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Role of *Adansonia digitata* L. Fruits in Development and Forest Conservation in Rashad Locality, Nuba Mountains, Sudan

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Abstract: The objectives of this work were (i) to investigate the contribution of the baobab tree (*Adansonia digitata* L., known locally as "tebeldi") fruits extraction in rural household's income and tree species conservation and (ii) to identify and analyze the determinants of income generation from *A. digitata* fruits extraction. Five villages were selected in Rashad Locality, South Kordofan State, based on proximity gradient to the resource. A sample of 276 households was taken from the selected villages, using a stratified sampling technique. Both quantitative and qualitative data were collected in 2009, using participatory rural appraisal tools. The results indicated that the household's annual average income from the *A. digitata* fruit sale was 44% of the total household income, aggregated across wealth categories. The results also showed that wealth, proximity to the resource and other household characteristics affected the income generation from *A. digitata* fruit sale. It was concluded that the *A. digitata* fruits extraction plays a key role in improving the livelihood of the rural households and conserving the tree species. Rural development and future conservation interventions should pay attention to the role of *A. digitata* fruits extraction in rural economic development and environmental sustainability.

Key words: *Adansonia digitata* fruits; rural income; forest conservation; Sudan

INTRODUCTION

The term non-timber forest products (NTFPs) represents the botanical and other natural products extracted from the forest other than timber. The integration between forest and forest dwelling communities is receiving increasing attention from social experts and policy-makers. This reflects a growing recognition of the contribution of the NTFPs to rural livelihood, both in terms of supporting subsistence and of financial income generation (Arnold and Ruiz Perez 1998; Belcher 2003). Moreover, harvesting NTFPs is less damaging to forest resources than timber (Arnold and Ruiz Perez 1998; Belcher 2003).The importance of NTFPs development and conservation stems from the assumption that NTFPs, much more than timber, can contribute in important ways to the livelihoods and welfare of people living in and adjacent to forests, providing them with food and medicines and can be a source of employment and income. The exploitation of NTFPs is less ecologically destructive than timber; thus, it provides sounder basis for sustainable forest management (Arnold and Ruiz Perez 1998). However, the holistic management of the NTFPs resource entails maintaining and sustaining the resource and its benefits, and contributing to sustainable development and conserve forests and biodiversity (Falconer 1996). The enthusiasm for NTFPs in economic development and conservation grew primarily from reports of their economic value. Such reports include that of Peters *et al.* (1989), on fruit and latex extraction in the Amazon, who reported that the net actual value of fruit and latex was more than twice that of timber.

Although recent studies highlighted the potential contribution of NTFPs activities to rural livelihood and poverty alleviation, their role in forest conservation is in doubt (Arnold and Ruiz Perez 1998; Ros-Tonen and Wiersum 2005). In fact, many NTFPs are harvested in a destructive or unsustainable manner, resulting in resource degradation (Peters 1996). It was also found that it is not easy to serve ecological, economical and social objectives simultaneously through sustainable extraction of NTFPs (Neumann and Hirsch 2000). Studies regarding ecological impact of NTFPs exploitation showed that commercial harvesting/extraction of NTFPs does have a number of negative impacts. These include a gradual

reduction of the harvested plants, decreasing rates of seedling establishment of harvested species and nutrient loss from harvested material (Peters 1996). In a comprehensive review of NTFPs commercialization, Neumann and Hirsch (2000) point out that sale of NTFPs often tends to provide a low level of income, rather than providing a method of socioeconomic advancement. Belcher (2003) indicated that the term NTFPs includes a very wide range of forest products and marketing systems, and while some NTFPs appear to be successful in alleviating poverty and contributing to forest conservation, others are harvested very intensively in a manner that results in excluding some actors from the process. Increased benefits of NTFPs might be achieved through human interventions such as cultivating forest with valuable NTFPs species (Ros-Tonen and Wiersum 2005).

Assuming that NTFPs are highly diverse in terms of their ecological and socioeconomic characteristics, there is a need to define which NTFPs have particular potential for development and conservation, and under what conditions their use and sale is likely to make a positive contribution to development and conservation (Belcher 2003; Lawrence 2003). Such information would help reduce the doubts and misdirection of donor investments identified by Sheil and Wunder (2002). The objectives of this study were (i) to investigate the role of the *A. digitata* fruit extraction in rural household's income and tree species conservation and (ii) to identify and analyze the determinants of income generation from *A. digitata* fruits extraction.

MATERIALS AND METHODS

Study area

The study was conducted in 2008/09 in five villages (Jolia, Tasi, El bederia, Kalinda and Mahala) in Rashad Locality in the north-western part of the central clay plain of the Nuba Mountains, in dry land Savanna Zone. Rashad Locality lies between latitudes 10° and 13° N and longitudes 29° and 33° E (Fig. 1). It occupies a total area of 7872 Km^2 with a population of around 241 046. The main land uses in the study area are traditional agriculture, animal husbandry, hunting and gathering. Forests cover most areas of the Locality with non-timber forest producing tree species.

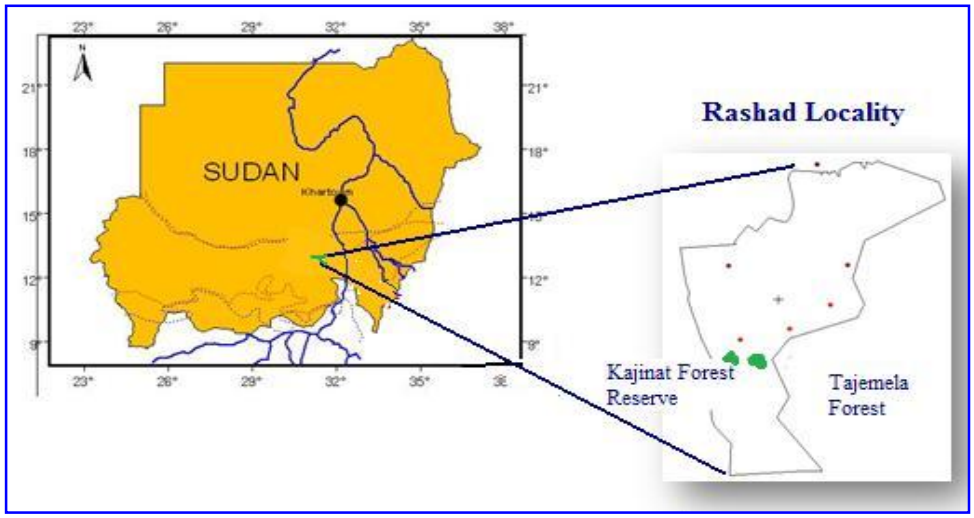

Fig. 1. Map of the study area, Rashad Locality in South Kordofan State, Sudan

The vegetation varies with soil type and rainfall pattern in the study area. The northern and western parts of Rashad Locality, where the rainfall is less abundant (372 mm on average), have poor to moderate vegetation, while the southern and eastern of the study area, where the mean annual rainfall is 712 mm, have denser vegetation (Pantuliano 2005). The dominant NTFP sources in the study area are *Adansonia digitata*, *Ziziphus spina- christi*, *Balanites aegyptiaca*, *Borassus aethiopum*, *Grewia tenax*, *Gerwia bicolor*, *Hyphaene thebaica*, *Sclerocarya birrea*, *Tamarindus indica*, *Cordia abyssinica, Cordia Africana*, *Detarium senegalense*, *Diospyros mespiliformis* and *Ximenia Americana* (El Tahir and Gebauer 2005; Adam 2011).

Data collection

The study site was selected purposefully on the bases of availability of NTFPs and long history of collection practices. Five villages were chosen based on proximity gradient to forest resources. The proximity gradients

were (a) a village is inside a forest (1st proximity class), and (b) four villages within 2nd, 3rd, 4th and 5th proximity class having distances of 2-4 km, 5-7 km, 8-10 km and > 10 km, respectively. From the selected villages, a sample of household-heads was taken using stratified sampling technique that involved groupings of the study population into different wealth strata (poor, medium and rich) using criteria developed by key informants. A random sample was used within each stratum. A total of 276 household-heads were selected. The procedure for wealth ranking was conducted as follows: village leaders and forest officers listed every member of the community and together with key informants grouped the population using wealth ranking. According to each and everyone's wealth status, the criteria for classification were size of farmland, farm plot size and livestock ownership.

A household head was interviewed for data collection and was taken as unit of measurement in this study. The questionnaire consisted of questions on household characteristic such as age, educational level, number of households, farm information, e.g. agricultural land holdings, crop production and animal husbandry, and source of livelihood, income and income sources from each of the various sources. The sampled households were also asked to give estimates of *A. digitata* fruits collected, amount sold by household for the past harvesting year. Since the reliability of such data is a bit uncertain as it depends on the memory capacity of individual respondent, extreme effort was exerted to triangulate the question by asking the household repeatedly in different ways. For instance, they were asked how much they sold. To complement and make up for the inherent shortcomings of most formal data collection methods, the study also drew some important tools from informal survey methods, by using PRA tools such as key informants, informal discussion, group discussion and field observations. The main advantage of employing these appraisal techniques was to gain maximum information within minimum time and resource and to assess the variety of information from the household interview.

Data analysis

The qualitative data that were obtained through key informant interviews and group discussion were narrated and summarized. The quantitative data, obtained through formal survey, were analyzed by using Statistical Package for Social Sciences (SPSS) version 18. Linear regression model and descriptive statistics were employed to analyze the quantitative data. Income approach was used to value the annual income from *A. digitata*, whereby the physical production was valued using surrogate market prices of the resource (Shylajan and Mythili 2007). The value of field crops and livestock products was calculated by multiplying the amount consumed in by the average price in the local market. Production costs were deducted from the income in all economic activities to obtain the net income.

RESULTS

Socioeconomic characteristics of the sample household

The majority of sample household heads (80.1%) were females (Table 1). This is due to migration of most adult males to big towns searching for work, because the study area is affected by the consequences of war and scarcity of income sources. The results showed that 15%, 20.9%, 40%, 20% and 4.1% of the sampled households were < 18, 18-28, 29-38, 39-48 and 49-58 years old, respectively. A large percentage (40%) of the sampled households was illiterate, and only 22.9% had some *Khalwa* (traditional Quranic School) education, 32.8% had received some primary education, 1.4% had some intermediate education and 2.9% had some secondary school education. About 50% of the surveyed households were married, 10.3% unmarried, 14% divorced, 19.8% widowed and 15% children.

Contribution of livelihood strategies to household income

The sampled household's income from different livelihood strategies for 2008/09 were sale of *A. digitata* fruits (US$ 530.64), crop production (US$ 422.1), animal husbandry (US$ 168.84) and other off farm activities (US$ 84.42), and respectively, contribute to the annual household income by 44%, 35%, 14%, and 7%. The total average annual household income was US$ 1206.

Table 1. Socioeconomic characteristics of sample households (percentage of households in each class)

Variable/attribute	Class	Percentage of households (n*=276)
Sex	Male	19.9
	Female	80.1
Age	<=18 years	15.0
	18-28 years	20.9
	29-38 years	40.0
	39-48 years	20.0
	49-58 years	4.1
Education level	Illiterate	40.0
	Khalwa	22.9
	Primary	32.8
	Intermediate	1.4
	Secondary	2.9
Marital status	Married	40.9
	Unmarried	10.3
	Divorced	14.0
	Widowed	19.8
	Children	15.0

*n= number of respondents

Determinants of income generation

The distance from the forest was significantly ($P \leq 0.05$) and negatively associated with income generated by household from the *A. digitata* fruit sale. However, land holding size and livestock size were positively and significantly ($P \leq 0.05$) correlated with household's income from the fruit

sale. Age of household head, education level and total family size were not significantly related to household income from *A. digitata* fruit sale (Table 2).

Table 2. Regression analysis of the household income versus socioeconomic characteristics

Variable	Unstandardized coefficients (B)	SE±	Standardized coefficients (Beta)	t-value	Sig. level
(Constant)	735.2	2529.80	-	2.906	0.0045
Distance to forest (Km)	-1509.47	312.18	-0.4021	-4.835	0.0061
Age of HH (years)	18.16	47.62	0.0366	0.381	0.7038
No. of years in education	182.90	569.95	0.0283	0.321	0.749
Family size	- 122.83	100.526	-0.1176	-1.222	0.2247
Land holding size (ha)	1132.38	438.61	0.2532	2.582	0.0113
No of animals	89.29	28.93	0.2682	3.087	0.0026

HH: Head of household

Forest proximity affected *A. digitata* fruits extraction by households (Fig. 2). The average annual income from *A. digitata* fruits sale in the first proximity class (US$ 767.6) was greater than the household income in the second proximity class by 21.8 %, and it was 68.1% of the fifth proximity class. This implies that households in the first proximity class generated more income from *A. digitata* fruits sale than the fifth proximity class.

Similarly, wealth class, considering all proximity classes together, affected income generation from the fruits sale. *A. digitata* fruits sale contributed 50% of the annual household total income for the poor, 37.5% for the medium and 33.3% for the rich. However, the rich household generated less cash income from *A. digitata* fruits than the medium and

the poor (Table 3). The average annual *A. digitata* fruits sale income of the rich category (US$ 300) was similar to that of the poor households (US$ 250).

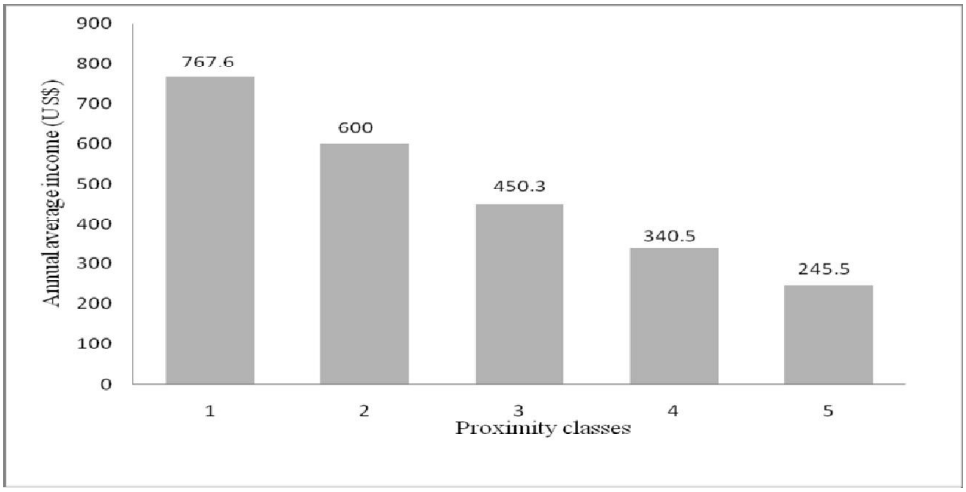

Fig. 2. Household annual average income from *A. digitata* fruits extraction by proximity classes.
1= the village inside the forest, 2= 2-4 km, 3=5-7 km, 4=8-10 km, 5= >10 km

Table 3. Annual household average total income and *A. digitata* fruits income among wealth categories

Income source	Wealth category					
	Rich		Medium		Poor	
	Average	SE±	Average	SE±	Average	SE±
Household average total income	900	2981	800.5	1600	500	216
Household average income from fruits sale	300	970	300	873	250	111
Percentage of income from NTFPs to total income	33.3		37.5		50	

DISCUSSION

The results showed that the rural households in the study area depend on different income sources for living. *A. digitata* sale, crop production, animal husbandry and non-farm activities were the main economic contributors to household's economy. Dependence on such diversified income sources has been indicated in numerous case studies. Shackleton and Shackleton (2004) and Ros-Tonen and Wiersum (2005) reported that extraction and sale of NTFPs constitute an essential part of household rural economy in the tropics. They combine sale of NTFP with other economic activities to improve and sustain rural welfare. Despite seasonality of the *A. digitata* fruits sale, it was the main contributor to household cash income in the study area. This finding disagrees with Getechaw *et al.* (2007) who reported that agriculture contributes to the total household income more than NTFPs sale in Ethiopia.

Selling of *A. digitata* fruits in Rashad Locality made a significant annual contribution (44%) to the rural household's total income. This is comparable to Campbell and Tewari (1995) finding which revealed that NTFPs contribute 63% to the total annual household economy in India when compared with crop production. On the other hand, Cavendish (2000) in Zimbabwe stated that NTFPs contribution was 35 % to total household's income.

Despite the considerable contribution of *A. digitata* fruit sale to household income, a number of constraints are downplaying their role in rural livelihood. Wealth proximity and household socioeconomic characteristics affected the amount of *A. digitata* fruits extracted from the forests. It is interesting to note that poor households extract higher income from NTFPs than the rich households do. Such finding is common in some NTFPs related studies (Shackleton 2006). This is due to the fact that poor households depend on NTFPs extraction and sale to sustain and improve their economy status than other household income categories. In fact, there are also results demonstrating the opposite (Getechew *et al.* 2007).

There is a negative and significant correlation between distance to forest and income from *A. digitata* fruits. Increasing distance from the forest edge reduced overall extraction of baobab fruits. This result agrees with the findings from many other studies. For instance, Hegde and Enters (2000) who noted that forest resource extraction is greater in proximal villages than in distant villages, possibly because the proximal villages had access to both resources and markets. On the other hand, Riadh (2007) stated that households in interior villages collect more NTFPs and generate more income than households in exterior villages.

Land holding had also positive and significant relationship with income from *A. digitata* fruit sale. Households with wild forest generate more income than those households who do not have wild forest, and they have customary right to exclude others. This agrees with the study conducted in India by Hegde and Enters (2000) who stated that rich households in the proximal villages maintained far larger land holdings compared with others. This may be because households settled in these areas long ago, and this enabled them to claim more land. However, loose regulations for access to and harvest of forest resource put immense pressure on forest resources in study area.

CONCLUSION

The sale of *A. digitata* fruits is the major income source to the rural household in Rashad Locality, particularly for the poor as they have less alternative sources of income. The poor household categories gain more income from the *A. digitata* fruit extraction than the rich households do. Households who reside inside a forest gain more income from fruit extraction than those outside and at distant villages. *A. digitata* trees coverage in the study area is declining, which may affect future prospect of sustainable fruit extraction and thus economic development and forest resource conservation.

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دور ثمار التبلدي (*Adansonia digitata* L.) في التنمية و المحافظة علي الغابات في محلية رشاد، جبال النوبة، السودان

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المستخلص: هدفت هذه الدراسة الي تقصي مساهمة ثمار التبلدي (*Adansonia digitata*) في دخل الأسرة الريفية و المحافظة علي أشجار التبلدي والي التعرف علي و تحليل محددات الدخل من هذه الثمار. أختيرت خمس قري من محلية رشاد بولاية جنوب كردفان بناءاً علي بعدها من المورد الغابي، وأختيرت عينة من 276 رب أسرة من القري الخمس المختاره، بإستخدام العينة الطبقية. جمعت البيانات الكمية والنوعية في عام 2009م بإتباع التقييم الريفي القائم على المشاركة. دلت النتائج علي أن متوسط دخل الأسرة السنوي من بيع ثمار التبلدي يمثل حوالي 44% من دخلها السنوي وإن مدي غني الأسرة وقربها من المورد الغابي لهما تأثير علي الدخل من بيع الثمار. خلصت الدراسة الي أن إستخلاص ثمار التبلدي له دور في تحسين دخل الأسرة والمحافظة علي أشجار التبلدي وأوصت بأن تعطي التنمية الريفية والمحافظة علي الأشجار إهتماماً لثمار التبلدي لما لها من دور في التنمية الإقتصادية وإستدامة البيئة.