, $p < 0.001$) as well as a very significant difference for livestock ($F = 5.56$, $p < 0.01$) among

the three different income groups (low, medium, above medium). NTFP income share was highest for the “medium income” group, followed by the “low income” and the “above medium income” group. NTFP income accounted for the largest income group in the second tercile (medium income), whereas the first (low income) and third tercile (above medium income) generated more income from crops than from NTFPs (Table 6).

On the contrary, income share from crop, off-farm and livestock production was highest in the “above medium income” group and only negligible lower in the two other income groups.

However, the difference within groups—concerning crop and NTFP income—are only pronounced for the above medium income group. The two other groups do not show great differences.

Total mean income values showed a different pattern. Households with higher total income also generated higher NTFP, crop, off-farm and livestock income in absolute terms.

NTFP income and income inequality

The Gini coefficient for total household income excluding NTFP income was calculated as 0.62. Including NTFP income into the calculation of the Gini coefficient reduced it considerably to 0.21. Thus, including NTFP income evidently reduced inequality by 0.41.

Table 6 Mean household income by income source and income group (in Euro per aeu)

	Low income			Medium income			Above medium income		
	Mean income	SD	Income share (%)	Mean income	SD	Income share (%)	Mean income	SD	Income share (%)
NTFPs	113	32.7	45	190	65.2	50	238	80.55	42
Crops	120	38.9	48	177	68.4	47	280	119.9	49
Off-farm	14	16.1	6	11	16.6	3	39	52.4	7
Livestock	1	7.57	1	2	7.0	0	10	22.7	2
Total	247			379			566		

aeu Adult equivalent unit (explanation see “[Income accounting and adjusting](#)” section), *SD* Standard deviation

Discussion

Income share of NTFPs to rural household economies

Our results clearly show the importance of NTFPs for local household economies. Forty-five percent of a household's total income is generated by NTFPs, exclusively in form of subsistence income since no NTFPs were sold (except for firewood in two households). Compared to other studies, this figure is considerably high. NTFP income range from 12 to 39 % in different regions of sub-Saharan Africa (Heubach et al. 2011; Ouédraogo et al. 2013; Pouliot and Treue 2013; Schaafsma et al. 2014; Worku et al. 2014). One reason for our comparatively high figure might be the practical absence of income alternatives as well as the generally very low total household income in our study area being considerably lower than in other rural West African areas, e.g. in Benin.

However, income composition in our study is similar to the one identified through the study of Heubach et al. (2011) in northern Benin. In both studies, income from NTFPs accounts for the second largest income share (45 % in our and 39 % in the study in Benin) and income from crop production is highest. Off-farm and livestock income only play negligible roles in household income, however, still a greater one in the study in Benin than in Burkina Faso. Income from cultivated exotic fruit trees (7 %) is an income source only found in the survey area of northern Benin. Therefore, respondents from the study area in Benin have a greater diversity of income sources and, except for crop production, higher shares of alternative incomes to NTFPs.

Melaku et al. (2014), with 47 % in Ethiopia, and Kalaba et al. (2013), with 44 % in Zambia, showed similar high NTFP contributions to rural households to our study. However, since both used different methods in quantifying NTFP income, comparisons are difficult to make. Yet, Kalaba et al. (2013) included similar NTFP incomes to ours and also included fodder in the NTFP income calculation, whereas Melaku et al. (2014) had several different NTFP incomes to ours, such as forest coffee, honey, bamboo, but did not include fodder. Therefore, the figure of Kalaba et al. (2013) is more directly comparable to ours. In addition, we assume that the NTFP income figure of 47 % of Melaku et al. (2014) would even be higher if fodder would be included.

Effect of different socio-economic variables on total household income and NTFP dependency

The significant effect of ethnicity on total household income as well as on NTFP dependency confirms our hypothesis that cultural background plays a role for income generation. This shows that the traditional mainly pastoral livelihood strategy of the Fulani leads to a difference in NTFP income composition. Interestingly, ethnicity does not affect NTFP dependency in the study in northern Benin. Due to a disease-caused livestock decrease for the Fulani in the investigated year and a concurrently lower fodder income the differences between the ethnicities was presumably lower than in other years (Heubach et al. 2011).

In our study, NTFP dependency is significantly higher in the village with lower overall household incomes (Kompibiga). This corresponds with our results from the income group comparison. Where

location makes a difference in our study, it does not apply for the study in northern Benin. This might be due to the fact, that the two villages of our study show slight differences in regard to the climatic factor and are located in a greater distance to each other than the two villages of the study of Heubach et al. (2011). In other NTFP dependency studies investigations in this regard remain scarce. However, in terms of use preferences and valuation of wild plant species in Benin and Burkina Faso, Leßmeister et al. (2015), Segnon and Achigan-Dako (2014) and Zizka et al. (2015) found that location, representing phytogeographical differences, and ethnicity have an effect. Several studies focusing on specific NTFP-providing species in West Africa found the same pattern (Avouhou et al. 2012; Atakpama et al. 2012; Ekué et al. 2010; Gouwakinnou et al. 2011).

In regard to farmland size, our results confirm our hypothesis that greater land holdings lead to higher total income and lower NTFP dependency since own land allows for better and more direct planning how to meet dietary needs. Furthermore, it has the advantage to be private good whereas NTFPs (mostly) belong to the commons. Subsequently, where private area for cultivation is lacking, which is usually holding true for the poorest, households are more dependent on NTFP income. The negative relationship of farmland size and NTFP dependency is concordant with results of Heubach et al. (2011) in Benin and Kamanga et al. (2009) in Malawi.

Our results confirm our hypothesis that households with more cattle are relatively more dependent on NTFP income since fodder for cattle is considered NTFP income. But, contrary to our hypothesis, we found that they earn less in total with more cattle. This is due to the fact that the Fulani, who own more cattle than the other ethnic groups, generate less income from crop production. The effect of number of cattle on NTFP dependency is in accordance with Heubach et al. (2011).

We confirmed our hypothesis that with increasing off-farm income, total household income also increases. Yet, it does not have the expected decreasing effect on NTFP dependency like in the study of Heubach et al. (2011) in Benin and Illukpitiya and Yanagida (2010) in Sri Lanka.

Likewise, contrary to our hypothesis, our results demonstrate that age and education of the household head and number of women in a household neither had

an impact on total household income nor on NTFP dependency. This is in contrast to findings of Heubach et al. (2011), who found an effect of age of the household head and number of women in a household on NTFP dependency. The different effect of polygamy (number of women in a household) can be explained by the fact that polygamy was considerably higher in the study in northern Benin (mean 36 %) than in our study (mean 29 %). In both studies, education does not have an impact, which is in contrast to findings of Mamo et al. (2007), Kamanga et al. (2009) and Illukpitiya and Yanagida (2010). Since only few respondents reported to have received primary school education in our study, education is very low in general and therefore does not show an effect on income and NTFP dependency.

These findings lead us to the assumption that farmland size and number of cattle are variables of comprehensive effect on NTFP dependency in a broader area, whereas all other variables depend on local differences.

Comparison between ethnic groups

Our results show that income structure is significantly different among ethnic groups. Income structure of the two agriculturalist societies is similar but significantly different from the pastoralist society. Owning more farmland, agriculturalists obtain their primary income from crop production. In contrast, the pastoralists gain their main income from NTFPs. This is in accordance with Heubach et al. (2011). Thus, NTFP income composition in terms of use-categories reveals that the greatest difference in income from NTFPs between the ethnic groups is generated by the use-category fodder. Due to a greater possessed livestock herd, the Fulani earned significantly more from the NTFP use-category fodder than the agriculturalist societies. Heubach et al. (2011) found the same pattern, revealing that primarily the activity of livestock breeding makes a considerable difference in NTFP income structures between agriculturalists and pastoralists in a Sudanien savanna. But for all ethnic groups, the NTFP use-category fodder contributes considerably less to NTFP income in the study in Benin (Heubach et al. 2011). This is due to the fact that households in the study area of Benin (mean 1.53 cattle per household) keep considerably less livestock than in the study area of Burkina Faso (mean 3.66 cattle per household). Irrespective of ethnicity,

Pouliot and Treue (2013) also found that fodder is one of the most important forest products in a study area in Burkina Faso but not in Ghana.

However, the higher amount of livestock per household of the Fulani does not lead to a higher livestock cash income (Table 4) since cattle is rarely sold: income from livestock contributes with only 1 % to total household income in Burkina Faso and with 3 % in Benin.

Mean household income is significantly higher for the autochthon Gourmantché than for the migrated Mossi and Fulani, who concurrently owned less farmland than the Gourmantché. This is in accordance with Malleson et al. (2014), who also found higher income for autochthon compared to migrated groups. Similarly, Coulibaly-Lingani et al. (2009) found that ethnicity influences access to land in southern Burkina Faso, with migrants having lower access than autochthonous people.

Intra-ethnic differences in knowledge, use and value of different species in West Africa have been reported in several studies (Fandohan et al. 2010; Heubach et al. 2013; Koura et al. 2011; Sop et al. 2012). Our results and other studies in West Africa (Assogbadjo et al. 2012; Houehanou et al. 2011) reinforce the importance of knowledge about different preferences between ethnic groups in general. But except for Malleson et al. (2014) and Heubach et al. (2011), other socio-economic studies on NTFPs did not investigate differences between ethnic groups. Therefore, our study adds valuable information on significant economic differences among ethnicities.

Comparison between villages

Irrespective of the similar characteristics of the villages, income structures differ between them. Total NTFP income is higher in Nagré but in Kompienbiga NTFPs contribute with a higher percentage share to total household income. This indicates that NTFP dependency is higher in the poorer village. Heubach et al. (2011) did not find differences among the two villages situated very close together in the same natural environment. However, in villages of different phytogeographical regions, Segnon and Achigan-Dako (2014) found differences of plant choices for consumption. Our results show that even in the same phytogeographical region, the North Sudanien zone, at a distance of 70 km, income structure can be

considerably different. One reason for the differences could be access to different NTFP providing species due to a slight climate gradient between the two villages. Situated in the North Sudanien vegetation zone, Kompienbiga lies at the edge to the more humid South Sudanien zone, where species compositions are slightly differing. Another reason is the fact that the market in Nagré is bigger than in Kompienbiga. Hence, market prices for crops are slightly higher leading to a higher cash income from crop sales and therefore a higher total household income in Nagré.

Income groups

Our results show that absolute NTFP income is lower in the low income tercile but their relative NTFP income is higher than in the above medium tercile. This confirms earlier corresponding results (Kalaba et al. 2013; Kamanga et al. 2009; Kar and Jacobson, 2012; Schaafsma et al. 2014). Alike other studies, we found that poorer households are relatively more dependent on NTFP collection than wealthier households irrespective of ethnic affiliation (Babulo et al. 2008; Heubach et al. 2011; Malleson et al. 2014). Surprisingly, alike Kamanga et al. (2009), we found that poor households (low income) are not more dependent on NTFPs than less poor (medium income) households. In accordance with Pouliot et al. (2012), we conclude that poor households earn less from NTFP collection than the above medium income group due to a more restricted access to parklands and fallows because of less farmland owned. Therefore, distances to NTFP-providing species in communal forests can be longer. In addition less equipment available, a lack of labour, time and health could also be reasons for less NTFP extraction by poor households (Kamanga et al. 2009).

NTFP income and income inequality

The reduction of the Gini coefficient from 0.62 to 0.21 including NTFPs into the calculations proves that forest income contributes to an equalisation of households' income. This is in concordance with (i) Kalaba et al. (2013) who found Gini coefficients of 0.51 with and 0.61 without forest income for households in Zambia, (ii) Kamanga et al. (2009) (0.39 with and 0.49 without forest income) in Malawi and (iii) Schaafsma et al. (2014) (0.61 with and 0.65 without forest

income) in Tanzania. When comparing our findings with Heubach et al. (2011), the reduction of the Gini coefficient including NTFP income is very strong in both studies (0.38 change units in northern Benin and 0.41 in our study). The similar result confirms that NTFP income helps reducing income inequalities in rural areas of Western Africa.

Conclusion

Our study showed the importance of forest environmental incomes, especially for poor households. Overall, 45 % of the total annual income is generated by NTFPs as subsistence income. The equalising effect of forest income on income inequality documented in our and other studies reveals the need of systematic collection of forest income data to inform national poverty assessments and national accounting, forming the basis of strategic planning and policy making.

Comparisons with other studies have shown that mainly access to land and number of cattle owned influence household economies and NTFP dependencies whereas the influence of other household characteristics seem to differ between the studies.

NTFP collection takes place in forests, on fallows and fields using products of parkland trees. Therefore, forest degradation would have a direct negative impact on income of all NTFP collecting households. Thus, as our study showed, poorest households would primarily be affected. Land-use planning thus needs to reflect needs of local households characterised by diverging income opportunities.

We found differences for agriculturalist compared to pastoralists as well as for autochthon compared to migrated ethnic groups. The differences between ethnic groups and villages show that management recommendations need to be adapted to the livelihood habits of different ethnic groups as well as adapted on a local level. We therefore conclude that socio-economic and ethnobotanical studies are highly valuable for the development of management strategies aiming at delivering appropriate outputs to local communities: reflecting existing differences in plant use and valuation.

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