The Contribution of Edible Wild Plants to Food Security, Dietary Diversity and Income of Households in Shorobe Village, Northern Botswana

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Research

Abstract

The objectives of this study were to investigate the indigenous knowledge on the use of edible wild plants (EWPs) and assess their contribution to the food security, dietary diversity and income of households in Shorobe Village, northern Botswana. Data were collected through: 1) a survey of 45 households randomly selected from a total of 128 households in the village, and 2) focus group discussions. Twenty seven species were found to be used as sources of food and beverage. Seven of the EWPs were harvested by 80% or more of the households. EWPs accounted for 25-76% of the annual food supply of households. Over two third of the population were engaged in the sale of 11 of the EWPs, and the sale of EWPs contributed between 1-100% to the monthly income of households. While 69% of the households earned money from the sale of EWPs, the sale of EWPs was the primary source of income for 21% of the respondents. The sale of EWPs was the second highest contributor, next to livestock, to the average monthly household income. The results revealed that EWPs are of high importance to the local population and confirmed the assumption that the availability of EWPs plays an important role in rural livelihoods through ensuring food security, dietary diversity and sustained income.

Introduction

Edible Wild Plants (EWPs) refer to both indigenous and naturalized exotic plants occurring in the natural environment (Shava 2005). Studies on the use of EWPs in different parts of Africa indicate that they are integral parts in the diet of people (Grivetti & Olge 1985). EWPs play an important role in household livelihoods, especially during periods of both natural and man-made stresses. They have significant nutritional, economic, ecological and socio-cultural values (Guijt *et al*. 1995, Scoones *et al*. 1992). In Zimbabwe, Wilson (1990) revealed that some poor households rely on wild fruits as an alternative to cultivated food for a quarter of all the meals in dry seasons. Similarly, in northern regions of Nigeria, leafy vegetables and other bush foods are collected as daily supplement relishes and for soups (Loghurst 1986). EWPs were previously recorded as contributed a greater share to annual diet than domesticated crops in Swaziland (Olge & Grivetti 1985). In Ethiopia, Teketay *et al*. (2010) identified 378 species of EWPs. In Tanzania, 326 species of EWPs have been reported (Ruffo *et al*. 2002). Katende *et al*. (1999) reported 210 EWPs that are being used in Uganda. The National Museum of Kenya has a database set up by the Indigenous Food Plants Programme. It includes data of over 800 plant species that are used for food. The majority of those plants are eaten as fruits and leafy vegetables (Maundu *et al*. 1999). In Botswana and Namibia, Story (1958) reported more than 78 species of EWPs. Grivetti (1979) reported that the Tswana in Botswana used 126 EWPs.

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Wild resources are more important to the poor than the wealthy (Bharuch & Pretty 2010). Forest foods increase the nutritional quality of rural diets. They have abundant phenolic compounds and other natural anti-oxidants (including vitamins and minerals) that have been associated with protection from and/or treatment of medical conditions such as malnutrition, heart disease, cancer, and diabetes.

EWPs are marketable and provide the opportunity to supplement household income. Today, wild fruits still represent some of the commodities sold by both local shops and street vendors (Mothanka *et al*. 2008) in different African countries. Consumption of wild food often saves money by reducing the necessity to buy food. For instance, people living far from forests spend three times more money on food than those living near forests (Bell 1995). Lower returns from farms necessitate the diversification of income from the sale of EWPs (Guijt *et al*. 1995).

In times gone by, some wild fruits were collected and given as offerings during wedding ceremonies. Some fruits served as ingredients for local traditional breweries (Mothanka *et al*. 2008). In addition to their roles as food, wild plants serve as craft materials for rural communities (Maghembe *et al*. 1994).

Edible wild fruit trees in Botswana play important roles for people living in rural areas. Some indigenous fruit trees yield a crop in poor rainfall years, thereby improving food security for rural households (Mojeremane & Tshwenyane 2004). Despite their significant importance, limited attention (Grivetti 1979, Mojeremane & Tshwenyane 2004, Mothanka *et al*. 2008, Ohikpehai 2003, Paya 2005, Story 1958) has been given to systematic documentation/profiling of existing knowledge and values of, and threats to, EWPs in the country in the context of climatic variability.

A few of the existing studies have paid attention to profiling and documenting values and threats to sustainable utilization of medicinal plants (Andrae-Marobela *et al*. 2010). Unlike medicinal plants, many EWPs are collected and consumed directly, and are not traded internationally, and they are, therefore, generally undervalued and ignored by government decision makers and international agencies. The danger of ignoring their hidden values is that policies tend to treat many areas where they are mostly harvested by the poor as unimportant (Guijt *et al*. 1995). Furthermore, existing studies tend to ignore other indirect values of EWPs (spiritual and recreational) and focus on monetary and consumptive values. Assessing the other values of EWPs so that they can be taken into account in planning and policy decision making is important to local populations. Therefore, there is a need for documentation of local knowledge of EWPs, the complexity of their values, distribution, anthropogenic factors threatening the sustainability and conservation status in different ecological zones in Botswana. This case study in the distinct ecological zone of the lower Okavango delta in north-western Botswana will contribute towards filling the knowledge gap.

The general objective of this study was to investigate indigenous knowledge related to the use of edible wild plants (EWPs) and to assess their contribution to the food security, dietary diversity and income of households in Shorobe Village. The specific objectives of the study were to: (i) determine the EWP species; (ii) investigate the socio-economic status of households consuming EWPs; (iii) determine the contribution of EWPs to the food supply and income of households (we hypothesized that the sale of EWPs is most relevant for low income households); (iv) investigate other values associated with EWPs; and (v) identify the perceptions of local people regarding threats to EWPs.

Materials and Methods

Study area

The study was carried out in Shorobe Village in Ngamiland District (19° 42’ 54” S and 13° 44’ 43” E) of northwestern Botswana (Figure 1). The village is located directly below the Okavango Delta and about 26 km north of the district administrative town (Maun), and 53 km south of the gate of Moremi Wildlife Reserve. The area is characterized by sandy and infertile soils, and rainfall is unreliable and unpredictable. Usually, the rainy period is from October to April, and the annual rainfall in the area is between 500-600 mm. The vegetation consists mainly of mopane veld, *Acacia erioloba* E. Mey. sandveld and riverine woodland. The area is the center of tourism in Botswana.

Shorobe Village was selected to evaluate the utilization and commercialization of EWPs since it is one of the main settlements located along a major tourist route to Moremi Wildlife Reserve. Shorobe is a representative of all the villages along the road to the Okavango Delta because of its diverse use of natural resources compared to other villages along the same route that specifically derive benefits from tourism with minimal commercialisation of veld products due to the long distance from the district capital. As a rural settlement in the vicinity of the district capital and being the gateway to a world renowned tourist destination, the Okavango Delta, the community derives benefits from the use of veld products for the production of crafts, edible products and other domestic uses. Another reason for having the study focusing in only Shorobe Village was the need to evaluate the importance of EWPs in a holistic manner, including not only their importance in terms of food security, dietary diversity and income, but also in terms of culture and environment.

According to the Central Statics Office (CSO 2001), the population of Shorobe is about 1,000. Ethnic groups residing in Shorobe are Bayei, Banajwa, Batawana, Basarwa and Baxereku.

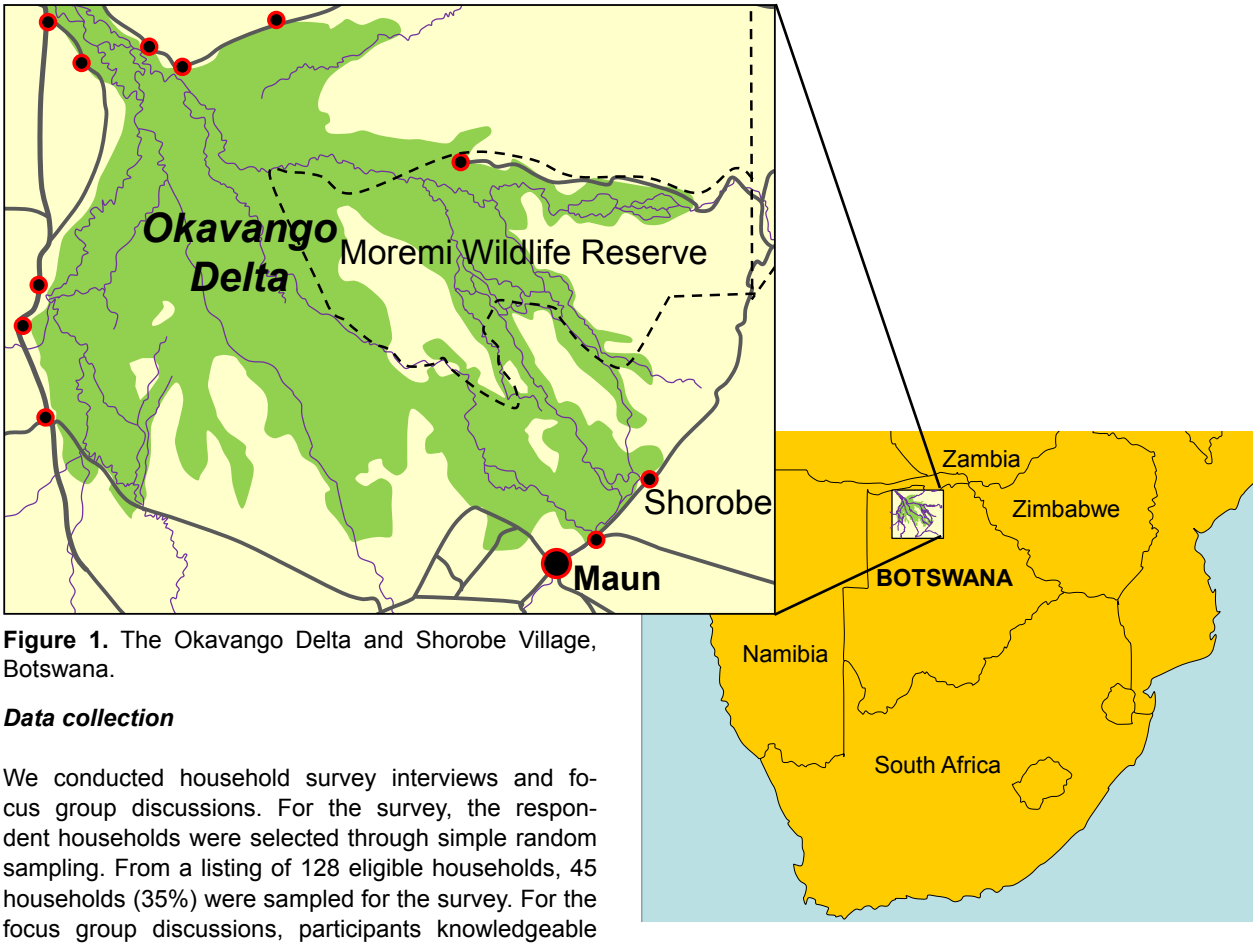

Figure 1. The Okavango Delta and Shorobe Village, Botswana.

Data collection

We conducted household survey interviews and focus group discussions. For the survey, the respondent households were selected through simple random sampling. From a listing of 128 eligible households, 45 households (35%) were sampled for the survey. For the focus group discussions, participants knowledgeable about EWPs were identified with the assistance of local people and authorities.

A questionnaire consisting of both open- and closed-ended questions, was prepared in five sections, i.e., socio-economic background of respondents, collection and harvesting, sales and sustainability of EWPs, perceptions of respondents on threats to EWPs and other values of EWPs. The questionnaire was first translated into the local language (Setswana) and pretested in a nearby village called Nxaraga. Following the pretesting, the questionnaire was revised and modified for flow and consistency.

The household survey was conducted through face-to-face administration of the questionnaire to either heads of households or knowledgeable adults responsible for management and distribution of food resources within the household. The interview was conducted in Setswana. Each interview lasted between 30 to 60 minutes, depending on the level of knowledge of the respondent. All EWPs collected by any member of the household, quantities collected, sales, factors leading to decline and other values of EWPs were recorded. Quantities were estimated using local measures as used in the homes and the markets. These measures are often mugs or empty sugar or maize meal bags.

The focus group discussion was comprised of a group of six people, three males and three females (five elders and a youth). When selecting the participants, care was taken to ensure inclusion of persons well knowledgeable on EWPs. The purpose of the focus group discussion was to free list EWPs, fill in the information gaps identified by the household survey, and to get information on the annual calendar of availability of the EWPs in Shorobe. Specific observations were reported from the focus group discussion, e.g., how some EWPs are harvested and prepared for cooking and preservation.

During the data collection in Shorobe, especially while conducting the interviews, observations were made about the habitat of the identified EWPs, and comments of respondents and other people of Shorobe were noted.

Plant voucher specimens were collected and deposited in the Peter Smith Herbarium, Okavango Research Institute, University of Botswana (PSUB), Maun.

Data analyses

After the data collection, questionnaires were validated and coded. Data were entered into the Statistical Package for Social Sciences (SPSS 2008) computer program. After cleaning the data, SPSS and Microsoft Excel were used to analyze them. Descriptive statistics were used to summarize the socio-economic status of households, the harvesting and consumption habits and the knowledge of respondents concerning EWPs. The consumption habits and incomes through the sale of EWPs were compared between households of different socio-economic status in order to find associations between certain socio-economic characteristics and the utilization of EWPs and their contribution to household incomes using the Chi-square test at the 0.05 level of significance. Qualitative data from the focus group discussion and open-ended questions were reduced into themes which, then, provided the bases for analyses.

Results

Demographic and socio-economic characteristics of households

Shorobe is predominantly inhabited by the Bayei ethnic group, which was represented by about half of the respondents of the household survey. About 24% of the respondents were Banajwa. The sample also included a few Batawana (11%) and Basarwa (4%). The Bakalaka, Bakgalagadi, Bangwato, Barotsi and Baxereku ethnic groups were represented by one respondent each. The majority of the respondents (80%) were females. Of the total households surveyed, 46.7% were *de jure* female-headed, 15.6% *de facto* female-headed and only 26.7% male-headed. The size of the households varied greatly. While there was only one person living in the smallest household interviewed, the largest household included 22 persons. The average number of persons per household was seven.

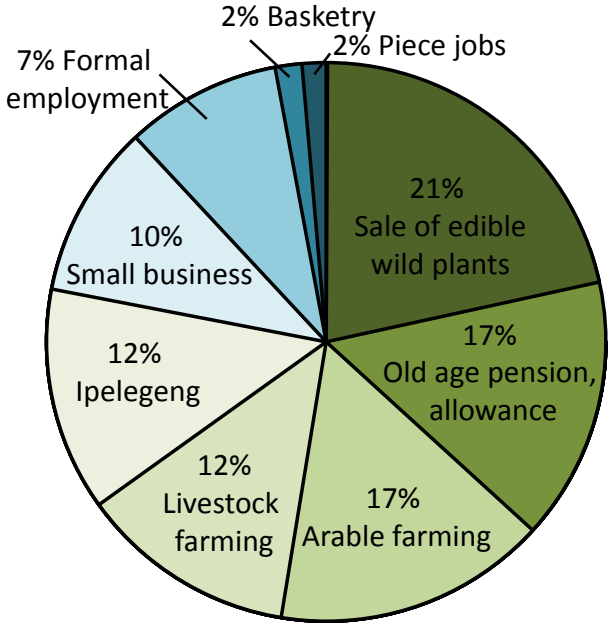

Figure 2. Primary sources of income of respondent households in Shorobe Village, Botswana.

The main income sources for the selected households (Figure 2) were the sale of EWPs, crop and livestock farming and old age pensions. A few people have small businesses. Labor intensive public works, locally referred to as **ipelegeng**, and basketry are further sources of income for a few of the respondents. Only a few of the respondents were formally employed. Their income is higher than the income of most of the other respondents. However, some of those involved in livestock farming have an even higher income.

The respondents were grouped into four different monthly income categories, i.e., (i) households with an income of less than 500 BWP (31% of the respondents); (ii) households that earned 501-1000 BWP (27% of the respondents); (iii) households with an income of 1001-2000 BWP (24% of the respondents); and (iv) households that earned more than 2000 BWP per month (11% of the respondents). Three households (7%) had monthly incomes that could not be established. The mean monthly income of the respondent households was 1083 BWP and most households had an income of less than 1000 BWP per month.

Floristic composition and number of EWPs

A total of 27 species of EWPs were used for food and beverage by the respondent households (Table 1). They belonged to at least 16 different families, of which Malvaceae was the most commonly represented. About 52% of the EWPs were woody species.

While some of the 27 species identified in Shorobe were commonly known and utilized by most of the local people, other species were only known and harvested by a few households in the village. Seven of the EWPs were harvested by 80% or more of the interviewed households (e.g., *Cleome gynandra* L., *Amaranthus thunbergii* Moq., *Hyphaene petersiana* Klotzsch ex Mart. and *Grewia flava* DC., *Grewia bicolor* Juss., *Ximenia americana* L. and *Nymphaea nouchali* Burm.f.) (Table 2).

In most cases (46%), the fruits were eaten. Tubers were also common edible parts (25%), and the other edible parts were leaves, stems, roots, grains and stem sap (Table 2). Most of the EWPs (80%) were eaten as snacks. This included all fruits but also some of the tubers, stems and leafy vegetables (Table 2). Leafy vegetables normally form part of a meal, in some cases the stems, tubers and

Table 1. Edible wild plants reported in Shorobe, Botswana. Woody species (green). Uses other than food: Alcoholic drink (**AD**); Biodiversity conservation (habitat, breeding ground, etc.) (**BC**); Brooms (**BR**); Bracelets (**BRA**); Basket weaving (**BW**); Carving (**CA**); Crafts (**CR**); Cooking utensils (**CU**); Decoration (**DE**); Drums (**DR**); Dye (**DY**); Feed (**FE**); Furniture (**FU**); Medicines (**ME**); **Mokoro** (dugout canoes)(**MO**); Necklaces (**NE**): Roofing (**RO**); Soil conservation (**SC**); Spiritual importance (**SI**); Source of water (**SW**); Windbreak (**WB**); and Walking sticks (**WS**).

Species	Family	Local Name	Uses other than food*
Amaranthus thunbergii Moq.	Amaranthaceae	**Thepe**	-
Azanza garckeana (F. Hoffm.) Exell & Hillc.	Malvaceae	**Moroja**	-
Berchemia discolor (Klotzsch) Hemsl.	Rhamnaceae	**Motsensela**	BC, DY & FU
Ceropegia sp.	Apocynaceae	**Serowa**	SW
Cleome gynandra L.	Capparaceae	**Leketla/Rothwe**	-
Corchorus olitorius L.	Malvaceae	**Delele**	-
Cyperus fulgens C.B. Clark.	Cyperaceae	**Monakaladi**	-
Diospyros mespiliformis Hochst. ex A.DC.	Ebenaceae	**Mokutsumo**	BC, FE, SC & WB
Ficus sycomorus L.	Moraceae	**Mochaba**	FE, FU, ME & SC
Fockea angustifolia K. Schum.	Apocynaceae	**Leruswa**	SW
Garcinia livingstonei T. Anderson	Cluisiaceae	**Motsaodi**	FU, ME & MO
Grewia bicolor Juss.	Malvaceae	**Mogwana**	AD, BC, FE, ME & SI
Grewia flava DC.	Malvaceae	**Moretlwa**	-
Grewia flavescens Juss.	Malvaceae	**Mokgomphatha**	BW & WS
Grewia retinervis Burret	Malvaceae	**Motsotsojane**	WB
Hyphaene petersiana Klotzsch ex Mart.	Arecaceae	**Mokolowane**	AD, BC, BR, BRA, BW, CA, CR, DE, DR, FE, FU, MO, NE, RO, SC & WB
Nymphaea nouchali Burm.f.	Nymphaceae	**Tswii**	ME
Rhus quartiniana A. Rich.	Anacardiaceae	**Moropaphiri**	-
Sclerocarya birrea (A. Rich.) Hochst.	Anacardiaceae	**Morula**	BC, CU, CR, FE & FU
Urochloa mosambicensis (Hack.) Dandy	Poaceae	**Phoka**	FE
Vangueriopsis lanciflora (Hiern.) Robyns ex R.D. Good	Rubiaceae	**Mmupudu**	-
Ximenia americana L.	Ximeniaceae	**Moretologa**	FE & ME
Unidentified sp.		**Lehubala**	-
Unidentified sp.		**Mokgothwane**	-
Unidentified sp.		**Natshwa**	-
Unidentified sp.		**Tshetla**	-
Unidentified sp.		**Xhoxhone**	-

flowers may make up a whole meal or at least a major part of it. Of all the EWPs, 24% formed part of a meal, 12% made up a whole meal on their own and 8% were sources of alcoholic drinks. Some EWPs were eaten as snack as well as part of a meal or as whole meals. Among the most commonly harvested EWPs mentioned above, *N. nouchali* was normally eaten as a whole meal or major part of a meal, *C. gynandra* and *A. thunbergii* formed part of a meal and the rest were normally eaten as snacks (Table 2).

EWPs are collected by all members of the households, i.e., adults and children as well as males and females. However, certain plants were often harvested by certain people. For instance, *A. thunbergii* was harvested by female adults, all members and male adults in 55, 42.5 and 2.5% of the households, respectively. *Cleome gynandra* was harvested by female adults and all members in 57 and 43% of the households, respectively. *Nymphaea nouchali* was harvested by females and all members in 78% and 22% of the households, respectively. *Hyphaene petersiana* was mostly harvested by male children. Wom-

Table 2. Edible wild plants (EWP) proportionately used by households in Shorobe, Botswana. Collection places: In village (**IV**); Outside village (**OV**); and at home (**HO**). Availability scale: Low (**1**); Medium (**2**); and high (**3**).

Species	Edible part	Mode of consumption	Collection Place	Availability (average)	Households collecting EWP (%)
Cleome gynandra L.	Leaves	Meal	HO & IV	1.8	93.3
Amaranthus thunbergii Moq.	Leaves	Meal	IV	2.4	86.7
Grewia flava DC.	Fruits	Snack	IV & OV	2.2	84.4
Hyphaene petersiana Klotzsch ex Mart.	Fruits	Snack	Mainly IV	2.3	84.4
Grewia bicolor Juss.	Fruits	Snack	IV & OV	2.3	80.0
Nymphaea nouchali Burm.f.	Roots	Meal	Mainly OV	2.2	80.0
Ximenia americana L.	Fruits	Snack	IV & OV	2	80.0
Berchemia discolor (Klotzsch) Hemsl.	Fruits	Snack	IV & OV	1.9	44.4
Garcinia livingstonei T. Anderson	Fruits	Snack	Mainly IV	1.7	42.2
Diospyros mespiliformis Hochst. ex A.DC.	Fruits	Snack	Mainly OV	1.4	37.8
Ficus sycomorus L.	Fruits	Snack	IV & OV	1.8	37.8
Hyphaene petersiana Klotzsch ex Mart.	Stems	Snack & Meal	IV	1.6	35.6
Grewia flavescens Juss.	Fruits	Snack	IV & OV	2.3	26.7
Sclerocarya birrea (A. Rich.) Hochst.	Fruits	Snack	IV & OV	1.7	20.0
Grewia retinervis Burret	Fruits	Snack	IV & OV	1.6	17.8
Urochloa mosambicensis (Hack.) Dandy	Ear	Meal	IV	2.2	11.1
Unidentified sp. (**Tshetla**)	Stems	Snack & Meal	OV	1	11.1
Ceropegia sp.	Roots	Snack	IV & OV	1.3	4.4
Corchorus olitorius L.	Leaves	Meal	IV	1.8	4.4
Hyphaene petersiana Klotzsch ex Mart.	Sap	Drink	IV	2	4.4
Azanza garckeana (F. Hoffm.) Exell & Hillc.	Fruits	Snack	IV	1	2.2
Cyperus fulgens C.B. Clark.	Roots	Snack	OV	1	2.2
Rhus quartiniana A. Rich.	Fruits	Snack	IV	3	2.2
Vangueriopsis lanciflora (Hiern.) Robyns ex R.D. Good	Fruits	Snack	OV	2	2.2
Unidentified sp. (**Mokgothwane**)	Roots	Snack	IV	3	2.2
Unidentified sp. (**Xhoxhone**)	Leaves	Snack	OV	2	2.2
Fockea angustifolia K. Schum.	Tubers	Snack & Meal	-	-	-
Unidentified sp. (**Lehubala**)	Tubers	Snack	-	-	-
Unidentified sp. (**Natshwa**)	Tubers	-	-	-	-

en reported harvesting the most EWPs. Other EWPs, e.g., *G. bicolor*, *Diospyros mespiliformis* Hochst. ex A. DC. and *X. americana*, were typically collected by everyone.

From open ended questions and focus group discussions other values of EWPs with regard to medicinal, environmental, spiritual and cultural aspects were identified (Table 1).

Contribution of EWPs to annual household food supply

As mentioned above, some of the EWPs utilized in Shorobe were harvested by over 80% of the respondent households. They were well known by the majority of the people and often eaten. About 50% of the most often harvested EWPs were eaten as snacks. About 45% of the respondents stated that EWPs made up 51-75% of the annual food supply in their households. About 42% of the other respondents estimated the contribution of EWPs

to be between 26 and 50%. For only about 11% of the households, EWPs made up less than 25% of the households food supply, and for one household (2.2%), EWPs made up over 76% of the annual food supply.

The contribution of EWPs to food supply in households with low and high income

Prior to the study, it was assumed that households with low-income are more dependent on EWPs for their food supply than those with high income. It was, therefore, expected that households with a low monthly income collect a greater variety of EWPs than those with high incomes. It was also expected that EWPs contribute more to the annual food supply of households with low income than to those with high income. After comparing the number of EWPs collected in each household with the monthly income from sources other than the sale of EWPs, the first expectation could no longer be supported. There was no association between these two factors. There was no association between the total monthly income and the contribution of EWPs to the food supply of households. In terms of food supply, EWPs were of the same importance for both low and high income households.

No association was established between the gender of the respondent and the contribution of EWPs to annual food supply (Chi square value; $P > 0.05$).

EWPs prepared as part of meals

The species that contributed most to household food in Shorobe are shown in Table 3. *Nymphaea nouchali*, one of the most commonly eaten EWPs in Shorobe, was a major component of an average of three meals per week for at least 80% of the households. Over 60% of those harvesting *N. nouchali* also sold it. It can, therefore, be assumed that some of the households that do not harvest *N. nouchali* buy it. This increased the amount of people eating *N. nouchali* and therefore, its contribution to the food

Table 3. Edible wild plants (EWP) consumption frequency (average number of days consumed per week) in Shorobe, Botswana. Consumption (average number of days/week); Collection (percent of households collecting the EWP/week).

Species	Consumption	Collection
Azanza garckeana (F. Hoffm.) Exell & Hillc.	7.0	2.2
Rhus quartiniana A. Rich.	7.0	2.2
Cleome gynandra L.	4.2	93.3
Hyphaene petersiana Klotzsch ex Mart. (fruits & sap)	3.9	84.4
Grewia flava DC.	3.3	84.4
Amaranthus thunbergii Moq.	3.3	86.7
Berchemia discolor (Klotzsch) Hemsl.	3.1	44.4
Diospyros mespiliformis Hochst. ex A.DC.	3.0	37.8
Nymphaea nouchali Burm.f.	3.0	80.0
Grewia retinervis Burret	2.8	17.8
Grewia bicolor Juss.	2.4	80.0
Ceropegia sp.	2.3	4.4
Urochloa mosambicensis (Hack.) Dandy	2.2	11.1
Grewia flavescens Juss.	2.1	26.7
Garcinia livingstonei T. Anderson	2.1	42.2
Corchorus olitorius L.	2.0	4.4
Vangueriopsis lanciflora (Hiern.) Robyns ex R.D. Good	2.0	2.2
Ficus sycomorus L.	1.8	37.8
Unidentified (**Mokgothwane**)	1.5	2.2
Sclerocarya birrea (A. Rich.) Hochst.	1.2	20.0
Hyphaene petersiana Klotzsch ex Mart. (stems)	1.1	35.6
Ximenia americana L.	1.1	80.0
Cyperus fulgens C.B. Clark.	1.0	2.2
Unidentified (**Tshetla**)	1.0	11.1
Unidentified (**Xhoxhone**)	1.0	2.2

supply of households. Generally, *N. nouchali* is cooked with meat, and in this combination, it made up a whole meal.

Cleome gynandra was harvested by over 90% of the households and eaten as part of a meal on more than four days a week by those who harvest it. Of those collecting *C. gynandra*, 30% stated that they ate it every day during the season, which is approximately two months in December and January. As a leafy vegetable, it is eaten as a side dish. It is the most common side dish obtained from the wild in Shorobe. It is predominantly harvested within the village or even in people's yards, so there is no need to walk long distances to collect it. *Amaranthus thunbergii* was also harvested by nearly 90% of the households on an average of 3.3 days per week for about eight weeks. The leafy vegetable is eaten as a side dish. It grows within the village in between yards and next to roads. *Amaranthus thunbergii* is the most abundant EWP in Shorobe.

EWPs may not be consumed as regularly as the three mentioned above. However, they still contribute to the food supply of households and cannot be ignored, especially because they are often cooked as the major part of a meal. *Urochloa mosambicensis* (Hack.) Dandy, *H. petersiana*, and **tshetla** are three EWPs that contributed significantly to household meals and four EWPs whose contribution is less important, but not irrelevant.

EWPs eaten as snacks

Among the EWPs that were eaten as snacks (Table 2), fruits of *G. bicolor*, *H. petersiana*, *D. mespiliformis*, *G. flava*, *Garcinia livingstonei* T. Anderson and *B. discolor* were the most harvested. These were eaten by at least a third of the respondents and for not less than 2 days a week during the season. Of these, fruits of *H. petersiana* and *G. flava* were utilized the most often. During their season, they are collected and eaten for three to four days per week by over 84% of the population. In addition, *G. flava* was sold by 25% of the respondents, so it can be assumed that the number of people consuming the species is even higher. *Hyphaene petersiana* was eaten even more often than *G. flava*. However, it is sold by only a few people. The value of these two plants increases even more when looking at their many other uses besides their contribution to nutrition. *Hyphaene petersiana* was not only eaten as a snack, but its sap is used for an alcoholic drink called **mochema**. In addition to being eaten, *G. bicolor* fruit is made into an alcoholic drink called **khadi**. Like **mochema**, it is used at weddings and other ceremonies.

EWPs and income of households

The sale of EWPs is a source of income in Shorobe. Over two thirds of the population were engaged in the sale of 11 EWPs most of which were fruits eaten as snacks (Table 4). Of the EWPs that were prepared as meals, *H. petersiana*, *C. gynandra* and *N. nouchali* were the only three sold in Shorobe. Among the fruits, *G. bicolor*, *D. mespiliformis*, *G. flava* and *B. discolor* were sold by most people. *Nymphaea nouchali* was the EWP that was sold most often in Shorobe, and more than half of the households earned money through its sale. The species is most common during winter when there is water in the river that passes through Shorobe. When the river is not flooded, it is collected in rivers further away from the village. It has an advantage in that it can be stored for several months. Some households store it in winter and sell it in summer when it is not available in the village. The species, therefore, has the potential to serve as a permanent source of income throughout the year. However, it was sold through-

Table 4. Edible wild plants (EWP) sold in Shorobe, Botswawa. Sellers (percent of respondents); Months (number of months the EWP is sold); Frequency (number of times EWP is sold/month); and Price (Botswana Pula).

Species	Sellers	Months	Frequency	Price
Nymphaea nouchali Burm.f.	51	2.1	9	2-10/tuber
Grewia bicolor Juss. (fruit)	31	2.3	3.7	2-6/mug
Grewia flava DC.	24	2	5.5	2-5/mug
Diospyros mespiliformis Hochst. ex A.DC.	20	1.4	11	2/mug
Berchemia discolor (Klotzsch) Hemsl.	18	1.1	6.9	2-3/mug
Cleome gynandra L.	16	2.1	8	5/mug
Hyphaene petersiana Klotzsch ex Mart. (**Mochema** beverage)	7	12	3	2/mug
Grewia flavescens Juss.	7	1	3	1/tea cup
Ficus sycomorus L.	2	2	3	2/mug
Grewia bicolor Juss. (**Khadi** beverage)	2	12	3	-
Hyphaene petersiana Klotzsch ex Mart.	2	12	1	3/stem
Hyphaene petersiana Klotzsch ex Mart.	2	2.4	6.9	0.25-0.5/fruit
Sclerocarya birrea (A. Rich.) Hochst.	2	1	8	3/mug

out the year in only one household while one other household sold the species for ten months every year. *Nymphaea nouchali* is not only sold within Shorobe by people of the village but also in Maun by some households. *Cleome gynandra* is also commonly sold in Shorobe. Unlike *N. nouchali*, the collection of *C. gynandra* is restricted to its season of availability.

Beverages prepared from EWPs

Hyphaene petersiana and *G. bicolor* are sold as fruits by some households, and then, prepared as beverages (**mochema** and **khadi**, respectively) by other households. **Mochema** is sold throughout the year. Those households selling **mochema** are highly dependent on it as it is their primary source of income. In total, three households (7% of the respondents) were engaged in selling **mochema**. For one of the households, it was the only source of income, another household also sold khadi as the second income source, and still another household earned money from the sale of livestock in addition to earnings through the sale of EWPs. Those having no other income source besides the sale of **mochema** and **khadi** highly depend on the sale of these EWPs. The households that sell **mochema** are those with the highest income through the sale of EWPs. On average, they earn more than 1,000 BWP per month from this source of income.

Contribution of EWPs to the income of households

For 33% of the respondents, the contribution from the sale of EWPs to the monthly household income was between 1 and 25%. For 19% of the households the sale of EWPs contributed 25-50% to the monthly income. For 12% of the households, EWPs made up over 50% but less than 76% of the total income. Five percent of the households obtained even 75-100% of their income from the sale of EWPs.

Most Shorobe households had more than one source of income. While 69% of the households earned money from the sale of EWPs, the sale of EWPs was the primary source of income for 21% of the respondents (Figure 2). More than a fifth of the population depended primarily on this source of income, and for others, the sale of EWPs was an additional income source.

The different sources of income contribute to the average monthly household income in different amounts (Figure 3). The sale of EWPs was the second highest contributor to the average monthly household income (1,083 BWP). The only source that contributed more than EWPs was the sale of livestock. While livestock was sold by only 16% of the households and the primary income source for 12%, it contributed 29% to the average household income. EWPs contributed 22% of the average monthly household income of the respondents although many households (69%) sold EWPs.

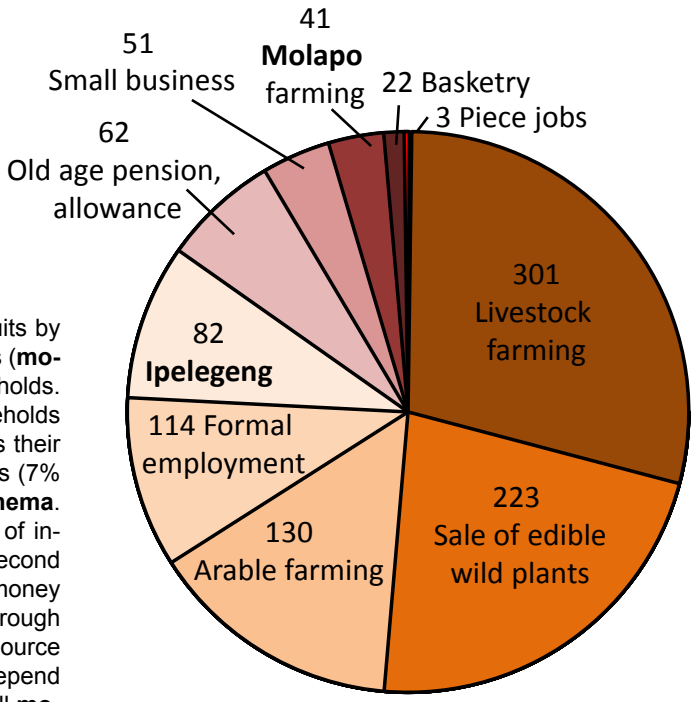

Figure 3. Sources of income (Botswana Pula) and their contribution to the average monthly household in Shorobe Village, Botswana.

The sale of EWPs and households with low income

There was no significant association between the total household income and income through the sale of EWPs based on Chi-square analysis. Therefore, the hypothesis that the sale of EWPs is most relevant for low income households could not be supported. In fact, the households with a high overall income generated most money through the sale of EWPs. Households with a total income of more than 2,000 BWP earned far more through the sale of EWPs than households with a lower income (Figure 4).

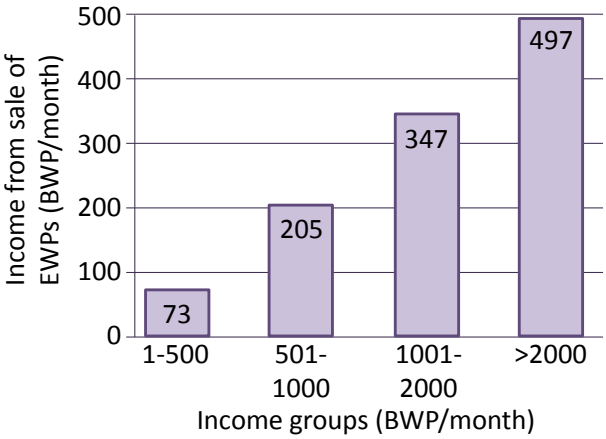

Figure 4. Income (Botswana Pula) generated through the sale of edible wild plants by different income groups in Shorobe Village, Botswana.

This trend was discussed in the focus group, and factors contributing to this situation were pointed out by the participants. Some better resourced households hire labor of less resourced households to harvest EWPs. One informant in the focus group compared these transactions with cattle ownership and access to high-end markets of the Botswana Meat Commission (BMC). Respondents from low income households collect EWPs and sell them to those with access to markets while other poor households barter EWPs they collect in exchange for perishables - food or grain. It is, then, the better resourced households who buy from less resourced households at a lower price and sell them at a higher price.

Annual calendar of availability of EWPs

Most of the EWPs (> 10 species) can be harvested during January-March, and October-December (Table 5). *Corchorus olitorius* L., *H. petersiana* (stems and sap), *N. nouchali* and **tshetla**, are available throughout the year.

Table 5. Availability of edible wild plant species in descending order based on months of availability per year. * Stems and Sap, ** Fruit.

Edible wild plant species	Months of availability											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Corchorus olitorius L.	■	■	■	■	■	■	■	■	■	■	■	■
Hyphaene petersiana Klotzsch ex Mart.*	■	■	■	■	■	■	■	■	■	■	■	■
Nymphaea nouchali Burm.f.	■	■	■	■	■	■	■	■	■	■	■	■
Tsheta	■	■	■	■	■	■	■	■	■	■	■	■
Ceropegia sp.	■	■	■							■	■	■
Cyperus fulgens C.B. Clark.	■	■	■							■	■	■
Fockea angustifolia K. Schum.	■	■	■							■	■	■
Lehubala	■	■	■							■	■	■
Mokgothwane	■	■	■							■	■	■
Natshwa	■	■	■							■	■	■
Rhus quartiniana A. Rich.			■	■	■	■	■					
Berchemia discolor (Klotzsch) Hemsl.	■	■	■	■								
Sclerocarya birrea (A. Rich.) Hochst.	■	■	■	■								
Azanza garckeana (F. Hoffm.) Exell & Hillc.					■	■	■					
Hyphaene petersiana Klotzsch ex Mart.**								■	■	■		
Ximenia americana L.	■	■	■									
Amaranthus thunbergii Moq.	■											■
Cleome gynandra L.	■											■
Diospyros mespiliformis Hochst. ex A.DC.							■	■				
Garcinia livingstonei T. Anderson	■	■										
Grewia bicolor Juss.				■	■							
Grewia flava DC.	■											■
Grewia flavascens Juss.			■	■								
Grewia retinervis Burret	■											■
Vangueriopsis lanciflora (Hiern.) Robyns ex R.D. Good						■	■					
Ficus sycomorus L.			■									
Urochloa mosambicensis (Hack.) Dandy		■										

These EWPs are of high relevance for local nutrition, especially during winter. In particular, *N. nouchali* is even more abundant in winter, when the Okavango Delta floods the river close to the village. *Corchorus olitorius*, which is often seasonal (November to March), was said to be found through the year near the river because of the permanent presence of water. In addition to the stems and sap, which are available all the year round, fruit of *H. petersiana* can be harvested for three months (August-October) each year. Six of the species are available for six months in a year. Sixteen of the species are harvested between one and five months per year (Table 5).

The highest number of EWPs (18 species) can be harvested in January followed by 16 species in March, 15 species each in February and December, and 10 species each in October and November (Table 5). The months with the lowest number of available species are August (five species) and September (four species).

Perceived threats to EWPs

The majority of respondents agreed that there are threats to EWPs and all but one stated, that there are EWPs that are not as abundant as were ten years ago. However, when asked about the threats, the respondents had different opinions. The factors considered to be the central threats to EWPs were wild animals (rated 2.89 on a scale from 1-3), deforestation (rated 2.8), the expansion of cultivated areas (2.76) and over-harvesting (2.62).

Wild animals were seen as a high threat to EWPs by 88.7% of the respondents. When asked for further explanation they stated that elephants destroy plants and, hence, threaten EWPs. *Grewia flava*, *G. bicolor*, *Grewia flavescens* Juss., *D. mespiliformis* and *H. petersiana* were some of the plants that were reported to be destroyed by elephants. Unstructured discussion with residents of Shorobe suggested that elephants frequently come close to the village, and that there is evidence of elephant destroyed plants around the village that can be seen by anyone. This was also observed by the researchers.

Deforestation was considered to be a high threat to EWPs by 80% of the respondents. This includes cutting of plants for fuel wood as well as deforestation due to land use change, e.g., the expansion of cultivated area and settlements. About 76% of the respondents agreed that the expansion of cultivated areas leads to a decline of EWPs and considered this factor to be a high threat to EWPs. In the focus group, participants explained that the abundance of *G. flava* has been reduced as a result of land clearing for residential plots. The participants also argued that the abundance of *U. mosambicensis* has declined since its natural ecosystem has been affected by the expansion of flood-recession (**molapo**) farming plots.

Over-harvesting was seen as a high threat to EWPs by 64.4% of the respondents. This was especially of concern to people that harvest large amounts of EWPs to sell. Some of the respondents stated that it is often people from outside the village or even people from neighboring countries that harvest EWPs in large quantities.

According to focus group participants, prolonged periods without water, i.e., desiccation of channels or drought or insufficient rainfall, is also one of the factors that leads to a decline of EWPs, in particular *Berchemia discolor* (Klotzsch) Hemsl., *U. mossambicensis*, *G. flava* and *Ficus sycomorus* L. However, *N. nouchali* and **tshetla** were reported to be more abundant currently compared to the past ten years.

Focus group participants also pointed out that the expansion of Moremi Wildlife Reserve cut them off from places of EWP abundance since it is forbidden by law to collect EWPs in the reserve. Another respondent argued that residents seemed reluctant to collect EWPs for consumption since they have become dependent on government handouts.

Unsustainable harvesting

More than 64% of the respondents believed that current EWPs harvest in Shorobe is non-sustainable. The most common reason given for this is the use of destructive harvesting methods. Often branches are cut or broken off instead of picking only fruits or leaves. Over-harvesting has also been mentioned as one reason for declining EWP populations. It was also pointed out that there is a lack of awareness of the importance of EWPs and about threats to these plants.

When asked how EWPs could be harvested sustainably, the majority of respondents stated that destructive harvesting methods have to be avoided. This may be achieved through creation of sustainability awareness and emphasis of sustainable harvesting. It was suggested that people should harvest only for their own consumption and not for sale. Other suggestions included the introduction of a license that permits people to harvest certain amounts and that people without a license should not be allowed to harvest EWPs. The establishment of harvesting regulations that restrict the quantity of edible parts that may be harvested was seen as another possible reaction to the current unsustainable use of EWPs. A further suggestion that was brought up is cultivation of some EWPs such as *Sclerocarya birrea* (A. Rich.) Hochst., *B. discolor*, *H. petersiana* and *G. livingstonei*.

Discussion

Although a total of 27 EWP species utilized in Shorobe were identified during this research only about a quarter of them are harvested by the majority of the respondents.

Seven species in total are each harvested by more than 80% of the population. These species are at the same time those that are consumed most regularly, often as part of a full meal, and some of them, e.g., *N. nouchali* and *H. petersiana* (as **gao** and **mochema**) throughout the year. Looking at the large amount and frequency of reported consumption, and the proportion of people utilizing them, it is clear that these species are very important for the local community. This is especially true for *N. nouchali*, *C. gynandra* and *A. thunbergii*, as they are prepared as part of a major meal. These three EWPs alone contribute much to the nutrition of people in Shorobe and make up a noteworthy part of many households annual food supply. Even though other EWPs contribute less to Shorobe households, their value cannot be neglected. A decline in availability of one or even more of these seven EWPs could have serious implications on the nutrition and livelihood of community households.

The fact that 47% of the respondents stated that EWPs make up more than 50% of household annual food supply gives an idea about the importance of EWPs for the nutrition of the people of Shorobe. The expectation that low income households depend on EWPs more than others could not be confirmed. EWPs are part of common traditional meals that are eaten by the majority of the population, both the poor and wealthy. These findings differ from studies conducted elsewhere. In Swaziland, for example, EWPs contribute more to people's food supply than domesticated crops (Wilson 1990).

There are a few EWPs that are available outside the crop harvesting season and/or are available throughout the year. These are particularly relevant for the nutrition of the people of Shorobe since they are also available in winter when there are few other sources of food. They have the capability of bringing households through food shortages, and, thus, are of high importance. It is noteworthy that it is primarily the species that are eaten as a main meal that are available throughout the year.

The number of households that earn income through the sale of EWPs is high. The facts that more than two thirds of the households earn at least a part of their income through the sale of EWPs, and that the sale of EWPs is the most common primary source of income clearly shows that EWPs not only play a vital role in Shorobe households, but also contribute economically. While the sale of EWPs is the primary income source for 21% of the households, it contributes 36% of the average household income in Shorobe through partial income generation. More than a third of the households earned more than a quarter of their income through the sale of EWPs. This, once again, underlines the importance of EWPs for the people of Shorobe.

While low-income households are more dependent on EWPs for their food supply, it is those with a high monthly income that gain most money from the sale of EWPs. Further reasons include greater resources available to high income households. These are more likely to be able to transport EWPs to other markets, e.g., Maun. They may also have the capacity to employ vendors to take care of the sale. It may also enable them to own or hire harvesting tools, including donkey carts that improve harvesting efficiency. Whereas the better resourced are more concerned with making a profit from the sale of EWPs, poorly resourced households are generally concerned about acquiring enough food. After all, it will be the wealthy that benefit from most of the sale of EWPs, but, nevertheless, the sale of EWPs is an opportunity that is open for everyone. This finding differs from that reported by Balemie and Kebebew (2006) on EWPs in Southern Ethiopia. According to their study, 12% of EWPs harvested by local communities in Derashe and Kucha Districts are sold through local markets. This is far less than in Shorobe (41%). On top of that, in the study area in southern Ethiopia, unlike to Shorobe Village, it is mainly the poor that depend on income from the sale of EWPs.

Some of the EWPs utilized in Shorobe are also used as medicinal plants. In addition, many are utilized for crafts and other cultural purposes. The value of EWPs cannot be restricted to the edible parts nor to the benefits that have been discussed in this report. The importance of EWPs for the environment is also not to be underestimated. These values are often less visible than the cultural values, however, they play an important role for sustainable development of the environment. Prevention of soil erosion is especially important in an area with less fertile soils. Survey respondents were not ignorant about these values. Among the respondents there was an awareness of the importance of EWPs that was not restricted to edible parts only. This awareness could also be recognized when asking people about the threats to and sustainable utilization of EWPs. Respondents emphasized that there is a need for further creation of awareness. They were also able to identify certain unsustainable harvesting methods and threats to EWPs. This underlines the fact that there is a given general awareness amongst the majority of the respondents.

As in many countries in Africa (e.g., Katende *et al*. 1999, Maundu *et al*. 1999, Ruffo *et al*. 2002, Teketay *et al*. 2010), EWPs in Shorobe are under continuous threat from different factors. Wild animals (primarily elephants) destroying EWPs were rated the greatest threat to EWPs. One can argue that wild animals and EWPs are part of the same environment, and depend on each other, and that they can, therefore, not be considered as a threat to EWPs. However, once a species exceeds its carrying capacity and starts to negatively impact its environment, it may well be considered a threat. This is the case with elephants in the area around Shorobe. Two of the three highest rated threats to EWPs in Shorobe are also among the three threats perceived as highest to EWPs by the local popula-

tion of Derashe and Kucha Districts in Southern Ethiopia (Balemie & Kebebew 2006, FAO 2009). In Derashe and Kucha Districts, the expansion of cultivated areas was rated as the highest threat while in Shorobe, the same factor was ranked among the first three. Fuel wood collection was also perceived as one of the highest threats in Derashe and Kucha Districts. In Shorobe, deforestation, including fuel wood collection, was mentioned as one of the major threats. The two studies differ when it comes to the impact of livestock on EWPs. While respondents in Ethiopia rated over-stocking as one of the major threats, overgrazing was mentioned among the least important factors threatening EWPs in Shorobe.

Conclusions

EWPs are of high importance to local populations and the availability of EWPs plays an important role in rural livelihoods through ensuring food security, dietary diversity and sustained income. EWPs are not only relevant for certain groups but for everyone in the community. EWPs contribute significantly to the food supply, particularly, in low income households. Nearly half of the households obtain a higher part of their food supply from EWPs than from other sources. The majority of the households harvest EWPs for domestic use and for sale as a primary source of income with the wealthy earning more than the poor.

Despite their high value, populations of some EWPs have been reported to be declining with wild animals, deforestation, expansion of cultivated areas, and over-harvesting being major threats. Sustainable utilization and awareness are needed to respond to these threats. The values of EWPs need to be recognized so that they can receive the conservation status they deserve and be developed both *in situ* and *ex situ*, e.g., through domestication.

Recommendations

There is a need to intensify efforts of raising awareness of the importance of conservation of EWPs. The study has shown that although some level of awareness exists more is required. Alternatives to increase the supply of EWPs such as domestication and cultivation of threatened wild plants have to be considered in order to supply local needs and provide alternative income generation. A very good example is a plantation of *H. petersiana* and *B. discolor* established by the Shorobe Multipurpose Cooperative Society Ltd. The value of wild resources should be considered when areas are expanded for cultivating crops. Locations with a high abundance of EWPs should not be turned into cultivated land but rather be conserved as natural environments that provide habitat for the well being of these plants. There is a need for policies and legislation that involve all stakeholders in wild resource conservation, management, and sustainable use as well as fair and equitable sharing of benefits from EWPs.

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