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Use and Management of *Balanites aegyptiaca* in Drylands of Uganda

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Abstract: There is strong evidence across the drylands of Africa that local communities have utilized Indigenous Fruit Trees (IFTs) including Balanites for generations. IFTs have however, received limited recognition from research and development community. It is now widely accepted that IFTs research needs to embrace local knowledge since this can be a useful resource in solving local problems and contribute to meaningful development. This study explored local use and management of the *Balanites aegyptiaca* among two contrasting dryland communities in Uganda. A survey involving 150 respondents was conducted using a semi-structured questionnaire. Focus group discussions and key informant interviews were conducted to capture detailed information on various aspects of Balanites use and management. The results revealed a wealth of information on local use and management of *B. aegyptiaca* tree and its products. Besides being a market commodity, several uses of the tree products were reported, especially among women and children. Contrary to its early reference as famine food, *B. aegyptiaca* products were used by most households. The young leaves and ripe fruits were regarded as dependable dry season food sources in both years of food scarcity and plentiful harvest. However, institutional arrangements for management of Balanites and other IFTs are weak and trees are increasingly being cut for fuelwood. There is a need to build on the local peoples' knowledge, especially on processing of products so as to realise increased contribution of Balanites to rural livelihoods in the drylands of Uganda and other areas where the species grows.

Key words: Conservation, desert date, indigenous fruit trees, livelihoods, community, Uganda

INTRODUCTION

Balanites aegyptiaca (L.) Del. commonly known as desert date is a small to medium-sized dryland tree or shrub belonging to family Zygophyllaceae (Balanitaceae). It is found in most African countries, stretching from arid and semi-arid regions to sub-humid savanna (Hall and Walker, 1991; Sands, 2001; NRC, 2008). As a multi-purpose tree, *B. aegyptiaca* provides food, medicines, cosmetics, fodder, fuelwood and pesticides valued for subsistence living in the arid and semi-arid areas where other options are few (NRC, 2008). Its fruit has an edible mesocarp and a hard woody endocarp enclosing an edible oil-rich seed kernel. The leaves are eaten as a vegetable in the dry season in many countries throughout its range in dryland areas of Africa. The fruit of *B. aegyptiaca* has been the basis of an active trade for many centuries in countries where the species grows. The seed kernel oil is rich in saturated fatty acids and is used as cooking oil (Hall and Walker, 1991; NRC, 2008). It also contains steroids (saponins, sapogenins, diosgenins) used as raw material for industrial production of contraceptive pills, corticoids, anabolisants and other sexual hormones (Abu-Al-Futuh, 1983). A report by the US National Research Council (NRC) ranked *B. aegyptiaca* high among the 24 priority lost crops of Africa and called for a concerted effort to develop its true potential using modern capabilities (NRC, 2008). The report observed that

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although, *B. aegyptiaca* produces the necessities of life in one of the world's most difficult zones of existence (drylands), it is surprising that the species is still considered a lost crop. A priority setting exercise to indentify Indigenous Fruit Trees (IFTs) with domestication potential in the drylands of five countries in Eastern Africa (Ethiopia, Kenya, Sudan Tanzania and Uganda) ranked *B. aegyptiaca* second after *Adansonia digitata* L. among the eight priority species (Teklehaimanot, 2008).

Despite its wide usage among dryland communities in Uganda (Katende *et al*., 1995, 1999), *B. aegyptiaca* has received limited attention and has therefore remained largely underutilized. Any attempt towards increasing the contribution of *B. aegyptiaca* and other IFTs to household food security and incomes requires a clear understanding of their current use, management and conservation. Documentation of local knowledge has been noted as a necessary starting point for strengthening the capacities of local people for developing their own knowledge and methodologies that promote activities to improve and sustain their livelihoods (Oduol *et al*., 2008). Kwesiga reported that local knowledge should form the basis for policy development and research on domestication of IFTs. Shanley (2006) also noted that local knowledge can offer an irreplaceable foundation for research and development. This study was therefore aimed at documenting local use and management of *B. aegyptiaca* among two contrasting dryland communities in Uganda. The research questions pursued were: How do the local people in the two study districts use *B. aegyptiaca* tree products? How are *B. aegyptiaca* trees managed both in the wild and on farm? and what are the constraints and opportunities for improved use and management of *B. aegyptiaca* in the study areas?

MATERIALS AND METHODS

Study area: The study was conducted in Adjumani and Katakwi districts in Uganda (Table 1). Five villages; Nyeu and Egge in Adjumani district and Aboiboi, Apuuton and Acoite in Katakwi district were selected for field work. These districts and villages were selected because of the prominence of *B. aegyptiaca* and a significant use of its products as a source of food and income among local communities.

Adjumani district is located in North Western Uganda with a coordinates of the coordinates of 03°23'N, 31°47'E (latitude: 3.3845; longitude: 31.7820). It experiences a bi-modal rainfall pattern and the rainfall seasons are April to June and August to November. The humidity is about 80% in most parts of the district. Drainage occurs towards the river Nile through a series of seasonal rivers. Most of Adjumani district lies on a coarse layered rock and soils are generally considered moderately fertile. The major soil types are vertisols, lithosols, alluvial deposits, ferruginous tropical soils and ferralitic soils (NEMA, 1996). Much of the vegetation in Adjumani is mainly savanna woodland and grassland dominated by Combretum, Acacia and Hyparrhenia species (NEMA, 1996).

Table 1: Biophysical attributes of Katakwi and Adjumani districts, Uganda

	Districts	
Attributes	Katakwi	Adjumani
Size of district (km^2)	2,505	3,128
Altitude above sea level (m)	1,036-1,127	900-1,500
Latitude	33°48'E-30°14'E	31°24'E-32°4'E
Longitude	1°38'N-2°20'N	2°53'N-3°37'N
Mean annual rainfall (mm)	1,000-1,500	750-1,500
Mean annual min and max temperature (°C)	18-31	19-36

Katakwi district is located in the North Eastern region of Uganda, lying between longitudes 33°48'E-34°18'E and latitudes 1°38'N-2°20'N. It experiences two climatic seasons; the wet season is from March to October while the dry season is from November to February. December and February are the driest months. Relative humidity ranges from 66-83% at 0600 GMT and reduces to 35-57% at 1200 GMT (KDLG, 2007). Katakwi district is generally a plateau with gently undulating slopes and wide swamps. The soils are ferralitic and mainly of sandy sediments and sandy loam while the basement complex is made of granites, gneiss, schists and quartzites (NEMA, 1996). The vegetation is savanna grassland dotted with shrubs and trees. The dominant species are Acacia, Combretum, Piliostigma, Vitellaria and Hyparrhenia (KDLG, 2007). Balanites and Acacia species are common along swamps.

Sampling and data collection: Systematic random sampling as described by Ott and Longnecker (2001) was used for selecting participating households using village lists obtained from the district administration. In each village, a 20% minimum sample size as recommended in social surveys, Hetherington (1975) was ensured. A local research assistant who was a forestry technician was identified in each of the two study districts to research with the research team in data collection. Data were collected using a combination of structured and semi-structured interviews. In addition to a questionnaire interview, three focus group discussions involving men, women and youth were held in each village.

Interviews were also conducted with key informants such as district, sub-county and village leaders and community members with specialised knowledge

including, collectors, processors and traders of Balanites products as well as elders. Respondents were asked to provide information on a wide range of issues regarding *B. aegyptiaca* such as, management, collection and utilization of Balanites products. Focus group discussions based on interview guide explored and probed key aspects related to management, conservation and utilisation of Balanites. Additional information captured included the constraints as well as opportunities for improved use and management of Balanites in the study areas. A total of 150 respondents, 15 focus groups and 25 key informants were interviewed in the two study districts.

Data were coded, entered and analyzed in SPSS statistical package (Version 16). Percentages, totals and means of selected variables were generated using descriptive statistics and cross tabulation for either single or multiple responses. Multiple responses were combined by defining the new sets and specifying whether responses where dichotomous or categorical. Information from key informants, focus group discussions and secondary sources were used to triangulate and close gaps on data collected using the questionnaire.

RESULTS

Socio-economic characteristics of respondents: The study sample was made of an equal number (50%) of both male and female respondents who were mostly from two ethnic groups, Iteso (55%) and the Madi (43%). Respondents were mainly aged between 36 and 50 years (37%) and attained primary level of education (47%). Only a few (13%) had attained tertiary level of education. The average number of people per household was eight and six for Katakwi and Adjumani, respectively.

The socio-economic characteristics of the respondents are shown in Table 2. About 62% of the respondents were engaged in subsistence farming as the main livelihood source while only a few (3%) were engaged in fishing, especially along the river Nile in Adjumani district. A majority (78%) had landholdings ranging from 1-4 ha with an average land size of 2.5 ha in Katakwi and 4 ha in Adjumani. The land was mainly acquired through inheritance (68%) with a communal system of ownership; nonetheless, some (13%) reported having bought their land. Most of the respondents were generally poor with about 62% living on <1 dollar a day.

Utilization of trees and their products: Balanites has been used by local communities in Adjumani and Katakwi districts for generations. While communities in Adjumani district valued *B. aegytiaca* for its fruits, communities in Katakwi highly valued Balanites leaves as a vegetable. The Iteso people in Katakwi district and the entire Teso sub-region call Balanites tree Ecomai while the Madi in Adjumani refer to it as Lugba. Except for the Balanites fruit which is locally known as irorokony among the Iteso and the oil referred to as edu by the Madi, no specific local names were reported for the other Balanites products. Most of the names were rather a description of the products in the local dialects (Madi and Ateso). Almost all (99%) respondents had at least used Balanites tree or its products in one way or another.

Table 2: Socio-economic characteristics of respondents (N = 150)

	Percentage		
Variables	Katakwi	Adjumani	Mean
Livelihood source			
Farmer	90.2	33.8	62.0
Employed	7.3	29.2	18.3
Business	2.4	30.8	16.6
Fishing	0.0	6.2	3.1
Land size (ha)			
1-2	57.3	27.4	43.8
3-4	33.3	32.3	32.8
5-6	4.0	11.3	7.3
7-8	4.0	16.1	9.5
>8	1.3	12.9	6.6
Means of land acquisition			
Inherited	65.3	71.2	68.3
Allocated (resettled)	8.0	27.3	17.6
Bought	25.3	1.5	13.4
Borrowed	1.3	0.0	0.7
Annual income level (UGX)*			
<100,000	26.0	1.5	13.8
100,000-400,000	35.6	10.4	23.0
400,000-700,000	11.0	40.3	25.6
>700,000	27.4	47.8	37.6

*Exchange rate: 1 1USD = UGX 2,200

The major uses of Balanites were vegetable (young leaves and flowers), snack food (fruit pulp) and oil (seed kernel). In Adjumani, the main uses of Balanites were oil extraction (53%) and snack food (44%) while in Katakwi, it was mainly used to provide a leafy vegetable (91%) and snack food (9%) (Fig. 1). These products were mainly used by children (54%) and women (37%). Men only accounted for 9% of the products usage.

Households used Balanites tree or its products in other numerous ways however, fuelwood and medicines were the other prominent uses (Table 3). Several parts and products were used, ranging from whole tree for provision of shade to use of branches for fencing. For medicinal purposes, the main parts/products used were the root and stem bark, oil, fruit pulp and kernel cake (Table 4). Several ailments were reported to be treated using these products including; body pains, stomach upsets, malfunctioning of internal body organs (liver and spleen), malaria, snake bites, skin diseases and de-worming children. The main source of Balanites products was trees in the wild (84%) while trees on-farms and those around homes contributed

Table 3: Other uses of *B. aegyptiaca* products in Adjumani and Katakwi districts

Uses	Part used	Responses (%)
Firewood	Stem, braches, nut shells	47.3
Charcoal	Stem and braches	23.7
Medicine	Stem/root bark and wood ash	21.6
Building	Poles from stem and branches	8.1
Tools/crafts	Stem and branches	8.1
Gluing	Bark exudates	7.4
Condiment	Wood ash	7.4
Shade	Whole tree	2.0
Fodder	Leaves and twigs	1.4
Remove jiggers	Thorns	1.4
Lubricant	Oil	1.4
Fencing	Thorny branches	1.4
Fish poison	Stem and bark extract	1.4

Table 4: Reported medicinal uses of *B. aegyptiaca* in Adjumani and Katakwi districts

Uses	Part used	Responses (%)
Chest pains	Gum from stem bark	45.6
De-worming (children)	Oil and fruit pulp	43.4
Joint pains	Bark	37.0
Liver and spleen disorders	Raw fruit	35.4
Malaria control	Kernel cake poured in mosquito breeding places	27.7
Malaria treatment	Root bark extract	27.6
Mosquito repellent	Smoke from nut shells	26.4
Skin diseases	Oil	25.1
Sore throat	Bark	21.2
Stomach pains	Stem and root bark	21.6
Cataracts (in animals)	Bark ash	10.7
Anti-diabetic	Fruit pulp	9.4
Snake bites	Root and stem bark mixed with other herbs	6.0
Tooth ache	Bark	5.7
Yellow fever	Bark	4.1

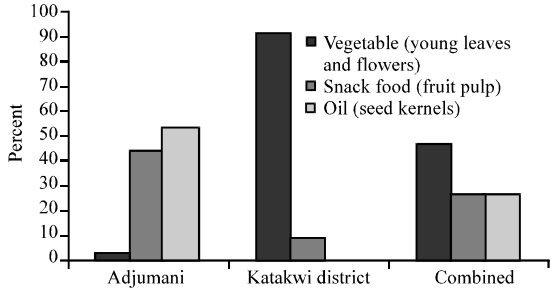

Fig. 1: Main uses of Balanites products in Adjumani and Katakwi districts, Uganda

only 14 and 3%, respectively. The distance travelled to collect Balanites products was generally short. A majority (72%) collected the products within a distance of <1 km while 21% travelled 1-2 km. However, a few (7%) respondents travelled 3-6 km to obtain Balanites products.

Harvesting and storage of *B. aegyptiaca* leaves, fruits and nuts: Balanites leaves, fruits and nuts were all collected during the long dry season (November to March).

Table 5: Collectors of Balanites products in household

	Responses (%)	
Products	Adjumani	Katakwi
Women		
Leaves	-	59.6
Fruits	48.0	34.0
Nuts	47.4	-
Children		
Leaves	-	32.1
Fruits	49.0	47.2
Nuts	49.5	-
Men		
Leaves	-	8.3
Fruits	3.1	18.9
Nuts	3.2	-

Women and children were the major collectors of these products (Table 5). In Adjumani, women and children mainly collected fruits and nuts while in Katakwi, they collected leaves and fruits. Just like leaves in Adjumani no nuts were collected in Katakwi.

The method of leaf and fruit collection was more or less the same for both wild and on-farm trees. Leaves were mainly collected by climbing the tree and cutting branchlets and twigs. Fruits were mostly collected after they have naturally fallen under the tree. However, fruits were also collected by shaking branches to dislodge ripe fruits. Nuts were collected from under the parent trees (60%) and in animal resting places (40%). Some accidents were reported to be encountered during the harvesting of Balanites leaves in Katakwi. The common accidents were injuries inflicted by the sharp Balanites thorns and falling from trees. The reasons for harvesting Balanites leaves by cutting of branchlets and twigs included the ease of picking leaves from below (26%), time saving (21%) and reduction of accidents (16%). Other reasons were to get more support for picking at home (14%), encourage coppicing for next season's harvest (12%) and a need to avoid biting small black ants which are always present in many trees (11%).

For trees that are difficult to climb, collectors always improvised ladders in form of tree logs or cut branches. Much as leaf harvesting by cutting young branches was said to increase leaf yield, respondents were also aware of the negative effects of this practice on the tree as a whole as well as yield of some products. For instance, it was noted to decrease tree vigour (45%) and fruit and/nut yield (30%).

Extent of *B. aegyptiaca* leaf usage among households: Balanites leaves were consumed in all households interviewed in Katakwi district and almost all (98%) households were involved in leaf harvesting which lasted for 5 months (November to March) every year. A household collected leaves for 4 times a week (a total of

about 30 kg month^{-1}). Thus, >5 months leaf collection period in a year each household in Katakwi collected about 150 kg of Balanites leaves. Over 63% of the leaves collected were directly consumed in households.

Balanites leaves were reported to be a priority dry season (November to March) vegetable in Katakwi. During this period, households consume Balanites leaf as a sauce for 3-5 times a week. A majority (80%) consumed the leaves 4 times a week >5 months dry season. Balanites leaves were reported to be boiled and mixed with groundnuts and/or sesame and eaten with staple foods such as cassava, potatoes and millet bread as a traditional delicacy.

Growing and management of *B. aegyptica*: *B. aegyptiaca* was reported to have been planted by only a few (7%) households however, many (51%) retained and protected natural regeneration on their farms and another 42% regarded it as God given with no need to plant. Among those who planted, seeds (46%) and wildings (36%) were the main sources of planting materials. Planting niches were mainly on farms (55%) and near homesteads (43%). Balanites trees were however, more retained near homes (56%) than scattered on farm (31%). About 57% of the respondents reported that Balanites trees decrease yield of associated agricultural crops, especially cereals. On the other hand, 31% of the respondents reported Balanites trees as having no effect on associated crops and another 10% reported an increase in yield. The main reasons for the limited planting Balanites were lack of knowledge and skills on its propagation (37%) and the species' slow rate of growth (30%). Balanites trees were reported to take about 12 years to fruit and respondents expressed the desire to reduce this period by half.

Wild trees were reported to benefit from the annual bush burning (42%) which cleared other vegetation leaving the fire resistant Balanites trees. Those on-farms benefited from weeding of associated crops (43%) while trees around homesteads were normally pruned (50%) (Fig. 2). Many (54%) respondents reported that Balanites trees in the wild were not managed and a few said trees on farms and around homes (25 and 18%, respectively) were not managed. Communities also reported that the negative effects of Balanites on associated crops can be minimized through management of the tree itself such as crown pruning, planting of shade tolerant crops and complete avoidance of the area under shade were reported. Balanites trees were mainly found in the wild, especially in communal areas. As such, they are in most cases an open access resource. Nonetheless, trees retained on farm and those found around homestead were treated as private property controlled by the farm or home owner.

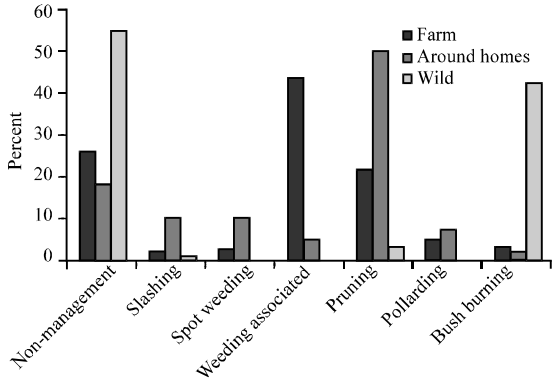

Fig. 2: Management practices applied to Balanites trees in different land use types in Adjumani and Katakwi districts, Uganda

Wild trees were reported to be controlled by the community (43%) and government local authorities (41%), especially the district forestry services. Balanites was found to be the third most common IFT retained on farms in the study sites after *Tamarindus indica* and *Vitellaria paradoxa*.

Institutions involved in management of *B. aegyptiaca* and other IFTs: Traditional, government and Civil Society Organisations (CSOs) were all playing some role in the management of Balanites and other IFTs. However, elders' councils and traditional leaders were the only two traditional institutions reported while there were a number of government and CSOs involved. District Forestry Services (DFS) and Lutheran World Federation (LWF) were leading government and non-government institutions, respectively. Although, more (33%) interviewees said that Balanites and other IFTs were not managed in the past, some (28%) reported use of controlled bush burning and another 16% pointed out use of pruning as past management practices. There was also mention of restrictions on cutting of IFTs whether on farms or in the wild since, they benefited the whole community.

Many (56%) respondents were unaware and another 20% were uncertain of any government regulation on IFTs. On the other hand, only 10% reported of no cutting of IFTs and 9% pointed out controlled cutting of IFTs supplemented by double replacement of whatever is cut as current government regulation on IFTs. A mere 4% were aware of the actual existing policy on trees in general that is all trees on non state land belong to the people and must be used in a sustainable way. At the local (district and sub-county) levels, some by-laws have been put in place to regulate IFTs and these included; no cutting down of IFTs, no bush burning, harvesting fruits from

one's own trees only and planting two if one ever cuts one. Penalties for community members breaking by-laws ranged from being fined in local courts to receiving a caution. About 30% of the respondents however, reported non-existence of penalties. The majority (62%) said the by-laws put in place were ineffective since IFTs have continued to be cut for other uses and are still regarded as God given resources. Total 34% reported that the by-laws were somehow effective.

Constraints and opportunities for improved use and management of *B. aegyptiaca*: A number of constraints and opportunities for improved management and utilisation of Balanites were identified. The key constraints were uncontrolled bush fires (65%), increasing human and animal population in the Balanites growing areas (56%), alternative uses of Balanites, especially as fuelwood 47%, limited knowledge and skills on propagation and value addition (40%) and the long juvenile phase of Balanites tree (30%). However, several opportunities were also identified and they included; high local demand for Balanites products (55%), high density of Balanites trees in the study areas (44%) and availability of local knowledge on processing (23%). The presence of some local institutions willing to play a role in improving the management and use of Balanites and other IFTs was also reported as an opportunity.

DISCUSSION

Use of *B. aegyptiaca* products: Communities in both Adjumani and Katakwi have a long history of Balanites use and the species is a highly valued. In Katakwi district however, it was more regarded as a source of dry season leaf vegetable while in Adjumani it was valued as a fruit tree as well as a source of oil. Though both communities consumed Balanites fruits as a snack food, only the Adjumani communities extracted oil from its seed kernels. Likewise, almost no Balanites leaf eating was reported in Adjumani. This divergence in the major use of Balanites could be partly explained by the fact that the two districts are occupied by different ethnic groups. Adjumani is dominated by the Madi while Katakwi is occupied by the Iteso.

The Iteso regarded Balanites leaves as their dependable dry season vegetable and likewise communities along the river Nile in Adjumani cherished Balanites fruits for being available at the peak of the dry season. It was therefore not surprising that Balanites was ranked as the 1st priority fruit tree in Adjumani. Communities in Katakwi were however, eager to engage in Balanites oil processing for both domestic use and income generation. Promotion of such an activity among the Katakwi communities may be easier because some of them are already involved in shea oil processing with more or less similar processes to Balanites oil. On the contrary, communities in Adjumani were not enthusiastic about eating Balanites leaves. Similar findings have been reported for other IFTs for instance, Muok *et al.* (2000) observed that within the drylands of Kenya, what is edible fruit in one ethnic group may be considered not edible in another.

The Balanites tree was very popular among all age categories and had names: Ecomai in Katakwi (Iteso) and Lugba in Adjumani (Madi). The fruits were referred to as irorokony among the Iteso while the oil was known as edu among the Madi. Communities throughout the drylands of Africa have been reported to refer to Balanites tree or its parts/products by various local names. Detailed lists of such names have been presented in reports such as Burkill (1985), Hall and Walker (1991), Neuwinger (1996), Sands (2001) and NRC (2008). The two study districts in Uganda are semi-arid and have frequent food shortages during the dry season. All respondents had used Balanites tree or its products in one way or another, the main uses were a vegetable (leaves and flowers), oil (seed kernels) and snack food (fruit pulp). All household members utilised Balanites leaves in Katakwi while the fruits were more frequently consumed by children and women in both districts. The elderly valued Balanites products highly whereas oil processing was unique to Adjumani.

Consumption of wild plants has been reported to be common and widespread in food insecure areas and among low-income households (Barnett, 2001; FAO, 2003). Guinad and Lemessa (2000) reported the importance of *B. aegyptiaca* tree (bedena in Amharic) among communities in Southern Ethiopia. They pointed out that the fruits are eaten by both children and adults and the new shoots which continuously grow during the dry season are cooked and eaten in households, especially during food shortages. Lockett *et al.* (2000) pointed out the use of fruits, leaves and nuts of Balanites (aduwa) among the Fulani of Northern Nigeria. Like in the drylands of Uganda, these products were mostly used by the Fulani during the dry season and with more intensive usage in drought periods.

Local people in Adjumani and Katakwi districts know the importance and the contribution that Balanites makes to their livelihoods, especially during the dry season. They also know of the possible health hazards such as minor stomach upsets that may occur after eating large quantities of Balanites leaves or fruits. However, such

hazards were noted to occur at the beginning of usage/season and were not long-lived. Balanites is usually a semi-deciduous tree in the drylands of Uganda, however due to the dry season bush fires that are common in this area, Balanites trees are sometimes forced to shed off almost all their leaves and within a period of 2 weeks or so, new tender leaves which are used as a leafy vegetable emerge.

In addition, flowering is initiated within 1-2 months after fire and these are collected along with the young leaves and twigs. In older trees, the thorns may be few or even absent at the growing tips and this facilitates picking of leaves together with flowers by stripping branchelets between the thumb and fingers. Balanites leaves picked this way are locally referred to as ekuruta (Ateso) and are highly sought after.

Balanites leaf collection takes place during the long dry season (November to March) when all other vegetables are not available. As a result, the locals reported that no household in Katakwi district lacks sauce in the dry season because of ecomai. Similarly in Adjumani, it is believed that no child lacks a fruit in the dry season because of lugba. Related to this, Iwu (1993) while reporting on the uses of Balanites in West Africa documented a Bornu proverb which extols Balanites-abito tree and a milk cow are just the same-referring to the many uses of Balanites products. According to Barnett (2001), the use of wild foods is ignored when there is sufficient food from normal crop harvests and people who eat them may even be considered inferior. This has given rise to the notion of famine-foods that include plants eaten at times of food stress and are indicators of famine conditions (Guinad and Lemessa, 2000).

However in the present study, all households interviewed in Katakwi reported that they depended on Balanites leaves every year. According to them, Balanites is a dry season vegetable which is depended upon even in years of plentiful crop harvest. The only variation reported was the increased intensity of its use in years of food shortage or famine. As such the use of Balanites leaves as vegetable was never under-looked. It was observed that this has helped in the conservation of the tree since all community members appreciated its use. This also presents an opportunity for participatory domestication and on-farm integration of Balanites. This has been achieved with the baobab tree (*Adansonia digitata* L.) in West Africa where the fruits and leaves are eaten (ICRAF, 2003). The use of Balanites fruits, leaves and flowers has been reported in other dryland countries in Africa (Burkill, 1985; Sands, 2001; Guinad and Lemessa, 2000). However, extraction of Balanites oil appears to be highly specialised and restricted to a few communities. Besides Uganda, available reports indicate that Balanites oil extraction is also carried out in Burkina Faso (UNDP, 2009) and the Sudan (Nour *et al*., 1985; Jens *et al*., 2002). Women groups in Burkina Faso have gone further to utilise Balanites oil as an ingredient for manufacture of indigestion syrup, soap and a range of skin soothing creams (UNDP, 2009).

In addition to leaves and oil, local communities in Adjumani and Katakwi districts used Balanites tree or its parts for fuelwood and medicines. The root, stem bark, fruit pulp and kernel cake have medicinal properties. Most ailments treated were similar to those reported by local communities in other areas where Balanites grows. However, the use of Balanites for treatment of snake bites and de-worming children seem to be unique to communities in Adjumani district.

According to Sands (2001), most parts of Balanites have traditionally been used medicinally and although the efficacy of such treatments has rarely been proven, there is no doubt that the plant yields useful steroidal saponins from which notably, the sapogenin and diosgenin can be extracted for use in the pharmaceutical industry. Extracts are also used as a pesticide, the active ingredient being a saponin which is very toxic to cold-blooded animals. Communities' local use of Balanites for malaria treatment seems to be supported by Chapagain and Wiesman (2005) who reported aqueous extracts of root and bark of *B. aegyptiaca* to be very effective against mosquito larvae. Iwu (1993) reported that Balanites features prominently in Hausa (West Africa) ethnomedicine and is also very useful for other household purposes. The oil from the fruit kernel is used for dressing wounds and as embrocation in rheumatism while the root is used for treatment of malaria, herpes zoster and venereal diseases. The saponins occurring in the roots, woodchips and fruits facilitate their use for washing clothes (Iwu, 1993).

Sources of Balanites products: The main source of Balanites in both study sites was the wild (84%) and the stocks were reported to be declining over the years due to land clearance for agricultural purposes. The destructive uses of Balanites such as cutting of trees for fuelwood and poor harvesting techniques for the leaves in Katakwi pose a threat to the species. Balanites grow along swamps and rivers and in other well drained sites but with access to ground water. About a decade ago most of these areas were not used for human settlement but the current increase in both human and animal population has forced some people to move into such areas. Much as this was a positive development among the children who said they were now living within a close reach to Balanites fruits,

older people noted that Balanites population was declining due to uncontrolled cutting for fuelwood and increased grazing pressure which hampers regeneration.

Cultivation and management of *B. aegyptica*: Much as a majority (93%) of the households interviewed did not plant Balanites, many (51%) had retained the trees on their farms. This demonstrates the importance these communities attach to Balanites since only useful trees are retained on farms. Although, some still regarded Balanites trees as God given with no need to plant, decreasing levels of wild trees coupled with increasing dependence on the tree products was a driving incentive for on-farm retention of the species along with other useful IFTs such as *Tamarindus indica* L. and *Vitellaria paradoxa* C.F. Gaertn. Akinnifesi *et al.* (2006) also observed that although many rural households rely on IFTs as sources of cash and subsistence in the Southern Africa there has been little effort to cultivate, improve or add value to these fruits. They further noted that as a result of the dwindling access to forest products, an increasingly higher proportion of households are finding it necessary to explore options to plant trees for supplying household requirements.

Balanites trees were reported to have no effect on yield of cereals, especially maize, sorghum and millet but with some negative effect on yield of pulses and tubers such as groundnuts and sweat potatoes and cassava. Local communities were however, aware of some tree management practices to minimise negative effects on associated crops such as shoot pruning just before sowing. These practices can be built upon in efforts to improve dryland agroforestry in these areas. In both Katakwi and Adjumani districts, Balanites trees were among trees left when clearing land for farming. In some areas, this has created the impression that Balanites and other IFTs are dominant on farms. According to Kang and Akinnifesi (2000), the retention of a low density of valuable trees in parklands of the semi-arid areas is a common practice to improve the yield of understory crops.

In Southern Tanzania, Akinnifesi *et al.* (2006) reported that farmers spare fruit trees such as *Uapaca kirkiana* Muell. Arg. and *Parinari curatellifolia* Planch. ex Benth. because of their importance to households. Constraints to growing Balanites such as lack of seedlings, lack of knowledge and skills on its propagation and the long juvenile phase of the species deserve attention of the researchers and forestry extension service providers. Harvesting of leaves in Katakwi by cutting young branches and twigs though appropriate from the collectors point of view is endangering the trees. This practice has negatively affected trees with some of them dying due to over-harvesting. Increasing intensity of annual bush fires coupled with the old age of most trees makes the over-harvested Balanites trees succumb to mortality. Such incidences were observed in Katakwi district. In West Africa, women and children found trouble climbing the giant baobab trees in natural stands thus making leaf picking a risky venture. This prompted scientists to initiate on-farm cultivation of baobab for leaf production (ICRAF, 2003).

Women and children were the major collectors of Balanites, although these products were used by all members of the household. UNDP (2009) reported a similar situation in Burkina Faso where women and children were the main collectors, harvesting as much as 40 kg of Balanites fruits per day in December and January. Women often have more specialized knowledge of wild plants used for food, fodder and medicine than men. Children mostly collect and eat the fruit from wild plants. In this study Balanites leaves, fruits and nuts were mainly collected by children and women and prepared by the latter in all the areas surveyed. Women frequently collected Balanites products as they performed other daily duties such as collecting firewood, on their way to fetch water or when walking home after farm work. They even collected fruits for the men to eat.

Balanites leaves and fruits play an important role in rural diets in both study sites while the oil extracted from the seed kernels is a commercial commodity in Adjumani district and most parts of West Nile sub-region. Balanites was equally important for sustaining livestock during the dry season when grasses are scarce. The young leaves and fruit pulp are source of food for animals, especially sheep, goats and cows. Cows were observed to spend at least 2-3 h while goats and sheep spent about 3-4 h daily feeding on Balanites fruits. Availability of the fruits during this period also makes Balanites shade the most preferred resting place for livestock. Goats spit the nuts after steeping the pulp while cows regurgitate them.

Much as the DFS and some CSOs were involved in management of Balanites and other IFTs in the two study districts, communities felt that IFTs were given very little attention. They noted that district authorities were not controlling the cutting of IFTs because the charcoal produced from these trees was needed in urban centres. It was also noted that large scale use of IFTs was brought about by immigrants who specifically cut Balanites for firewood or charcoal to generate income. The DFS seemed to be constrained by both human and financial resources to carry out their research. Among all the CSOs encountered in the two districts, forestry in general and IFTs in particular was not their core business but rather

formed a small component. They mainly promoted multiplication and growing of exotic fruits such as citrus and mangoes and in a few cases timber trees. This left the communities with no technical help on management of IFTs. Communities also expressed a desire to start up small scale processing of indigenous fruits but they lacked technical support, especially in oil processing. Respondents were generally unaware of government regulations on IFTs and other trees in the drylands. This partly stems from limited capacity of the DFS to disseminate information to rural communities. Some bylaws which had been put in place such as no cutting of fruit trees or cut one, plant two are not respected due to break down in social cohesion. Penalties set for offenders were also not deterrent enough and were rarely enforced. IFTs in the wild have therefore continued to be destroyed with little regard while those on farms are protected to some extent.

CONCLUSION

The current findings reveal that *B. aegyptiaca* products form an integral part of dryland communities' diet whose usage increases significantly during drought and/or famine periods due to their ready availability and affordability. Communities are endowed with gender specific knowledge on use of Balanites. This knowledge and skills has been passed on over generations. There are regulations on management and conservation of Balanites and other IFTs in both study sites, however such regulations lack effective implementation. There is a break down in traditional tree management institutions yet local government institutions lack the capacity to manage IFTs and/or do not recognize their contribution to household nutrition and income. Cutting of Balanites trees for fuelwood or sheer destruction during land clearing are therefore leading to increased loss of trees.

RECOMMENDATIONS

Improved management and utilisation of Balanites could be easily achieved through building the capacity of local institutions with technical support provided by DFS and local-based CSOs. It is important for the research and development community to work with local dryland communities, especially women groups to add value to Balanites products. In this regard, oil processing seems to offer greater promise given the high unsupplied market and its high market value. This could raise the status of Balanites leading to its protection. Participatory domestication can be applied to solve the problem of long juvenile phase through vegetative propagation and also improve fruit characteristics. In the short run, the method of leaf harvesting in Katakwi and control of bush fires in all the study sites need to be addressed to sustain the resource base. Furthermore, community sensitisation is needed for raising awareness about the potential role of Balanites and other IFTs in the drylands of Uganda for livelihood improvement.

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REFERENCES

Abu-Al-Futuh, I.M. 1983. *Balanites aegyptiaca*: An unutilized raw material potential ready for agro-industrial exploitation. Technical Report/10.494, TF/INT /77 /021, pp 1-100. http://library.wur.nl/WebQuery/clc/194657.

Akinnifesi, F.K., F. Kwesiga, J. Mhango, T. Chilanga and A. Mkonda *et al*., 2006. Towards the development of miombo fruit trees as commercial tree crops in Southern Africa. For. Trees Livelihoods, 16: 103-121.

Barnett, A., 2001. Northern Ethiopia: What's on the menu. Nutr. Food Sci., 31: 35-49.

Burkill, H.M., 1985. The Useful Plants of West Africa. 2nd Edn., The Royal Botanical Gargens, Ithaka Harbors Incorporation, Kew, UK., ISBN-10: 094764301X.

Chapagain, B. and Z. Wiesman, 2005. Larvicidal effects of aqueous extracts of balanites aegyptiaca (desert date) against the larvae of Culex pipiens mosquitoes. Afr. J. Biotechnol., 4: 1351-1354.

FAO, 2003. Contribution of Trees and Forests to the Livelihoods of HIV/AIDS-Affected Households. FAO, Rome.

Guinad, Y. and D. Lemessa, 2000. Wild food plants in Southern Ethiopia: Reflection on the role of famine foods at a time of drought. University of Pennslvania African Studies Center. http://www.ocha-eth.org/Archive/DownloadableReports/famp0300.pdf.

Hall, J.B. and D.H. Walker, 1991. *Balanites aegyptiaca*: A monograph. School of Agricultural and Forest Sciences Publication, 3. University Wales, Bangor, pp: 65.

Hetherington, J.C., 1975. Samples? What shape? How large? How many?. Scott. For., 29: 260-267.

ICRAF, 2003. When a Tree Becomes a Garden Vegetable-Baobab Gardens in Mali. ICRAF, Nairobi.

Iwu, M.M., 1993. Handbook of African Medicinal Plants. 1st Edn., CRC Press, Boca Raton, FL., ISBN-10: 084934266X, pp: 464.

Jens, G., K. El-Siddig and G. Eberta, 2002. The Potential of Under-utilized Fruit Trees in Central Sudan. Proceeding of the Conference on International Agricultural Research for Development, Oct. 9-11, Witzenhausen, pp: 1-4.

KDLG, 2007. Katakwi district 2002 population and housing census analytical report. Planning Unit, Katakwi District Local Government, Uganda.

Kang, B.T. and F.K. Akinnifesi, 2000. Agroforestry as alternative land-use production systems for the tropics. Nat. Res. Forum, 24: 137-151.

Katende, A.B., A. Birnie and B. Tengnas, 1995. Useful Trees and Shrubs for Uganda: Identification, Propagation and Management for Agricultural and Pastoral Communities. Regional Soil Conservation Unit, Nairobi, Kenya, ISBN-13: 9789966896223.

Katende, A.B., P. Ssegawa and A. Birnie, 1999. Wild Food Plants and Mushrooms of Uganda. Regional Land Management Unit/Sida, Nairobi, Kenya, pp: 473-475.

Lockett, C., C. Calvert and L. Grivetti, 2000. Energy and micronutrient composition of dietary and medicinal wild plants consumed during drought. Study of rural Fulani, northeastern Nigeria. Int. J. Food Sci. Nutr., 51: 195-208.

Muok, B.O., B. Owuor, I. Dawson and J. Were, 2000. The potential of indigenous fruit trees: Results of a survey in Kitui district, Kenya. Agroforestry Today, 12: 13-16.

NEMA, 1996. State of the Environment Report, 1996. National Environment Management Authority, Kampala, Uganda.

NRC, 2008. Lost Crops of Africa, Volume III: Fruits: Development, Security and Cooperation Policy and Global Affairs. National Academies Press, Washington DC., ISBN-13: 978-0309105965, pp: 351.

Neuwinger, H.D., 1996. African Ethnobotany: Poisons and Drugs. 1st Edn., Chapman and Hall, London, ISBN: 3-8261-0077-8.

Nour, A.A.M., A.R. Ahmed and A.A. Abdel-Gayoum, 1985. A chemical study of *Balanites aegyptiaca* L. (Lalob) fruits grown in Sudan. J. Sci. Food Agric., 36: 1254-1258.

Oduol, P.A., O.C. Ajayi, P. Matakala and F.K. Akinnifesi, 2008. The Role of Institutional Arrangements and Policy on the Conservation, Utilization and Commercialization of Indigenous Fruits in Southern Africa. In: Indigenous Fruit Trees in the Tropics: Domestication, Utilisation and Commercialisation, Akinnifesi, F.K., R.R.B. Leakey, O.C. Ajayi, G. Sileshi, Z. Tchoundjeu, P. Matakala and F.R. Kwesiga (Eds.). ICRAF/CABI, Nairobi, pp: 310-321.

Ott, R.L. and M. Longnecker, 2001. An Introduction to Statistical Methods and Data Analysis. 5th Edn., Thomson Learning Inc., Boston, MA pp: 1152.

Sands, M.J.S., 2001. The desert date and its relatives: A revision of the genus balanites. Kew. Bull., 56: 1-128.

Shanley, P., 2006. Science for the poor: How one woman challenged researchers, ranchers and loggers in Amazonia. Ecol. Soc., 11: 28-28.

Teklehaimanot, Z., 2008. The Role of Indigenous Fruit Trees in Sustainable Dryland Agriculture in Eastern Africa. In: Indigenous Fruit Trees in the Tropics: Domestication, Utilisation and Commercialisation, Akinnifesi, F.K., R.R.B. Leakey, O.C. Ajayi, G. Sileshi, Z. Tchoundjeu, P. Matakala and F.R. Kwesiga (Eds.). The World Agroforestry Centre, Nairobi, Kenya, pp: 204-223.

UNDP, 2009. Expanding valuable harvests, creating viable employment: UNDP assists with production of Burkina Faso's Non-Wood Forest crops. UNDP, Ouagadougou. http://www.pnud.bf/DOCS/Expanding-ENG.pdf.