Economic value and socio-cultural determinants of non-timber forest products harvesting in the W Transboundary Biosphere Reserve, Benin

Alice Bonou Fandohan*
Belarmain Fandohan **
Anselme Adegbidi **
Brice Sinsin **

*Agronomist. Master in Natural Resource Manegenment (University of Abomey-Calavi). Ph.D in Economy (University Cheikh Anta Diop, Senegal). Professor at African School of Economics.
** University of Abomey-Calavi, Benim.

Abstract: This paper examined the economic value of non-timber forest products and their contribution to cash income of people living around the W Transbundary Bioreserve of W in Benin. 148 people among two ethnic groups were interviewed. Data were analysed using the indirect method of opportunity cost and raw margin estimation. Results showed that local people use to harvest mostly five products: one non-marketable product (firewood) and four marketable products (almonds of *Vitellaria paradoxa*, C.F.Gaertn, seeds and pulp of *Parkia biglobosa* (Jacq.) R. Br. ex G. Don and leaves of *Adansonia digitata* L.). The mean contribution of marketable products to surveyed dwellers was estimated at XOF 255,484 ($US 510.968) (standard error: XOF 37,109), representing about 11.46% of the annual cash income per household. Age and sociolinguistic group were the main determinants of non-timber forest products harvesting. Given their value to the communities, those plants should be prioritized for domestication and conservation.

Key-words: non-timber forest products, economic value, West Africa.

1. Introduction

"Transbundary bioreserve of W" is an exceptional natural heritage shared by Benin, Burkina Faso and Niger. It takes its name from the meandering river Niger and covers more than one million hectares. Benin'spart, the largest, covers an area of 5,632 km2 and was ranked in 1954. At the institutional level, development projects started in 1984 (Ecosystèmes Protégés en Afrique Soudano-Sahélienne, ECOPAS, 2005).
As it is elsewhere, the problem of ecosystem conservation is perceived by the authorities as a biological and ethno botanical problem. This fact had led to the failure of several conservation policies. Among the reasons for these failures is the neglect of the needs and preferences of surrounding communities who exploit forest resources from centenarians (Gopalakrishnan *et al.*, 2004). Thus, the authorities in charge of the development of the transbundary bioreserve of W adopted the approach of participatory management at the end of the Project Management of Natural Resources (PGRN) in 1997. This approach assumes the accountability of the local community living around this reserve. Then, the integration of useful resources in the management plans (eg buffer zone and parkland) would significantly reduce the pressure exerted by the dwellers on this reserve.

There are several non-timber forest products (NTFPs) in this reserve. Non timber forest products are defined as any biological material aside timber, from forest or other wooded land and trees outside forests (FAO Forestry, 1999). They contribute significantly to rural livelihoods and the national economy of many countries in Sub-sahara Africa (Appiah *et al*., 2009; Shackleton *et al*., 2010). However, the magnitude of the income derived from these resources has not been documented due to lack of a systematic and rigorous data collection and estimation. Moreover, given that communities do not value and use plants in the same way, researchers believe that identifying the plants most valued by the local community could help better define and implement priorities for conservation and then strategies for sustainable management (Dalle *et al*., 2004). Finally, in the current context of climate change, indigenous food plants could play a key role in future production systems. Indeed, although the latter may also suffer from these changes, they represent an important resource for future strategies of production (Fandohan *et al*., 2011). However, the magnitude of the income derived from these resources is not well known because of lack of a systematic and rigorous data collection and estimation. Moreover, given that communities do not value and use plants in the same way, researchers believe that identifying the plants most valued by the local community could help better define and implement priorities for

conservation and then strategies for sustainable management. So, if these plants are to be prioritized for agricultural diversification in future, the question, what is the real current contribution of these plants to the livelihood of the local population? (dependence of the population vis-a-vis these resources), could be asked.

This study was conducted in Benin, West Africa. It is the first study that analyses the dependent relations between this reserve and surrounding communities. It was used to estimate the economic value of non-timber forest products harvested by the communities surrounding the reserve.

According to several previous studies, the use of non-timber forest products contributes to the livelihood of households (Arnold *et al*., 2001; Codjia *et al*., 2003; Biloso *et al*., 2006; Kusters, 2009; Vodouhe *et al*., 2011). We therefore hypothesized that non-timber forest products contribute significantly to the income of dwellers living around this reserve. Moreover, in traditional societies, the gender of the respondents significantly influences the use of wild plants (Camou-Guerrero *et al*., 2008; Vodouhe *et al*., 2009). The difference between men and women regarding the use of non-timber forest products is partially explained as a consequence of the division of labour in the household in traditional societies (Müller-Schwarze, 2006). Comparing the indigenous knowledge of men and women in Ethiopia, it proved that women specially mastered knowledge of plants and herbs used for fodder (Gemedo-Dalle *et al*., 2005). Women on Madre de Dios in Peru valued more fruit species and species of timber than men (Lawrence *et al*., 2005). In addition, age of a respondent determines the intra-cultural variations in perceptions and traditional knowledge about wild plants (Hanazaki *et al*., 2000). Learning about plants uses in a community begins at an early age and continues gradually as a person grows. So an old person usually has more knowledge about wild plants than a younger person (Müller-Schwarze, 2006; Camou-Guerrero *et al*., 2008). It was thus hypothesized that around the reserve, age determines the use of non-timber forest products. Finally, previous research revealed large differences in use of these products regarding the factor of ethnic groups (Case *et al*., 2005; Fandohan *et al*., 2010).

We therefore hypothesized that around the reserve, socio-economic and demographic factors do influence the quantity of non-timber forest products harvested.

The objectives of this study are to: estimate the economic value of marketable and non- marketable NTFPs; assess the contribution of marketable NTFPs to the overall income of household; and determine the socio-economic factors influencing the quantity of non-timber forest products harvested.

2. Theoretical background

Economic analysis of farmers' decision on labor allocation is deeply rooted on the assumption of utility maximization (Rahman, 2003; Baidu-Forson, 1999; Adesina and Baidu-Forson, 1993; Boussard,1987)

Assume a representative farmer living in the periphery of W reserve area. This farmer is engaged in three typical major activities which are agriculture, NTFPs collection and wage-earning work following Gopalakrishman et al. 2005. Regarding the marketability, two types of NTFP can be collected in the reserve: subsistence ones such as firewood and commercial ones like leaves and almonds of *Vitellaria paradoxa* for example.

Following Sadoulet and de-Janvry (1995), let the production function of a typical farmer be given by:

$h(q, x, z) = 0$ (1)

where q is the vector of output quantities, x is the vector of variables input quantities, and z is a vector of fixed factor quantities. Variables inputs are usually labor, fertilizer, water, pesticides, seeds, and such, which can be purchased in the desired quantities. Fixed factors are either private factors that cannot be acquired in the time span analyzed (land, equipment), public factors (infrastructure and extension services), or exogenous features (such as weather and distance to market).

If *w* and *p* are the prices of inputs and outputs, respectively, the producer's restricted utility is $pq - wx$ also called profit. The producer is assumed to choose the combination of variable inputs and outputs that will maximize profit subject to the technology constraint:

$Max_{x,q} pq - wx$ *s.t. h(q,x,z)=0* (2)

The solution to this maximization problem is a set of input demand and output supply functions that can be written as:

$x = x(p, w, z)$and $q = q(p, w, z)$ (3)

Substituting these expressions into the definition of profit gives the profit function g which the maximum profit that the farmer could obtain given the prices, w and p, the availability of fixed factors, z, and the production technology, *h( )*:

$g = pq(p, w, z) - wx(p, w, z) = g(p, w, z)$ (4)

Considering that the production function takes the form of a Cobb-Douglas function which best suits agricultural production, the output q can be expressed as follow:

$q = AK^{\alpha}L^{\beta}$ (5)

where A is a scalar and K and L represent respectively the capital invested and the labor.

In the particular case of NTFPs, *labor* is the only one variable factor so that equation (4) becomes:

$g = pq_{ntfp}(p, w) - wx_{ntfp}(p, w) = g(p, w)$ (6)

And equation (5) can be rewritten as $q_{ntfp} = AL^{\beta}$

Maximization of the profit $g = pAL^{\beta} - wL$ is given by the First Order-Condition (FOC):

$pA\beta L^{\beta-1} - w = 0$ (7)

The optimum level of input L is $L = \left(A\beta \frac{p}{w}\right)^{\frac{1}{1-\beta}}$

The according quantities of NTFPs collected and the related revenue are derived from that optimum level. The computation process of these indicators is described in section 3.4.

3. Materials and methods

3.1. Study area

The study was undertaken in Sampeto village which borders the W Transboundary Biosphere Reserve (WTBR) (Banikoara district; between 11°20'- 12°23'N and 2°04'-3°05'E). The WTBR Park is shared by three countries of West Africa: Benin, Burkina Faso and Niger). Benin's part covers 5,632 km^2 which equals 56.32% of the total area of the reserve (Figure 1).

Sampeto is one of the 61 villages surrounding the WTBR. It is constituted of eight hamlets and counts 320 households (Table 1). Dwellers of Sampeto were estimated at 254,286 people in 2002 (*Institut National de Statistique Appliquée et Economie*, INSAE, 2002).

Two main sociolinguisticgroups live together in this village: The Baatonou (70%) and the Fulani (23%). Fulani people were not investing enough in the collection of NTFPs. Dwellers are mainly Muslim (51.7%).

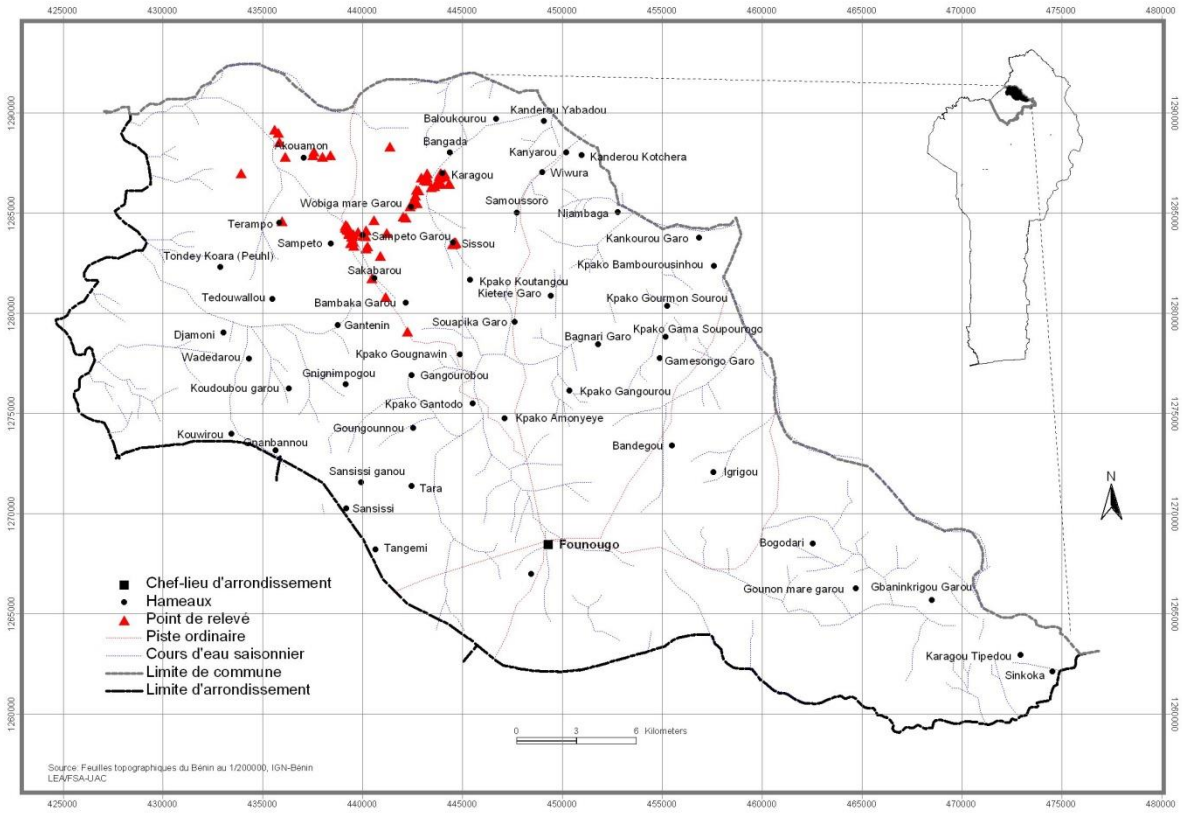

Figure 1: Map of study area. Map of Sampetoin the northern part of Benin (West Africa), illustrating eight hamlets where data collection was carried out.
Source: Elaborated by the authors.

Hamlets	**Sampled numbers**		
	Baatonou ethnic group	***Fulani ethnic group***	***Total***
Karagou	6	3	9
Akouamon	19	1	20
Bambaka	16	0	16
Sampeto-center	21	10	31
Sakabarou	5	2	7
Sissou	14	2	16
Terampo	19	0	19
Wobiga	14	16	30
Total	**114**	**34**	**148**

Table 1: Patterns of sampled households per hamlet per ethnic groups
Source: Elaborated by the authors.

3.2. Sampling

Based on preliminary investigations among 100 farmers (respondents) randomly sampled among the two ethnic groups in the study area, it was found that 35% of the respondents had harvested at least one non-timber forest product. This information was used to calculate the size of sample according to the formula of Dagnelie (1998):

$N = (U^2_{1-\alpha/2})\, P\,(1-p)/\, d^2$

where N is the size of sample;
$U_{1-\alpha/2} = 1.96$ is the value of the normal random variable for a probability value of $\alpha = 0.05$;
P is the proportion of people harvesting at least one non-timber forest product (P= 0.35);
and d is the expected error margin of any parameter to be computed from the survey which was fixed at 0.08 (usually d is chosen between 5 and 15%).

Under these assumptions, the size of sample was established to be 136 ± 48 people. For practical reasons, 148 people were used in this study.

3.3. Data collection

Data collection was carried out using a quantitative and qualitative ethnographic method as described by Lawrence *et al*. (2005). At the beginning of data collection (July 2007), four focus group discussions (two for each ethnic group) were organized during which participants were invited to list all plant species that they had used as non-timber forest products. Ten men and women ranging from 19 to 50 years of age participated in each focus group discussion. In most cases, men outnumbered women and the discussion lasted approximately two hours. Participants listed the names of all useful plants with which they were acquainted as well as the specific use of each. From the list, five most important non-timber forest products were identified: almonds of *Vitellaria paradoxa*, C.F.Gaertn, seeds and pulp of *Parkia biglobosa* (Jacq.) R. Br. ex G. Don, leaves of *Adansonia digitata* L.and firewood.

Detailed information using questionnaire surveys during a period of eight weeks (from the end of July to the beginning of September 2007) were collected. The questionnaire was written in French but the interviews were entirely conducted in local languages of participants (Baatonou ethnic group and Fulani ethnic group) with the assistance of an interpreter. The respondents' answers were based on the method of memory recall.

Recorded information included socio-economic characteristics of respondents as well as information on NTFP harvesting, processing, selling and consumption. Concerning NTFPs, preliminary investigations have revealed that five major products were harvested: almonds of *Vitellaria paradoxa*, C.F.Gaertn, seeds and pulp of *Parkia biglobosa* (Jacq.) R. Br. ex G. Don, leaves of *Adansonia digitata* L. and firewood. For each of the fourth first products information as harvested /consumed/ sold/, transformed overall quantities and the price per unit were recorded. Then information about firewood concerned the plant species which they harvested, the number of adults per household that was engaged in the collection of firewood, the total number of work hours per day per adult, the total number of work days per adult per year and the part of work time taken on firewood collection. Finally, minor products gathered (honey, gum of wild tree, fruit of *Vitellaria paradoxa*, C.F.Gaertn, fruit of *Parkia biglobosa* (Jacq.) R. Br. ex G. Don, fruit of *Tamarindus indica* L., fruit of *Adansonia digitata* L. and fresh leaves of *Vitex doniana*, Sw.) constitute a significant part of the income of these households. For them, the annual income obtained from their sale per household was recorded. Other household activities include crop production (cotton, maize, sorghum, rice, beans, groundnut, bambara groundnut, soybean, yam, sweet potato, okra, peppers, tomatoes and mangoes), livestock (beef, goat, mutton, pork, chicken, guinea fowl, pigeon and guinea fowl eggs), and secondary activities (crafts, trade and ploughing-oxen off-farm). For each of them, sold quantities and the price per unit or overall income were recorded. Data processing was done with Microsoft Access 2008.

3.4. Data analysis

Data analysis was done with the software Stata 11 and SPSS 10. The quantity of each of five main non-timber forest products mentioned above was measured in local units, and then converted into kilograms. Units of measure were calibrated and samples of products were dried in oven at 105°C for 48 hours to determine the dry weight. So the dry weight of harvested quantity was obtained in Kg, in order to sum all non-timber forest products and get a total weight of them per household per year. Thus, the average quantity of harvested products per household per year was calculated. Revenue was also estimated in franc CFA per household per year. Data on non-timber forest products harvested, obtained from our samples were used to aggregate the amount of non-timber forest products collected per year in Sampeto village. The annual income of household made from marketable NTFPs is the sum of revenues of all sold product relative to *Vitellaria paradoxa*, C.F.Gaertn, *Parkia biglobosa* (Jacq.) R. Br. ex G. Don, *Adansonia digitata* L. and minor NTFPs.

Household overall income includes income from many activities such as collection and processing of NTFPs, agriculture, livestock, non-farm activities (hunting, trade, crafts, the use of off-farm labour etc).

To estimate the economic value of non-timber forest products, it was equivalent to the selling price, which means also the financial price. Then the raw margin method was used to estimate the income of marketable NTFPs by year.

$RM = Q_i \times P_i$

With RM = raw margin,
Q_i = quantity of NTFP (i) collected or sold and
P_i = unit price of product i.

The financial value of the amount of each marketable non-timber forest products that was consumed by each household is computed by timing the raw amount consumed or processed by the price of each product.

Concerning firewood, which was solely used for the self-consumption, the indirect opportunity cost method was used (Chopra, 1993; IIED, 1994). It means that the opportunity cost of time taken for collecting NTFPs is an approximation of the value of this latter. The mathematical model for this kind of estimating is described by Svarrer *et al.* (2005):

$V=a\times l\times d\times t\times w$

V: economic value of firewood collected per household per year,
a: number of adults per household that is engaged in the collection of firewood,
l: total hours of work per day per adult,
d: total days of work per adult per year,
t: part of time taken for collecting firewood and
w: wage rate of labour in Sampeto village.

Finally, a linear regression was used to identify the determinants of non-timber forest products harvest. As the dependent variable is a continuous variable, the suitable model is a linear model. The dependent variable (Y) is assumed to have a normal distribution and represents the dry quantity of non-timber forest products collected per household. This variable is the total by adding the followed products: almonds of *Vitellaria paradoxa*, C.F.Gaertn, seeds and pulp of *Parkia biglobosa* (Jacq.) R. Br. ex G. Don and leaves of *Adansonia digitata* L.. Independent variables are: sex, age, ethnic group, education level of household head and household size.

$Y=a+b_1sex+b_2age+b_3ethn+b_4ninst+b_5taill+£$
With a, b_1, b_2, b_3, b_4, b_5 are the regression coefficients and £ the error term.

4. Results

4.1. Economic value of non-timber forest products

4.1.1. Marketable NTFPs

Table 2 summarizes collected/processed/sold/consumed quantities in local units, as well as dry weight of different non-timber forest products mostly used in Sampeto village. In addition, the table provides information on the number of households that used each of these products. Almonds of *Vitellaria paradoxa*, C.F.Gaertn were the mostly used NTFPs in Sampeto according to the harvested quantity, lastly by the seeds and pulp of *Parkia biglobosa* (Jacq.) R. Br. ex G. Don and followed by leaves of *Adansonia digitata L.*. Table 3 shows the annual incomes from all household activities including agriculture and NTFPs harvesting.

Vitellaria paradoxa, C.F.Gaertn fruits, almonds, butter and soap were used. Among these four products, fruits were mainly consumed by children. Almonds were processed into butter. Butter is used for cooking, cosmetic and medicine. Butter is also processed into soap which was used for cosmetic. About 98% of the sample collected shea almonds with a total of 6799.5 local unit (1 local unit is 20.35 kg dry weight) which is equivalent to 138,370 kg for the whole harvest season. So, income from *Vitellaria paradoxa*, C.F.Gaertn (shea tree) is the sum of revenue from shea almonds, shea butter and shea soap sold. Statistical analysis showed that Baatonou households got more income from the NTFPS of this plant than Fulani ethnic households. The first ethnic group had got significant income with a maximum of 2,230,000 franc CFA ($ 4,460) per household per year. Regarding the sample, the average is 195,753 ± 26,982 franc CFA ($ 391.50) per household per year. The last quartile (ie classifying the sample according to NTFPs income, the last quarter which is equivalent to households with higher income from NTFPs), equalled 206,000 franc CFA ($ 412).

Regarding *Parkia biglobosa* (Jacq.) R. Br. ex G. Don, its seeds and pulp were used. Pulp are mixed with porridge or used to make juice. Seeds were processed into a condiment used to enhance sauce. About 62% collected 8,664 local unit (1 local unit is 2.2 kg dry weight) which is equivalent to 19,061 kg for the whole season. Concerning the pulp of this plant, a total of 4,389 local unit was harvested (1 local unit is 0.67 kg dry weight) which is equivalent to 2,940 kg. So, income from this plant is the sum of revenue from seed, sauce enhancer and pulp. The average income was 51,073 ± 15,590 franc CFA ($ 102.14) per household per year. Here, Baatonou ethnic group again harvested more than Fulani ethnic group. The difference between the two ethnic groups was significant at 10% (P = 0.09).

Adansonia digitata L. was the third useful tree in Sampeto village. Leaves were harvested, dried, ground and used to make sauce. It was used mostly during the dry season when food was scarce. About 83.7% of households were using this product. So the average income was only 382 franc CFA ± 259 (less than $ 1). The difference between the two ethnic groups was not significant.

Minor non-timber forest products were also important in household income. These included wild honey (19% of households), gum (2% of households) and fruit of *Adansonia digitata* L. (2% of households). Gums were produced mostly by two trees: *Acacia senegalensis* (L.) Wild and *Combretum nigricans* Lepr. ex Guill. and Perr. Table 3 shows that the annual income of household from these minor products was around 7,185 franc CFA± 2,012 (14.37$). Fulani people were not investing enough in this collection. However, the difference in income between the two ethnic groups was not significant at 10% (P = 0.054).

4.1.2. Non-Marketable non-timber forest products: Firewood

Firewood is very important to Sampeto people and used mainly for cooking. In Sampeto, firewood was not sold. People of each household collected their own firewood. Fallen branches of two species of plant were mostly used: *Anogeissus leiocarpa* (DC.) Guill. and Perr. and *Crossopteryx febrifuga* (Afzel. ex G.Don) Benth. Firewood collection takes place most of the time during harmattan. So, all female members of all households cut the dead branches or harvest fallen branches for one week. In Sampeto, the average time spent to collect firewood per household per year was 97.84 ± 0.52 hours; the wage rate of rural labour was 1,000 franc CFA ($ 2) per hour. Wage labour was predominantly used for ploughing. According to the mathematical model, the indirect

opportunity cost method, the estimation of economic value of firewood collected per household per year was on average 97,840 ± 6,044 F CFA ($ 195.68) (Table 3).

Products (local unit with its correspondence in kg or liter)	Percentage of households concerned (%)	Amount (local unit)	Quantity (kg of dry weight or liter of butter)
Products of Shea (*Vitellaria paradoxa*)			
Collected almonds (1 local unit= 20.35 kg)	98.65	6799.5	138,370
Sold almonds (1 local unit= 20.35 kg)	70.95	3920.0	-
Transformed almonds(1 local unit= 20.35 kg)	87.16	2818.5	-
Obtained Butter (1 local unit=20 liters)	-	1278.0	-
Sold butter (1 local unit=20 liters)	55.41	882.0	-
Remaining butter (1 local unit=20 liters)	-	357.0	-
Consumed butter (1 local unit=20 liters)	87.16	229.5	-
Transformed butter (1 local unit=20 liters)	-	150.5	-
Obtained soap (1 local unit= 13kg)	58.11	359.5	-
Sold soap (1 local unit= 13kg)	22.3	235.0	-
Consumed soap (1 local unit= 13kg)	58.11	122.0	-
Products of *Parkia biglobosa*			-
Collected seeds (1 local unit =2.2 kg)	71.62	8664.0	19,061
Sold seeds (1 local unit =2.2 kg)	52.03	7834	-
Transformed seeds (1 local unit =2.2 kg)	67.57	820	-
Obtained sauce enhancer (1 local unit =0.6 kg)	-	1686	-
Sold sauce enhancer (1 local unit =0.6 kg)	0	0	-
Consumedsauceenhancer (1 local unit =0.6 kg)	71.62	1465	-
Collected pulp (1 local unit =0.67 kg)	71.62	4389	2,940
Sold pulp (1 local unit =0.67 kg)	36.49	3715	-
Consumed pulp (1 local unit =0.67 kg)	71.62	674	-
Products of Baobab (*Adansonia digitata*)			
Collected pulp (1 local unit =1.47 kg)	2.03	380	-
Collected dry leaves (1 local unit =1.47 kg)	83.78	1237	1,818
Sold dry leaves (1 local unit =1.47 kg)	22.30	583	-
Consumed dry leaves (1 local unit =1.47 kg)	83.78	533	-
Minor non-timber forest products			
Quantity of collected gum / sold (local unit)	2.03	43	-
Quantity of collected honey / sold (Litres)	19.59	1164	-

Table 2: Table summarizing quantities of harvested non-timber forest products
Source: Elaborated by the authors.

	Income from Shea products	Income from *Parkia biglobosa* products	Income from Baobab	Income from firewood	Income from minor products	Income from sold products	Overall economic value of all used products	Agriculture income	Annual overall income	Percentage of income from sold products
Average	195753	51073	382	97840	7185	**255,484**	**303,657**	1727580	1983669	**11.46**
Error	26982	15590	259	6044	2012	37,109	38,298	111254	124491	1.05
Median	80500	5300	0	80000	0	110,000	152,525	1510500	1642150	7.56
Minimum	0	0	0	2000	0	**0**	**0**	132500	147200	**0.00**
Maximum	2230000	2000000	30000	360000	170000	**3, 115,000**	**3,185,000**	7291500	7516500	**75.49**
Quartiles 1st	24250	0	0	49000	0	36,775	76,700	778125	880688	3.58
2nd	80500	5300	0	80000	0	110,000	152,525	1510500	1642150	7.56
3rd	206000	41500	0	120000	0	251,250	312,700	2122500	2551650	15.24

Table 3: Table summarizing annual revenues (XOF) earned from NTFPs harvested by Sampeto Household
Source: Elaborated by the authors.

4.2. Importance of non-timber forest products on the Sampeto village economy

The annual income of household made from marketable NTFPs was on average per household 255,484 franc CFA ± 37,109 ($ 510.96). The difference of income from marketable NTFPs between the two ethnic groups was significant at 0.1% (P = 0.0001). By summing-up the income of each household from sold non-timber forest products for the whole sample, the total income is about 38 million francs CFA ($ 76,000). Next, the total financial and economic values of firewood that was solely non-marketable NTFP was 303,657 ± 38,298 F CFA ($ 607.31). The difference of this financial value from non-marketable NTFPs between the two ethnic groups was significant at 0.1% (P = 0.000).

Finally, the overall annual income of the household was 1,983,669 franc CFA ± 124,491 ($ 3,967.33) considering the sample. The average is 2,212,353 franc CFA ($ 4,424.70) for the ethnic group Baatonou. This overall annual income difference between the two ethnic groups (Baatonou and Fulani) was highly significant at 0.1% (P = 0.0001).

Using the two results above (annual income from sold non-timber forest products and annual overall income), the percentage of overall income from non-timber forest products sold was calculated for each household. This percentage ranged from 0 to 75.49% for the whole sample. The average was 11.46%.

4.3. Socio-economic determinants of NTFPs harvesting

Regression of total dry weight of non-timber forest products (almonds of *Vitellaria paradoxa*, C.F.Gaertn, seeds and pulp of *Parkia biglobosa* (Jacq.) R. Br. ex G. Don and leaves of *Adansonia digitata* L.) on the socio economic determinants was estimated by Ordinary Least Squares method (OLS). The results were summarized in Table 4. Analyzing this table, the model was overall significant at 1% (Prob> F is equal to 0.002 <1%). In addition, 35% of the total dry weight variations of NTFPs harvesting was explained by variations of the five socio-economic variables of the household head. Finally, only two variables: age and ethnic group were significants. It appeared that Baatonou ethnic group exploited more NTFPs than Fulani. It was also revealed that the more the head of household got older, more he collected NTFPs.

Variables	Coefficient of variables	Error-type	Statistic of Student	Signification of coefficients
Constancy	-142.24	899.81	-0.15	0.87
Size of household	11.52	19.31	0.59	0.55
Ethnic group	895.27	329.66	2.71	0.00***
Sex	-622.44	729.75	-0.85	0.39
Age	24.39	10.69	2.28	0.02*
Education level	-19.61	42.68	-0.46	0.64
Sample		N=148		
F(5. 142)		4.05		
Prob> F		**0.002<0.01****		
R^2		**0.35**		

*. ** et ***= significatif respectivement à 5%. 1% et 0.1%

Table 4: Factors determining non-timber forest products harvest level
Source: Elaborated by the authors.

5. Discussion

Statistical analysis showed that Baatonou households got more income from *Vitellaria paradoxa*, C.F.Gaertn (shea tree) than Fulani ethnic households. The first ethnic group had got significant income with a maximum of 2.230,000 franc CFA ($ 4,460) per household per year. Three reasons explain this fact. First, Fulani ethnic group collected small quantity of *Vitellaria paradoxa*, C.F.Gaertn. In addition, unlike the Baatonou, the Fulani ethnic group directly sold the shea almonds without adding value by processing. Finally, they sold these almonds during abundance period when the selling price was low.

In Sampeto village, the average income that a household had got from marketable NTFPs annually was 255,484 francs CFA ($ 510,968). Including the financial value of consumed quantities of marketable NTFPs and the economic value of the firewood, this income was 303,657 francs CFA ($ 607.31). Then this amount was monthly around 25,304 francs CFA. NTFPs contributed an average of 11.46% of the overall income of household. These results allowed to conclude that NTFPs contribute substantially to the household economy in Sampeto. However, this percentage was lower than the finding of Lebel (2002). He worked on the perception of farmers concerning the share of their income that was got from NTFPs in Senegal (Lebel *et al*., 2002). According to these authors, while half of the farmers revealed that more than a quarter of their income came from NTFPs, 41% of the farmers got 50% and more of their income from the sale of NTFPs. Finally, 8% of the households surveyed got 75% and more of their income from these activities. Similarly, (Cavendish, 2002) estimated the value of goods taken from nature by rural communities in Zimbabwe to 37% of total income. Also, in three Indian States, Bahuguna found that forest products represented 37 to 76% of the total income of rural communities (Bahuguna, 2000). In the same vein, Kramer estimated that 40% of total income of communities was derived from wild resources in Madagascar (Kramer *et al*., 1995). Such studies indicated that wild resources can represent a significant proportion of household income in some rural areas of developing countries (Clerici *et al*., 2007; Vodouhe *et al*., 2011). Ndoye (1998) reported that in Africa the contribution of NTFPs to the household economy remained below 50%. However, the variation in results from one side to another could be caused by several factors such as: the variability of methods and approaches used to estimate the variation of the importance of NTFPs among ethnic groups and among region.

Regarding the differences in income from NTFPs between ethnic groups, Ambrose-Oji (2003) in a study in the forest zone of south-west of Cameroon, reported that for the majority of poor migrant communities like the Fulanis, NTFPs had not a significant share in the total household income (not more than 6%) while richer households derived about 15% of their income from NTFPs. The results of this study were similar to the results of that paper. In this study, the main reason might be more related to the fact that Fulani ethnic group had no parkland and were mostly livestock producers.

The economic value of firewood was estimated at 97,840 francs CFA ($ 195.68) per household per year by the indirect method of opportunity cost in Sampeto village. This value was greater than $95 found in a study on NTFPs in India (Kant, 1997), and $66 per household per year in Madagascar (Kramer, 1995). However, a higher value was observed in Sri Lanka (U.S. $ 253) per household per year for a variant of NTFP (Gunatilake *et al*., 1993). Pearce (2001) summarized the results of more recent studies and concluded that the value of NTFPs was between U.S. $ 1-100 per hectare. However, some studies concluded higher value like the case of Biloso *et al*., 2006 who estimated $ 960 per person per year as the income from the exploitation of NTFPs, for a group of 25 farmers in Dumi (Democratic Republic of Congo). Several reasons might justify the differences observed. The value of dollar at the time of this study, the difference in wage rate from one side to another, (eg in Benin, the wage rate is 1000 franc CFA / hour ($ 2/hour), which was relatively higher than which what was practiced in Malaysia (650 franc CFA / hour) (Svarrer *et al*., 2005). Another reason could be the differences among the methods used to estimate NTFP value. Attention should be paid to result compararizing. The results might differ even when the methodology was similar because of biological and economic diversity of study areas and the diversity of NTFPs.

Regression of NTFPs (almonds of *Vitellaria paradoxa*, C.F.Gaertn, leaves of *Adansonia digitata* L. and seeds and pulp of *Parkia biglobosa* (Jacq.) R. Br. ex G. Don) on the socio-economic determinants revealed that the variables, age and ethnic group, were significant. It appeared that Baatonou ethnic group exploited more NTFPs than Fulani ethnic group. The older the head of household was the more the household collected NTFPs.

6. Conclusion

In the study area, local people use to harvest mostly five products: one non-marketable product (firewood) and four marketable products (almonds of *Vitellaria paradoxa*, C.F.Gaertn, seeds and pulp of *Parkia biglobosa* (Jacq.) R. Br. ex G. Don and leaves of *Adansonia digitata* L.). The mean contribution of marketable products to surveyed dwellers was estimated at XOF 255,484 ($US 510.968) (standard error: XOF 37,109), representing about 11.46% of the annual cash income per household. Then, non-timber forest products contribute significantly to the income of dwellers living around this reserve. Furthermore, socio-economic and demographic factors do influence the quantity of non-timber forest products harvested such as age and ethnic group. To sustainably meet the needs of people, it is important to domesticate the following species and also include them in the development plans of the Transboundary Biosphere Reserve W and the parkland of dwellers. There are *Vitellaria paradoxa*, C.F.Gaertn, *Parkia biglobosa* (Jacq.) R. Br. ex G. Don, *Adansonia digitata* L., *Anogeissus leiocarpa* (DC.) Guill. and Perr. and *Crossopteryx febrifuga* (Afzel. ex G.Don) Benth.

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Valor econômico e determinantes socioculturais dos produtos florestais não madeireiros na Reserva Transnacional W da Biosfera, Benim

Alice Bonou Fandohan*
Belarmain Fandohan **
Anselme Adegbidi **
Brice Sinsin **

*Agrônoma. Mestre em Gerenciamento de Desastres Naturais (University of Abomey-Calavi, Benim). Ph.D em Economia (University Cheikh Anta Diop, Senegal). Professor at African School of Economics.
** Pesquisador na University of Abomey-Calavi, Benim.

Resumo: Este trabalho examina o valor econômico dos produtos florestais não madeireiros e sua contribuição para a renda da população que reside na Reserva Transnacional W da Biosfera em Benim. No estudo, 148 pessoas de dois grupos étnicos foram entrevistadas. Os dados foram analisados com base no método de estimativa indireta de custo de oportunidade e margem bruta. Os resultados mostram que a população local colhe cinco tipos de produtos: lenha (não comercializado) e quatro produtos comercializados (*Vitellaria paradoxa*, C.F.Gaertn, sementes e polpa de *Parkia biglobosa* (Jacq.) R. Br. ex G. Don e folhas de *Adansonia digitata* L.). A média da contribuição dos produtos comercializados dentre os entrevistados foi estimada em XOF 255,484 ($US 510.968) (desvio padrão: XOF 37,109), representando cerca de 11,46% da renda anual dos domicílios. Grupos de idade e aspectos sociolinguísticos foram os maiores determinantes da exploração de produtos florestais não madeireiros. Tendo em vista o valor desses produtos para as comunidades, deve-se priorizar a domesticação e conservação as plantas identificadas nestes estudo.

Palavras-Chave: produtos florestais não-madeireiros, valor econômico, Oeste Africano.

Informações da autora principal

Alice Bonou Fandohan
E-mail: abonou@africanschoolofeconomics.com
Link para o currículo lattes: https://africanschoolofeconomics.com/faculty/alice-b/

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