# Folk Classification of Shea Butter Tree (*Vitellaria paradoxa* subsp. *nilotica*) Ethno-varieties in Uganda

Samson Gwali, John Bosco Lamoris Okullo, Gerald Eilu, Grace Nakabonge, Philip Nyeko & Peter Vuzi

## Research


## Abstract

Folk knowledge has been the basis for selection and improvement of many food crops such as potatoes, sorghum, yams, cassava and rice. In Uganda, there is strong potential to utilize folk knowledge to select and domesticate the shea butter tree (*Vitellaria paradoxa* C.F. Gaertn. subsp. *nilotica* (Kotschy) A.N. Henry & Chithra & N.C. Nair), an important economic tree species. Farmers report high variation in fruit yield, tree form and pulp taste. In this study, we documented shea tree folk classification by interviewing 300 respondents, 15 focus groups and 41 key informants across three farming systems of Uganda. Data were analyzed using Kruskall-Wallis and Spearman's tests, Chi-square, Multivariate, Factor and Discriminant Function Analyses. Folk classification and nomenclature of shea tree ethno-varieties is based on fruit/nut organoleptic (color and taste) and morphological attributes. Interestingly, despite the socio-cultural importance of shea oil, it does not feature as a factor in the folk classification and nomenclature of shea tree ethno-varieties. There was no significant difference in classification knowledge across the three farming systems (Kruskal – Wallis $\chi^2 = 28$, df = 28, $p > 0.05$; Spearman's $R > 0.8$, $p < 0.0001$) although there was significant influence from ethnicity of the respondents (Pillai's trace = 0.817, $p < 0.001$). While this study provides a record of shea tree ethno-varieties and associated classification criteria, there is need to validate these 'ethno-varieties' using detailed morphological, biochemical and molecular analyses.


## Introduction

*Vitellaria paradoxa* C.F. Gaertn. subsp. *nilotica* (Kotschy) A.N. Henry & Chithra & N.C. Nair (shea butter tree) is a small to medium-sized deciduous tree that occurs in a wide swathe of territory above 1° of latitude in tropical Africa (Hall *et al.* 1996). All over its distribution, from Uganda in the south to Senegal in the west, it is mostly known for its nuts that produce abundant oil (Hemsley 1968). The oil is used for cooking, cosmetic and medicinal ointments, as a hair cream, and for illumination and water proofing (Abbiw 1990, Lamien *et al.* 1996, Maranz & Wiesman 2003). The fruit pulp can be eaten fresh when ripe (Lovett & Haq 2000, Lovett *et al.* 2000). Due to its importance in rural farmers' economies, the shea tree is a species with great value for domestication (Bounkoungou *et al.* 1998, Franzel *et al.* 1996, Maghembe *et al.* 1998).

As domestication is a long-term process involving selection, improvement and integration into various agroforestry practices (Akinnifesi *et al.* 2006), it is normally imperative to understand the target plant's desirable traits. These traits, such as fruit size and taste, are often available in traditional (folk) knowledge (Ghimire *et al.* 2004, Kebebew *et al.* 2001, Thrupp 1989). Folk knowledge is important in


### Correspondence

Samson Gwali, School of Forestry, Environmental and Geographical Sciences, Makerere University, P. O. Box 7062 Kampala, UGANDA and National Forestry Resources Research Institute, P. Box 1752, Kampala, UGANDA.
gwalis@yahoo.co.uk

John Bosco Lamoris Okullo, Gerald Eilu, Grace Nakabonge, Philip Nyeko Faculty of Forestry and Nature Conservation, Makerere University, P. O. Box 7062 Kampala, UGANDA.
jblokullo@forest.mak.ac.ug; eilu@forest.mak.ac.ug; nakabonge@forest.mak.ac.ug; nyeko@forest.mak.ac.ug

Peter Vuzi, School of Biological Sciences, Makerere University, P. O. Box 7062, Kampala, UGANDA.
pvuzi@sci.mak.ac.ug


**Ethnobotany Research & Applications 9:243-256 (2011)**

Published: June 13, 2011

www.ethnobotanyjournal.org/vol9/i1547-3465-09-243.pdf

identifying the value of farmers' varieties for breeding programs (Appa Rao *et al.* 2002). Indeed, folk knowledge has been documented and used as a basis for the domestication/breeding of many plant species including potatoes in Chile (Quiros *et al.* 1990), *Sorghum bicolor* (L.) Moench in Ethiopia (Mekbib 2006), *Colocasia esculenta* (L.) Schott in China (Jianchu *et al.* 2008), *Manihot esculenta* Crantz in Brazil (Sambatti *et al.* 2001) and *Oryza sativa* L. in Laos (Appa Rao *et al.* 2002).

Many studies have shown that folk biological classification and local knowledge systems are highly organized and culturally structured (Berlin *et al.* 1973, Berlin 1992, Brown 1993, Holman 2002, Raven *et al.* 1971). These studies outlined the principles of folk classification and showed that folk taxonomies are arranged in hierarchical levels, the most common of which are the life form (e.g., trees, vines, grasses), generic (e.g., corn, bamboo) and specific (e.g., common bean) levels. Depending on the cultural significance of an organism, the folk-specific level may be further differentiated into folk-varietal levels (Berlin 1992, Hunn 1982). All these hierarchical levels are related to each other by class inclusion while they also share taxonomic, linguistic, biological and psychological properties. Besides these hierarchical levels, sometimes farmers have developed names that refer to particular parts or stages of a crop (partonomy) (Brown *et al.* 1976). Berlin *et al.* (1973) showed that there is consistency in folk classifications across many traditional communities – 'his theory of universality'. This universal cognition implies that folk classification knowledge is not arbitrary but explains biological realities that are held by traditional societies (Holman 2002).

Folk knowledge is however very dynamic and is strongly influenced by indigenous creativity, innovation and contact with other knowledge systems (Kakudidi 2004). Moreover, folk knowledge is strongly rooted in geographical and cultural cognition and representation (Komáromi 2009, Mazzocchi 2006). Because of its oral nature, folk knowledge is very vulnerable to degradation (Kakudidi 2004, Madhav *et al.* 2000) and even complete loss (Ramirez 2007, Reyes-Garcia *et al.* 2005). Even then, traditional communities all over the world have utilized local knowledge systems to sustain their survival for millennia (Krishna 2006, Mazzocchi 2006). The present work examined the folk classification and local knowledge of shea tree ethno-varieties in Uganda.

The prefix 'ethno' refers to traditional knowledge and cognition available in a given culture (Sturtevant 1964). The concept of 'ethno-variety' can therefore be defined as the infra-specific diversity, especially in crop plants, as understood and managed by farmers (Rivera *et al.* 2006). In this paper therefore, a grouping of shea trees identified by farmers under a single name within a particular ethnic group is referred to as an 'ethno-variety'. Farmers point to the existence of high variation in fruit yield, shape, canopies, flowering and fruiting of shea trees in Uganda. This folk knowledge is however not yet adequately documented (Okullo 2004, Okullo *et al.* 2004). The objectives of this study, therefore, were to: (1) document folk knowledge of shea tree ethno-varieties including classification, naming and associated criteria; (2) examine the consistence of folk classification across the three farming systems of the shea tree range, and (3) unravel the underlying factors that influence folk classification of shea trees in Uganda. A sound knowledge of shea tree classification and nomenclature based on folk knowledge will provide a useful baseline for the development of efficient selection strategies for the breeding and domestication of shea trees in Uganda.

### *Study Area*

This study was carried out in three farming systems (Teso, Northern and West Nile) of Uganda where the shea butter tree is predominantly found (Figure 1). Within these farming systems, the ecological conditions (soil types, topography and rainfall) and farming practices are fairly homogeneous. Rainfall in the Teso farming system is bimodal and ranges from 800 to 1300 mm annually with one long dry season that lasts from December to March (Ebanyat *et al*. 2010, Gavigan *et al*. 2009). The Northern and West Nile farming systems have a less pronounced bimodal rainfall pattern with a mean precipitation of between 800 - 2000 mm annually (Mwebaze 1999, NEMA 1997, UBOS 2006).

All three farming systems are agro-pastoral with heavy dependence on subsistence mixed annual cropping and livestock production (Oluka *et al*. 2005, Okorio *et al*. 2004). The main crops grown are cotton (*Gossypium hirsutum* L.), sunflower (*Helianthus annuus* L.), cassava (*Manihot esculenta* Crantz), finger millet (*Eleusine coracana* (L.) Gaertn), sorghum (*S. bicolor* (L.) Moench), groundnuts (*Arachis hypogaea* L.), simsim (*Sesamum indicum* L.) and sweet potatoes (*Ipomoea batatus* (L.) Lam) (MAAIF & MFPED 2000).

Customary land tenure is the most predominant type of land ownership in these farming systems (Kamanyire 2000). This tenure system recognizes the right of individuals to possess and till the land but under superintendence of the family, clan or community. Some natural resources such as shea trees, therefore, are common property and belong to the whole community rather than the individuals on whose land such trees may be found.

## Methods

### *Selection of field study sites*

Data collection was conducted between August and December 2008. First, a reconnaissance visit was made to the three farming systems during which at least four key

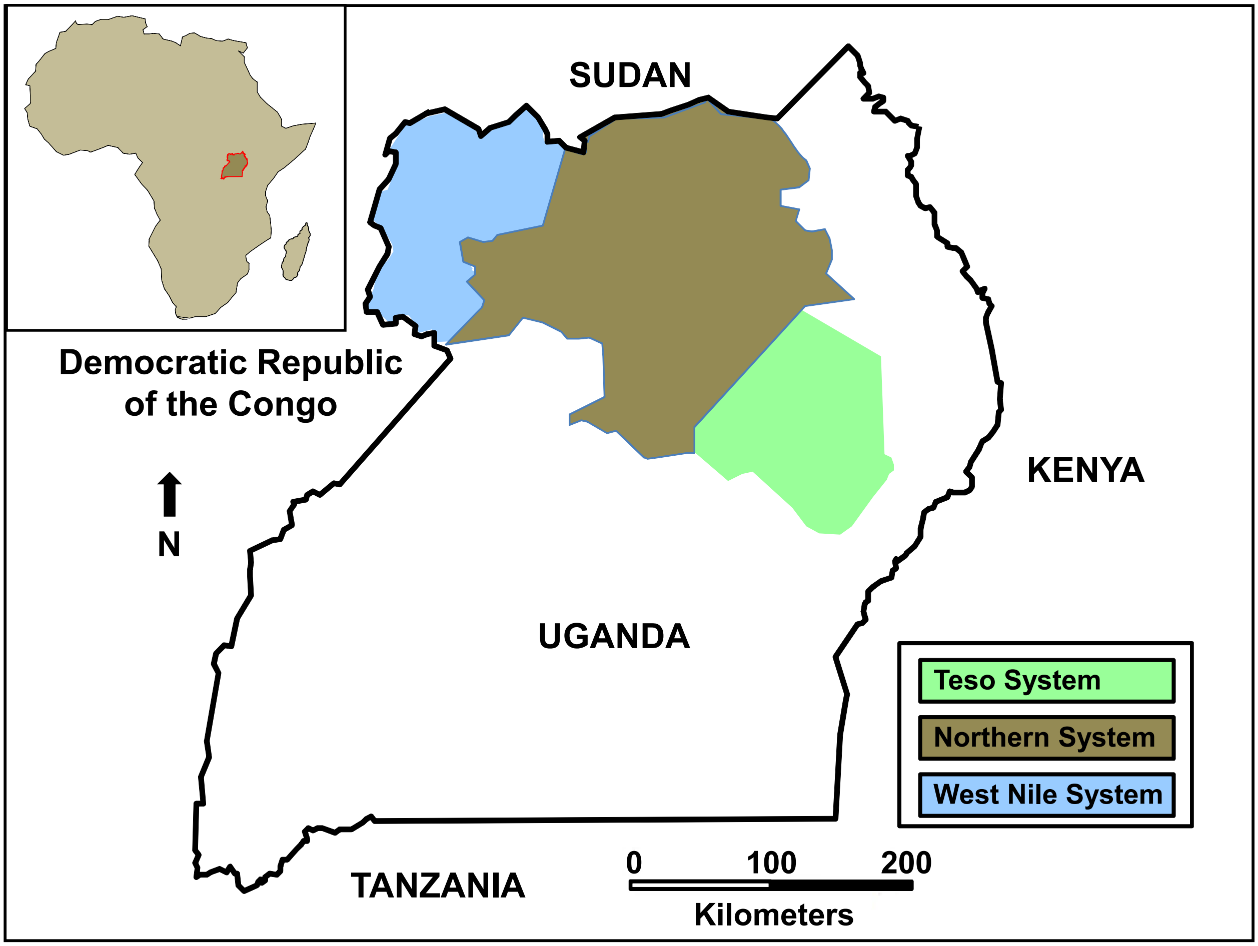


**Figure 1**. Farming systems of the shea *Vitellaria paradoxa* C.F. Gaertn.subsp. *nilotica* (Kotschy) A.N. Henry & Chithra & N.C. Nair belt of Uganda. Inset: Africa showing location of Uganda.

informants from each of the three farming systems were identified with the help of local leaders, technical staff and elders. Through secondary sources, key informant responses and personal observations, purposive sampling was used to identify 12 sub-counties with high populations of shea trees in the three farming systems. A sub-county is the lowest administrative unit in Uganda at which local development planning and budgeting are carried out. Within the sub-county, random sampling was done at household level. Due to the ethnic homogeneity of the Teso farming system, only one sub-county was selected for data collection. However, the Northern and West Nile farming systems encompass many ethnic groups. Therefore, data collection was conducted in seven sub-counties of the Northern system and four sub-counties of the West Nile system. This made it possible to capture folk knowledge from eight large ethnic groups within the shea belt of Uganda.

### *Data Collection*

Following the reconnaissance visit, a detailed survey using participatory rural appraisal (PRA) tools (Martin 1995) was conducted. A total of 15 focus group discussions (FGDs) and 41 key informant interviews (KIIs) were conducted across the three farming systems during which a semi-structured questionnaire was refined. All communication with the key informants, questionnaire respondents and during focus group discussions were done in the local languages of the ethnic groups studied. The focus groups and key informants were instrumental in elucidating the criteria for local nomenclature and shea tree folk classification in the different ethnic groups sampled. Questionnaire pre-test was then done in a sub-sample of the target communities using cognitive interviewing (Fisher & Geiselman 1992, Tourangeau 1984). A total of 300 respondents from the selected sub-counties were then interviewed using the pre-tested questionnaire. The questionnaire sought responses on shea tree varieties according to respondents' criteria, the different classification criteria and the underlying factors that influence the folk classification schemes. The questionnaire was administered to only one respondent from each randomly selected household in the three farming systems. Respondents from each household were selected on the basis of gender, such that if a respondent chosen in the first household was a male, the next respondent chosen in the next household would be a female. This was done so as to capture as much information as possible from the two gender categories.

***Data Analysis***

All data analyses were performed using the Statistical Package for Social Scientists (SPSS) version 16.0. Shea tree folk classification across the three farming systems was assessed using the Kruskal-Wallis test (Kruskal & Wallis 1952). To understand the criteria upon which folk classifications are based, a principal axis factor analysis was performed. Factor analysis is based on the assumption that all variables are correlated to some degree (Ho 2006). Factor analysis is an appropriate tool as it can group similar variables into meaningful groups based on the patterns of responses across all respondents (Hair *et al.* 1998). According to Kaiser (1960), all factors with eigen-values greater or equal to 1.0 and a minimum correlation coefficient greater than 0.33 contain a substantial amount of variation and should therefore be retained for further analysis. Factors were therefore retained only if they had eigen-values greater than or equal to 1.0 and a minimum correlation coefficient greater than 0.33. In order to minimize cross loading of variables, all variables with communalities less than or equal to 2.0 were excluded from the analysis. To achieve the best grouping patterns, the Oblimin oblique method with Kaiser Normalization was used to rotate the factors. Rotation methods ensure that more discrete components with minimum overlapping are extracted from the variables (Hair *et al.* 1998).

A chi-square analysis was performed to establish whether there was a significant relationship between respondent's age, education, ethnicity and gender on the one hand and local knowledge on the other. Local knowledge was determined by the numbers of ethno-varieties, rituo-cultural uses of shea products, and different fruit/nut organoleptic (taste and color) properties a respondent could mention. Relationships that were significant at the 95% confidence level ($p < 0.05$) were then subjected to a multivariate analysis of variance (MANOVA) for further analysis of the effect of age, education, ethnicity and gender on local knowledge. MANOVA was selected as an appropriate method because of its comparative efficiency in testing for overall (multivariate) responses (Warton & Hudson 2004). Significant effects from the multivariate analysis of variance were subjected to a discriminant function analysis to assess relationships in shea tree traditional knowledge of the different ethnic groups that were sampled.

## Results

***Socioeconomic characteristics of the respondents***

Eight ethnic groups were sampled of whom the majority (61.2%) had attained primary school educational level. Most of the respondents (57%) were young (less than 40 years old) while 81% were married peasant farmers practicing subsistence agriculture for their livelihoods (Table 1).

***Folk classification criteria and ethno-variety nomenclature***

The classification of shea tree ethno-varieties was found to be based on nine criteria (Table 2). Across the three farming systems, the shea tree folk classification criteria were similar (Kruskal – Wallis $\chi^2 = 28$, df = 28, $p > 0.05$) suggesting a common naming/classification system in the shea tree belt of Uganda. Pair-wise comparisons indicated a strong correlation (Spearman's $r > 0.8$, $p < 0.0001$) of classification knowledge across the three farming systems. Among all the ethnic groups sampled, the use of fruit and nut size, pulp taste and nut color were very common (Table 2). Interestingly however, despite the socio-cultural importance of shea oil/butter in all the ethnic groups of the shea tree belt, all focus groups mentioned that oil/butter properties are not utilized in shea tree characterization. Rather, a linkage was made between nut color and oil/butter yield. Farmers indicated that it is possible to tell high oil yielding nuts on the basis of their color. Thus, dark brown nuts were said to yield more oil than light brown nuts. In terms of fruit yield by individual trees, the focus groups mentioned that the highest fruit yield was usually obtained from trees that produced small fruits. Indeed, across the three farming systems, all respondents expressed knowledge of specific shea trees that produced fruits with particular properties such as small sized fruits and nuts, little pulp and astringent pulp.

To understand the basis of ethno-variety classification by farmers, a principal axis factor analysis (n = 300) utilizing all classification variables yielded a 3-factor solution explaining 51.5% of the total variance. A subsequent analysis excluding all variables with communalities equal to or less than 2.0 yielded a 3-factor solution. However, the scree plot (Figure 2) showed that only 2 factors could be clearly extracted and explained. A 2-factor solution explaining 54% of the total variation was therefore extracted. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.747 and the Bartlett's test of sphericity yielded a chi-square ($\chi^2$) of 33.55 (with df = 21 and $p < 0.001$).

The first factor clearly revealed that organoleptic and morphological properties of shea tree drupes are very important in folk classification (Table 3). Five variables (nut size, nut color, fruit shape, fruit size and pulp taste) loaded onto this factor at a value of 0.5 and greater (Table 3). There was strong support (Cronbach's alpha = 0.74) for organoleptic and morphological properties as a factor in shea tree classification. This factor had an eigen value of 2.55 and explained 36.4% of the total variance.

**Table 1.** Socio-economic and demographic characteristics of the respondents (n=300) to a detailed survey about folk classification of shea butter tree (*Vitellaria paradoxa* C.F. Gaertn.subsp. *nilotica* (Kotschy) A.N. Henry & Chithra & N.C. Nair) ethno-varieties in Uganda.

| **Category** | **Farming System (percent responses)** | | | **Total** |
|---|---|---|---|---|
| | **Teso** | **Northern** | **West Nile** | |
| **Age group** | | | | |
| <20 | 10.2 | 2.0 | 4.0 | 4.0 |
| 20 – 29 | 24.5 | 21.9 | 25.0 | 23.3 |
| 30 – 39 | 26.5 | 30.5 | 31.0 | 30.0 |
| 40 – 49 | 16.3 | 21.2 | 16.0 | 18.7 |
| 50 – 59 | 8.2 | 7.3 | 12.0 | 9.0 |
| 60 – 69 | 10.2 | 11.3 | 9.0 | 10.3 |
| 70 – 79 | 4.1 | 5.3 | 3.0 | 4.3 |
| 80+ | 0.0 | 0.7 | 0.0 | 0.3 |
| **Ethnic group** | | | | |
| Lango | 0.0 | 33.8 | 1.0 | 17.4 |
| Acholi | 0.0 | 33.1 | 0.0 | 16.7 |
| Thur | 0.0 | 33.1 | 0.0 | 16.7 |
| Iteso | 100.0 | 0.0 | 0.0 | 16.4 |
| Madi_Okollo | 0.0 | 0.0 | 48.5 | 16.1 |
| Madi | 0.0 | 0.0 | 47.5 | 15.7 |
| Lugbara | 0.0 | 0.0 | 2.0 | 0.7 |
| Kuku | 0.0 | 0.0 | 1.0 | 0.3 |
| **Gender** | | | | |
| Female | 53.1 | 37.1 | 42.0 | 41.3 |
| Male | 46.9 | 62.9 | 58.0 | 58.7 |
| Marital status | | | | |
| Married | 79.6 | 86.3 | 74.2 | 81.2 |
| Single | 12.2 | 5.0 | 20.2 | 11.2 |
| Widowed | 8.2 | 6.5 | 4.5 | 6.1 |
| Divorced | 0.0 | 2.2 | 1.1 | 1.4 |
| **Education level** | | | | |
| None | 24.49 | 14.86 | 4.12 | 12.93 |
| Primary | 51.02 | 62.84 | 63.92 | 61.22 |
| Secondary | 18.37 | 18.24 | 20.62 | 19.05 |
| Vocational | 6.12 | 4.05 | 9.28 | 6.12 |
| **Occupation** | | | | |
| Peasant | 93.33 | 92.00 | 70.41 | 84.98 |
| Informally employed | 6.67 | 2.67 | 22.45 | 9.90 |
| Formally employed | 0.00 | 3.33 | 6.12 | 3.75 |
| Student | 0.00 | 2.00 | 1.02 | 1.37 |

**Table 2**. Shea tree (*Vitellaria paradoxa* C.F. Gaertn.subsp. *nilotica* (Kotschy) A.N. Henry & Chithra & N.C. Nair) ethno-varieties among different ethnic groups in the shea tree belt of Uganda.

| Property | Ethno-variety names from different linguistic groups sampled | | | | | | Literal meaning |
|---|---|---|---|---|---|---|---|
| Trait | Acholi | Ateso | Lango | Madi | Madi-Okollo | Thur | |
| Fruits/ nuts | | | | | | | |
| Size | **Abor, Aboro, Abunkuru, Ajigi, Aliboro, Alwoyo, Atitina** | **Eitiyo** | **Ajigi, Aliboro, Alindiri** | **Ciria, Totokwiloro** | **Nyiri** | **Abor** | Small or tiny |
| | | **Naburon** | | **Futua, Futugo, Ritugo** | **Luara, Mbele, Wangaraka** | | Big |
| Shape | **Acula, Aloto** | **Nasomel** | **Acula** | **Coloa** | **Julu** | | Oval or elliptic |
| | **Alulung** | **Nalungur** | **Alulung** | **Gburu, Gburua** | **Gburua, Ngulu** | | Round |
| Pilosity | **Ajayer** | **Nacekan, Nacekum** | **Ajayer** | | | | Hairy |
| Nuts | | | | | | | |
| Color | **Elila** | **Naironon** | **Col** | **Enyi, Onia** | | | Dark brown |
| | | **Narengan** | **Rema** | **Ikaa** | | | Light brown |
| Pulp | | | | | | | |
| Quantity | | **Ikinei** | | **Ngorokwa** | | | Little |
| Taste | **Limny** | **Ewiny** | **Abono, Lim** | **Limi** | **Mbilimbili** | **Lim** | Sweet |
| | | **Egeget** | **Yao-amakudong** | **Etria** | **Etria** | | Astringent |
| | | **Epiana** | | **Asa** | **Asa** | | Tasteless |
| Hardness | **Acogo, Atega, Atekateka** | **Nakweet, Okorocho** | **Acogo, Yao-atek** | **Okpoa** | | | Hard |
| | **Apoco poco, Yao-ayom** | **Naboroch, Oborocho, Opirisia** | **Apocopoco** | **Kpetea** | | | Soft |
| Color | | | **Aremo** | | | | Pink |
| Habitat | | | | | | | |
| Edaphic conditions | | | **Wigweng** | | | | Stony soils |

The second factor showed that utilitarian values are important in shea tree classification. Two variables (domestic and rituo-cultural uses) loaded onto this factor with values of 0.4 and greater. The eigen value for this factor was 1.23 and explained a further 17.6% of the total variance. The variables that loaded onto this factor related to various socio-cultural values of the shea tree and its products (Table 3). These values relate to the use of the shea trees and their products for domestic and rituo-cultural practices such as in food festivals, rituals (such as those of rainmaking, marriage and funerals) and taboos (such as those against felling of shea trees, climbing and picking of shea nuts at night). The Cronbach's alpha reliability for this factor was however very low at 0.25.

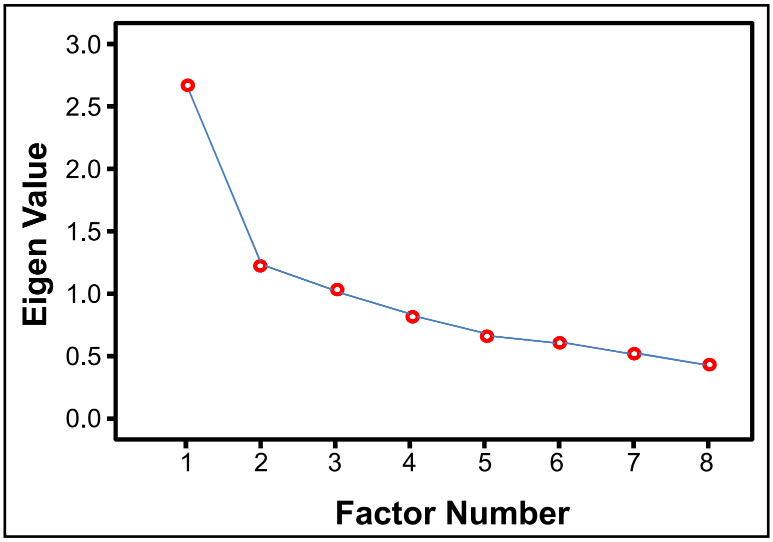


**Figure 2**. Scree plot showing eigen values of eight factors that influence shea tree (*Vitellaria paradoxa* C.F. Gaertn.subsp. *nilotica* (Kotschy) A.N. Henry & Chithra & N.C. Nair) classification criteria in Uganda.

***Consistence of folk classification knowledge in the shea tree belt of Uganda***

A Multivariate Analysis of Variance (MANOVA) revealed that there was significant difference between independent variables (respondents' education, ethnicity and sex) in relation to the derived dependent factors (shea tree classification, fruit/nut nomenclature and rituo-cultural uses). Only ethnicity significantly influenced all three dependent factors that measured folk classification knowledge (Pillai's trace = 0.817, $p < 0.001$) (Table 4). A test of between-subjects effects showed that there was a significant difference in effect of respondents' education and shea tree classification on the one hand ($p = 0.019$) and respondent's education and fruit/nut nomenclature and rituo-cultural uses on the other ($p > 0.05$).

**Table 3.** Factors that influence shea tree (*Vitellaria paradoxa* C.F. Gaertn.subsp. *nilotica* (Kotschy) A.N. Henry & Chithra & N.C. Nair) folk classification in the shea tree belt of Uganda.

| Classification variable | Factor | |
|---|---|---|
| | 1 | 2 |
| | Drupe morphology and organoleptic properties | Socio-cultural values |
| Nut size | .687 | |
| Nut color | .623 | |
| Fruit shape | .609 | |
| Fruit size | .608 | |
| Pulp taste | .510 | |
| Domestic uses | | .450 |
| Rituo-cultural uses | | .431 |

**Table 4.** Multivariate tests of the effect of respondents' education, ethnicity and sex on traditional shea tree (*Vitellaria paradoxa* C.F. Gaertn.subsp. *nilotica* (Kotschy) A.N. Henry & Chithra & N.C. Nair) classification knowledge in Uganda.

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| Intercept | Pillai's Trace | .031 | 2.710 | 3.000 | 258.000 | .046 |
| | Wilks' Lambda | .969 | 2.710 | 3.000 | 258.000 | .046 |
| | Hotelling's Trace | .032 | 2.710 | 3.000 | 258.000 | .046 |
| | Roy's Largest Root | .032 | 2.710 | 3.000 | 258.000 | .046 |
| Education | Pillai's Trace | .037 | 1.642 | 6.000 | 518.000 | .133 |
| | Wilks' Lambda | .963 | 1.642 | 6.000 | 516.000 | .133 |
| | Hotelling's Trace | .038 | 1.642 | 6.000 | 514.000 | .133 |
| | Roy's Largest Root | .031 | 2.712 | 3.000 | 259.000 | .045 |

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| Ethnicity | Pillai's Trace | .817 | 13.911 | 21.000 | 780.000 | .000 |
| | Wilks' Lambda | .360 | 15.106 | 21.000 | 741.387 | .000 |
| | Hotelling's Trace | 1.313 | 16.049 | 21.000 | 770.000 | .000 |
| | Roy's Largest Root | .792 | 29.419 | 7.000 | 260.000 | .000 |
| Sex | Pillai's Trace | .017 | 1.525 | 3.000 | 258.000 | .208 |
| | Wilks' Lambda | .983 | 1.525 | 3.000 | 258.000 | .208 |
| | Hotelling's Trace | .018 | 1.525 | 3.000 | 258.000 | .208 |
| | Roy's Largest Root | .018 | 1.525 | 3.000 | 258.000 | .208 |
| Education* Ethnicity | Pillai's Trace | .132 | 1.199 | 30.000 | 780.000 | .215 |
| | Wilks' Lambda | .873 | 1.198 | 30.000 | 757.957 | .216 |
| | Hotelling's Trace | .140 | 1.196 | 30.000 | 770.000 | .218 |
| | Roy's Largest Root | .077 | 2.005 | 10.000 | 260.000 | .033 |
| Education* Sex | Pillai's Trace | .042 | 1.846 | 6.000 | 518.000 | .088 |
| | Wilks' Lambda | .958 | 1.859 | 6.000 | 516.000 | .086 |
| | Hotelling's Trace | .044 | 1.871 | 6.000 | 514.000 | .084 |
| | Roy's Largest Root | .044 | 3.762 | 3.000 | 259.000 | .011 |
| Ethnicity* Sex | Pillai's Trace | .039 | .682 | 15.000 | 780.000 | .804 |
| | Wilks' Lambda | .962 | .680 | 15.000 | 712.626 | .806 |
| | Hotelling's Trace | .040 | .678 | 15.000 | 770.000 | .807 |
| | Roy's Largest Root | .026 | 1.337 | 5.000 | 260.000 | .249 |
| Education* Ethnicity* Sex | Pillai's Trace | .065 | .959 | 18.000 | 780.000 | .506 |
| | Wilks' Lambda | .936 | .959 | 18.000 | 730.219 | .507 |
| | Hotelling's Trace | .067 | .958 | 18.000 | 770.000 | .507 |
| | Roy's Largest Root | .044 | 1.921 | 6.000 | 260.000 | .078 |

A discriminant function analysis of ethnicity on folk classification knowledge showed that all three canonical discriminant functions that were used in the analysis were significant ($p < 0.001$) (Table 5). The first discriminant function measured shea tree ethno-variety nomenclature across the different ethnic groups and accounted for 62.3% of the total variation while the second function measured rituo-cultural uses of shea tree products across the different ethnic groups and accounted for 32.8% of the total variation. The third discriminant function measured drupe (fruit/nut) classification across the different ethnic groups and accounted for 4.9% of the total variation.

There was aggregation among ethnic groups based on the three discriminant functions. The Iteso were discriminated and grouped separately on the basis of shea tree ethno-variety nomenclature (canonical function variate 1 as shown in Table 5 and Figure 3). The Lugbara and Madi – Okollo were grouped together and separated from the rest on the basis of rituo-cultural use of shea tree products (canonical function variate 2). The rest of the ethnic groups, i.e. the Acholi, Lango, Kuku, Madi and Thur constituted a separate group on the basis of drupe (fruit/nut) classification. Within this group, the Kuku were more distantly discriminated with a much higher negative value (Table 5).

## Discussion

Traditional classification systems are usually developed for species that have attained high utilitarian and cultural significance (Kakudidi 2004, Montoya *et al.* 2003, Volpato *et al.* 2004). However, the existence of traditional classification systems is being threatened by a range of exogenous factors including wars, internal displacement, modern education and commerce, and international movements of people. Therefore, the need to capture this knowledge has never been more urgent. In an expansive area such as the shea tree belt of Uganda, there is likely to be a slow erosion of folk knowledge. However, once a

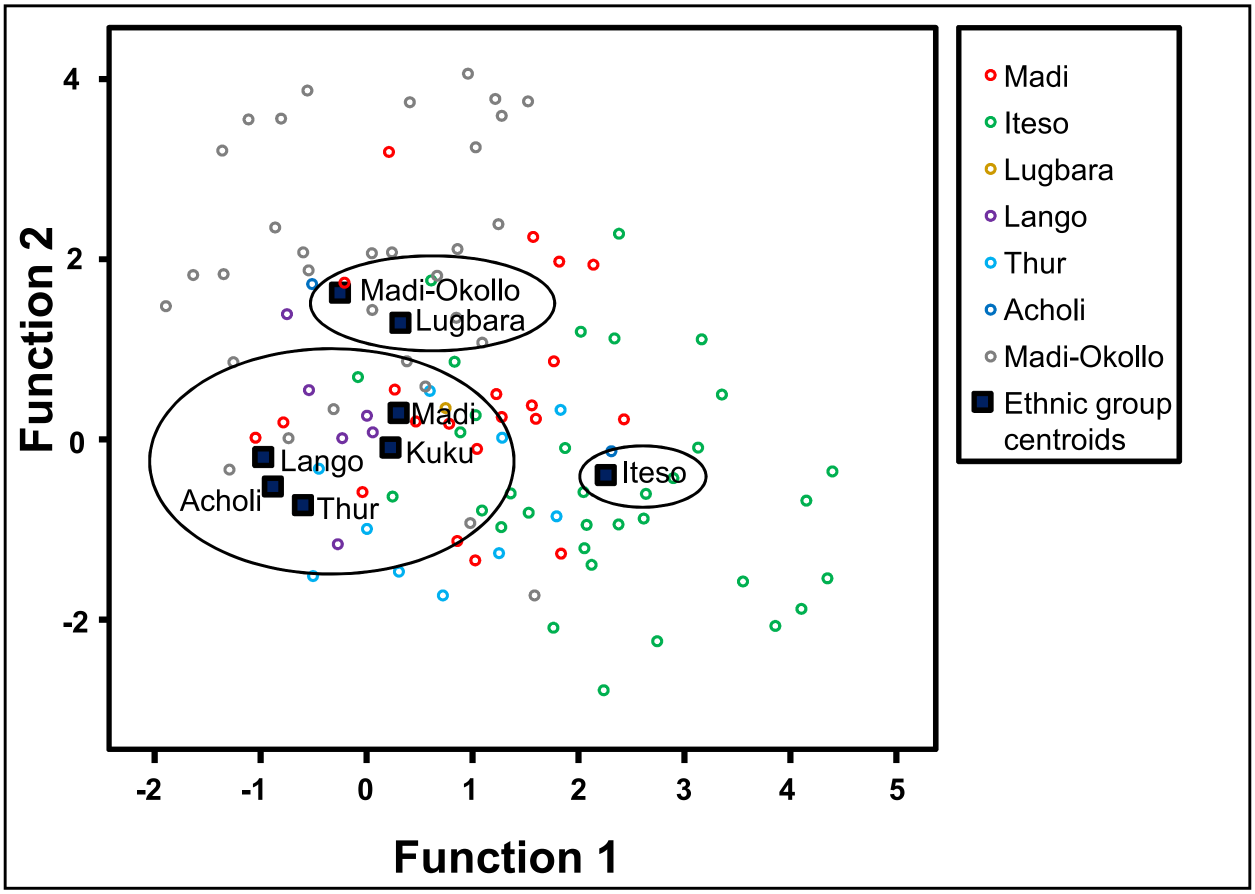


**Figure 3.** Ethnic grouping of shea tree (*Vitellaria paradoxa* C.F. Gaertn.subsp. *nilotica* (Kotschy) A.N. Henry & Chithra & N.C. Nair folk classification in Uganda from canonical discriminant function analysis.

**Table 5.** Canonical discriminant functions of shea tree (*Vitellaria paradoxa* C.F. Gaertn.subsp. *nilotica* (Kotschy) A.N. Henry & Chithra & N.C. Nair) folk classification among the different ethnic groups in the shea tree belt of Uganda.

| Ethnicity | Discriminant Function | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| | Shea tree ethno-variety nomenclature | Traditional / cultural uses | Shea fruit/nut organoleptic / morphological attributes |
| Acholi | -.831 | -.529 | .000 |
| Iteso | 2.274 | -.391 | .153 |
| Kuku | .251 | -.133 | -1.727 |
| Lango | -.953 | -.248 | -.060 |
| Lugbara | .340 | 1.283 | -.382 |
| Madi | .323 | .278 | -.607 |
| Thur | -.583 | -.760 | .264 |
| Madi-Okollo | -.213 | 1.629 | .266 |

pattern of agreement or congruence *sensu* Romney and Weller (1984) can be established, it is then possible to document the available knowledge. The results from this study show that the criteria used for shea tree classification are basically similar in the three farming systems of the shea tree belt of Uganda. Both during the focus group discussions, key informant interviews and questionnaire surveys, the respondents were able to identify individual shea trees by their fruits and nuts and not by merely looking at the trees.

Across the three farming systems, the consistent use of fruit, nut and pulp characteristics indicates an infusion of similar classification knowledge across the shea tree belt of Uganda. This was found in all the age groups in contrast to the general trend in variation in local biological knowledge, for example, in medicinal plants where particular knowledge may be held by particular age groups, men and a few families (Subramanyam *et al.* 2008, Teklehaymanot 2009). The MANOVA analysis showed that folk classification knowledge was not influenced by education or gender. This can be explained by the socio-economic discourse and rich culture of knowledge transmission across age, gender and social categories in the communities of the shea tree belt of Uganda (Wood 2008). Considering that peasant farmers in this area of Uganda base their way of life, social structure and many rituals on subsistence agriculture, folk classification knowledge is highly developed and shared by many ethnic groupings. The Acholi people of the Northern farming system, for example, have been recorded to transmit traditional knowledge across all social and gender categories through dances, rituals, stories and legends (Cordileone 2008). It is therefore possible to transmit knowledge of different shea tree ethno-varieties from parents, elders and peers. Children are wont to gain most of the knowledge of shea tree ethno-varieties, their attributes and management through personal experiences and oral transmission during shea nut collection. Children therefore grow up with this knowledge which is also maintained in social networks like peers, neighbors, relatives and even sometimes strangers. In some instances, for example, during the civil war between 1986 and 2004 many communities in the shea tree belt of Uganda were resettled in Internally Displaced Persons (IDP) camps, therefore there was increased interaction between elders and young people from diverse villages thereby enhancing propagation of folk knowledge. Although the civil war seriously disrupted the social order in these areas, it is possible that there was enhanced knowledge sharing among people across age and gender categories. Indeed, some focus group discussions and interviews for this study were conducted in IDP camps.

With regards to shea tree folk classification across Uganda's shea tree belt, all the ethno-variety nomenclature recorded across the three farming systems is based on morphological and organoleptic traits. For example, **Limi** is distinguished from **Asa** on the basis of pulp taste, **Alulung** is distinguished from **Acula** on the basis of fruit or nut shape. Classification is based on a single feature without reference to super-ordinate categories. Therefore, **Limi** (=sweet) is simply named so and is universally understood to refer to sweet pulp varieties. Reference to the fruit (a super-ordinate category to the pulp) is not included in the nomenclature. Similar optional binomialisation has been reported by Hays (1976) among the Ndumba people of Papua, New Guinea. Only one ethno-variety, **Wi-gweng**, is distinguished on the basis of habitat. This latter case presents a problem as environmental conditions, such as soil types, can be variable across the shea tree belt. There was, however, a tendency to use different names to refer to the same ethno-variety. In most cases, these semantics are used in different localities and are a result of the high state of flux of some of the dialects in the shea tree region of Uganda. The Acholi, Lango and Thur ethnic groups, for example, belong to one large cultural grouping referred to as 'Luo'. From Table 2, it is apparent that their characterization criteria are very similar and differ only by spelling or pronunciation. For example, **Ajigi** (trees with small shea fruits/nuts) among the Acholi and Lango people are named as **Ajiki** among the Thur (Table 2).

Therefore, consistency in folk classification is highly influenced by ethnic groupings. The results from the canonical discriminant function analysis point to an inter-gradation of folk knowledge across the shea tree belt of Uganda. It is worth noting that this inter-gradation follows the common ethnic inter-gradation across the shea tree belt. From the Teso farming system in the east (Figure 1) occupied mainly by the Iteso ethnic group, taxonomic knowledge is connected by the Thur people who speak a dialect that is closer to the Lango but with some lexical relationships to the Iteso and Karimojong people. The Lango and Acholi people share more than 95% of there lexicon and therefore have very similar ethno-varietal nomenclature. On the other hand, the Madi (Moyo) are not related to the Acholi at all, and are physically separated by the river Nile, but by virtue of their proximal location to each other, some of the ethno-variety nomenclature is shared such as **Limi** (Madi) and **Lim** (Acholi and Lango) to refer to shea trees that produce nuts with sweet pulp (Table 2). The intersection of shea tree folk knowledge of the Northern with the West Nile farming system through the Madi and Kuku people (Figure 3) shows that the Madi folk knowledge forms a continuum with that of the Acholi. In the west Nile farming system, the folk classification schemes of the Madi – Okollo is closer in similarity to the Lugbara with whom they inhabit Okollo county and are separated from the Madi of Moyo.

There is, however, a significant influence of ethnicity on ethno-variety nomenclature (Figure 3). The variation in folk knowledge among the various ethnic groups may be due to the intensity of utilization of the shea tree and its products. In the Teso region, for example, there is only moderate utilization of shea tree products while in the Northern and West Nile farming systems, the shea tree forms a central role in the culture of the people (personal observation). In the latter two farming systems, the shea tree is used for different purposes from food and drink, to household uses and beautification, weddings and funerals, and ritual sacrifices. Shea tree populations are therefore higher in the Northern and West Nile farming systems due to more awareness for their conservation.

Given that the shea tree products are equally important to all social groups, folk classification and knowledge of shea products domestic uses has not been structured according to social groups. Indeed, during the data collection exercise, detailed knowledge of different shea tree types and exact locations of particular trees was exhibited by individuals of all age and gender categories. The respondents also exhibited an acute awareness of ecological surroundings of the shea tree population. This is concordant with the findings of Choudhary *et al.* (2008) who reported that local people are usually very much aware of the ecological and phenological attributes of particular plants that are important for everyday life. The factor analysis showed good reliability, with a KMO measure of 0.747 which is a good indicator of distinct and reliable factors (Field 2005). From the factor analysis therefore, shea tree ethno-variety classification can be said to be based mainly on morphological and organoleptic variation in shea tree drupes (fruits/nuts). Although factor analysis revealed the use of rituo-cultural knowledge in folk classification, this factor is not reliable as a basis for classification on account of the very low and unstable Cronbach's alpha value ($\alpha = 0.25$). On the other hand, drupe properties (a factor that had a more reliable Cronbach's alpha value of 0.74) can be considered as the main basis of folk classification of shea tree ethno-varieties. Within the drupe or fruit characteristics, fruit/nut morphology and organoleptic attributes are the two most important factors for folk classification. This is concordant with many folk classifications all over the world. For example, Assogbadjo *et al.* (2008) reported the use of morphological classification system for baobab (*Adansonia digitata* L.) in West Africa. Results from similar studies have revealed the critical importance of organoleptic properties of plants in folk classifications (Heinrich 1998, Newmaster *et al.* 2006). In Mexico, the Popoluca people of southern Veracruz utilize organoleptic properties of plants to distinguish between medicinal and non-medicinal plants (Leonti *et al.* 2002). In the Himalayas of Nepal, Ghimire *et al.* (2004) suggested underlying chemical differences in medicinal plants on account of the folk classification based on organoleptic differences.

## Conclusion

Although traditional classification methods are mainly qualitative, they are nevertheless valuable because they are based on long term observations often incorporating experiential learning and utilization of different tree products. Folk classification knowledge in Uganda indicates the presence of shea tree ethno-varieties based on fruit/nut morphological and organoleptic properties. It is possible to use these ethno-varieties as a basis for further studies on the inherent variation among and within shea tree variants in Uganda. Ultimately this can lead to a domestication/breeding program once the variation has been quantified and the variants or 'ethno-varieties' validated by detailed morphological, biochemical and molecular studies.

## Acknowledgements

We are grateful to all the shea parkland communities of Amuria, Abim, Moyo, Pader and Arua for providing innumerable support and cooperation during fieldwork. Our sincere gratitude goes to Henry Asiandu, Jaspher Okello, Paul Okiror and Richard Amuge for all their efforts during fieldwork and language translation. This study was kindly funded by the European Union INCO – CT project no. 032037 (Innovative Tools and Techniques for Sustainable Use of the Shea Tree in Sudano - Sahelian zone – INNOVKAR), with additional support from the School of Graduate Studies, Makerere University, Uganda (through the Carnegie Corporation grants), and the World Agroforestry Centre, Nairobi through the SII/World Agroforestry Project: 'Advancing Agroforestry Research and Development through Training and Education'.

## Literature Cited

Abbiw, D.K. 1990. *Useful plants of Ghana: West African uses of wild and cultivated plants*. Intermediate Technology Publications Limited and Royal Botanic Gardens, Kew. London.

Akinnifesi, F.K., F. Kwesiga, J. Mhango, T. Chilanga, A. Mkonda, C.A.C. Kadu, I. Kadzere, D. Mithofer, J.D.K. Saka & G. Sileshi. 2006. Towards the development of miombo fruit trees as commercial tree crops in southern Africa. *Forests, Trees and Livelihoods* 16(1):103-121.

Appa Rao, S., C. Bounphanousay, J.M. Schiller, A.P. Alcantara & M.T. Jackson. 2002. Naming of traditional rice varieties by farmers in the Lao PDR. *Genetic Resources and Crop Evolution* 49(1):83-88.

Assogbadjo, A.E., R.G. Kakai, F.G. Chadare, L. Thomson, T. Kyndt, B. Sinsin & P. van Damme. 2008. Folk classification, perception and preferences of Baobab products in West Africa: Consequences for species conservation and improvement. *Economic Botany* 62 (1):74-84.

Berlin, B. 1992. *Ethnobiological Classification: Principles of categorization of plants and animals in traditional societies.* Princeton University Press, Princeton, New Jersey.

Berlin, B., D.E. Breedlove & P.H. Raven. 1973. General principles of classification and nomenclature in folk biology. *American Anthropologist* 75: 214-242.

Bounkoungou, E.G., M. Djimde, E.T. Ayuk, I. Zoungrana & Z. Tchoundjeu. 1998. *Taking stock of agroforestry in the Sahel: Harvesting results for the future*. ICRAF, Nairobi, Kenya.

Brown, C. 1993. The folk biology of the Tobelo people: A study in folk classification. *Journal of Linguistic Anthropology* 3(1): 119–120.

Brown, C.H., J. Kolar, B.J. Torrey, T. Trúóng-Quang & P. Volkman. 1976. Some general Principles of biological and non-biological folk classification. *American Ethnologist* 3 (1): 73-85.

Choudhary, K., M. Singh & U. Pillai. 2008. Ethnobotanical Survey of Rajasthan-An Update. A*merican-Eurasian Journal of Botany* 1 (2): 38-45.

Cordileone, A. 2008. Freireian mud: Investigating the use of drama in Ugandan classrooms. Pp. 104-114 in *Social Justice in Context* (3). Edited by M.S. Jackson. Carolyn Freeze Baynes Institute for Social Justice, East Carolina University, Greenville, North Carolina.

Ebanyat, P., N. de Ridder, A. de Jager, R. Delve, M. Bekunda & K. Giller. 2010. Drivers of land use change and household determinants of sustainability in smallholder farming systems of Eastern Uganda. *Population & Environment* 31 (6):474-506.

Field, A. 2005. *Discovering statistics using SPSS*. SAGE Publications. London.

Fisher, R.P. & R.E. Geiselman. 1992. *Memory-enhancing Techniques for Investigative Interviewing: The Cognitive Interview.* Charles C. Thomas, Springfield, Illinois.

Franzel, S.C., H. Jaenickle & W. Janssen. 1996. *Choosing the right trees: setting priorities for multipurpose tree improvement.* Research Report 8. International Service for National Agricultural Research (ISNAR). The Hague, Netherlands.

Gavigan, J., R. Mackay & M.O. Cuthbert. 2009. Climate change impacts on groundwater recharge in semi-arid Uganda and the role of groundwater in livelihood adaptation and peacebuilding. Pp. 153-160 In *Groundwater and Climate Change in Africa.* Edited by R. Taylor, C. Tindimugaya, M. Owor & M. Shamsudduha. International Association of Hydrological Sciences (IAHS) Publication 334.

Ghimire, S.K., D. McKey & Y. Aumeeruddy-Thomas. 2004. Heterogeneity in ethnoecological knowledge and management of medicinal plants in the Himalayas of nepal: Implications for conservation. *Ecology and Society* 9 (3): 6-6.

Hair, J.F., R.E. Anderson, R.L. Tatham & W.C. Black. 1998. *Mulitvariate Data Analysis.* Prentice-Hall. Upper Saddle River, New Jersey.

Hall, J.B., D.P. Aebischer, H.F. Tomlison, E. Osei-Amaning & J.R. Hindle. 1996. *Vitellaria paradoxa: A monograph.* School of Agricultural and Forest Sciences, Publication no. 8. University of Wales. Bangor, U.K.

Hays, T. 1976. An empirical method for the identification of cover categories in ethnobiology. *American Ethnologist* 3(3):489-507.

Heinrich, M. 1998. Indigenous concepts of medicinal plants in Oaxaca, Mexico: Low-land Mixe plant classification based on organoleptic characteristics. *Journal of Applied Botany* 72:75-81.

Hemsley, J.H. 1968. Sapotaceae. Pp. 79 in *Flora of Tropical East Africa.* Edited by E. Milne-Redhead & R.M. Polhill. Crown Agents for Overseas Governments and Administrations, London.

Ho, R. 2006. *Handbook of Univariate and Multivariate Data Analysis and Interpretation with SPSS*. Chapman & Hall/CRC Press. Boca Raton, Florida.

Holman, E.W. 2002. The relation between folk and scientific classifications of plants and animals. *Journal of Classification* 19:131-159.

Hunn, E. 1982. The utilitarian factor in folk biological classification. *American Anthropological Association* 84: 830-847.

Jianchu, X., Y. Yongping, P. Yingdong, W.G. Ayad & P.B. Eyzaguirre. 2008. Genetic Diversity in Taro (Colocasia esculenta Schott, Araceae) in China: An ethnobotanical and genetic approach. *Economic Botany* 55 (1):14-31.

Kaiser, H.F. 1960. The application of electronic computers to factor analysis. *Educational and Psychological Measurement* 20: 141-151.

Kakudidi, E.K. 2004. Folk plant classification by communities around Kibale National Park, Western Uganda. *African Journal of Ecology* 42 (s1): 57-63.

Kamanyire, M. 2000. Natural resource management and policy in *Uganda: Indicators for natural resource management and policy*. Working Paper No. 3, IDPM, University of Manchester. Manchester, U.K.

Kebebew, F., Y. Tsehaye & T. McNeilly. 2001. Morphological and farmers cognitive diversity of barley. *Genetic Resources and Crop Evolution* 48: 467-481.

Komáromi, R. 2009. *Sharing Knowledge: Intra-cultural variation of ethnobotanical knowledge and the factors that pattern it in a Mambila community in the Cameroon- Nigeria borderland.* MSc Thesis, University of Kent at Canterbury. Kent, U.K.

Krishna, J.D. 2006. Health care practices of tribals. *Orissa Review* :55-57. (Accessed 13 May 2010) www.orissa.gov.in/e-magazine/Orissareview/dec-2006/engpdf/55-57.pdf

Kruskal, W.H. & A.W. Wallis. 1952. Use of ranks in one-criterion variance analysis. *Journal of the American Statistical Association* 47 (260): 583-621.

Lamien, N., A. Sidibé & J. Bayala. 1996. Use and commercialization of non-timber forest products in western Burkina Faso. Pp 51-64 in *Domestication and commercialization of non-timber forest products in agroforestry systems; Proceedings of an international conference held in Nairobi, Kenya, 19 - 23 February 1996* ; Non-Wood Forest Products (FAO) , no. 9. Edited by R.R.B Leakey, A.B. Temu, M. Melnyk, & P. Vantomme. FAO, Rome, Italy.

Leonti, M., O. Sticher & M. Heinrich. 2002. Medicinal plants of the Popoluca, Mexico: organoleptic properties as indigenous selection criteria. *Journal of Ethnopharmacology* 81 (3): 307-315.

Lovett, P. & N. Haq. 2000. Evidence for anthropic selection of the Sheanut tree (*Vitellaria paradoxa*). *Agroforestry Systems* 48:273-288.

Lovett, P.N., J. Ouna, P. Ojok, A. Apunyu, L. Akot, C. Erongot & E.T. Masters. 2000. *Shea tree improvement in Uganda: Germplasm diversity, selection and propagation.* Paper presented at The Shea Tree (*Vitellaria paradoxa* subsp. *nilotica*): First Regional conference for Eastern and Central Africa 26-30 June 2000, Lira, Uganda.

MAAIF & MFPED 2000. Plan for Modernisation of Agriculture: Eradicating Poverty in Uganda. Ministry of Agriculture, Animal Resources and Fisheries and Ministry of Finance, Planning and Economic Development, Kampala, Uganda.

Madhav, G., P.R.Seshagiri Rao, G. Utkarsh, P. Pramod, A. Chhatre & Members of the People's Biodiversity Initiative. 2000. New Meanings for Old Knowledge: The people's biodiversity registers program. *Ecological Applications* 10 (5):1307–1317.

Maghembe, J.A., A.J. Simons, F. Kwesiga & M. Rarieya. 1998. Selecting Indigenous Trees for Domestication in *Southern Africa: Priority setting with farmers in Malawi, Tanzania, Zambia and Zimbabwe.* ICRAF, Nairobi, Kenya.

Maranz, S. & Z. Wiesman. 2003. Evidence for indigenous selection and distribution of the shea tree (*Vitellaria paradoxa*), and its potential significance to prevailing parkland savanna tree patterns in sub-Saharan Africa north of the equator. *Journal of Biogeography* 30 (10): 1505-1516.

Martin, G.J. 1995. *Ethnobotany: A methods manual.* Chapman & Hall, London.

Mazzocchi, F. 2006. Western Science and Traditional Knowledge. *Embo Reports* 7(5): 463-466.

Mekbib, F. 2006. Farmer and formal breeding of sorghum (Sorghum bicolor (L.) Moench) and the implications for integrated plant breeding. *Euphytica* 152: 163-176.

Montoya, A., O. Hernandez-Totomoch, A. Estrada-Torres, A. Kong & J. Caballero. 2003. Traditional knowledge about mushrooms in a Nahua community in the state of Tlaxcala, Mexico. *Mycologia* 95 (5): 793-806.

Mwebaze, S.M.N. 1999. *Uganda: Country Pasture/Forage Resource Profiles*. Ministry of Agriculture, Animal Industry and Fisheries 1999 [Accesed 13th May 2010]. http://www.fao.org/ag/AGP/AGPC/doc/counprof/Uganda/uganda.htm.

NEMA. 1997. S*tate of the Environment Report for Uganda.* National Environment Management Authority, Kampala, Uganda.

Newmaster, S.G., R. Subramanyam, R.F. Ivanoff & N.C. Balasubramaniam. 2006. Mechanisms of ethnobiological classifications. *Ethnobotany* 18 (1&2): 4-26.

Okorio, J., S. Musana, A. Okiria, V. Odeke, J. Opusi, Okwii & M. Opoi. 2004. *Determination, propagation and evaluation of important trees/shrubs with potential for agroforestry in Teso and Lango farming systems.* National Agricultural Research Organisation (NARO), Entebbe, Uganda.

Okullo, J.B.L. 2004. *Vitellaria paradoxa in Uganda: Population structures and reproductive characteristics*. PhD thesis, University of Wales, Bangor, UK.

Okullo, J.B.L., J.B. Hall & J. Obua. 2004. Leafing, flowering and fruiting of *Vitellaria paradoxa* subsp. *nilotica* in savanna parklands in Uganda. *Agroforestry Systems* 60: 77-91.

Oluka, J., B. Owoyesigire, B. Esenu & E. Sssewannyana. 2005. Small stock and women in livestock production in the Teso Farming System region of Uganda. Pp. 151-161 in *Small stock in development. Proceedings of a workshop on enhancing the contribution of small livestock to the livelihoods of resource-poor communities.* Edited by T. Smith, S.H. Godfrey, P.J. Buttery, E. Ssewannyana & E.Owen. Natural Resources International Ltd., Aylesford, Kent, U.K. ISBN: 0-9546452-5-1

Quiros, C.F., S.B. Brush, D.S. Douches, K.S. Zimmerer & G. Huestis. 1990. Biochemical and folk assessment of variability of Andean cultivated potatoes. *Economic Botany* 44 (2): 254-266.

Ramirez, C.R. 2007. Ethnobotany and the loss of traditional knowledge in the 21st century. *Ethnobotany Research & Applications* 5:245-247.

Raven, P.H., B. Berlin & D.E. Breedlove. 1971. The origins of taxonomy. *Science* 174(4015): 1210-1213.

Reyes-García, V., V. Vadez, E. Byron, L. Apaza, W.R. Leonard, E. Perez & D. Wilkie. 2005. Market economy and the loss of folk knowledge of plant uses: Estimates from the Tsimané of the Bolivian. *Current Anthropology* 46(4): 651-656.

Rivera, D., C. Obón, M. Heinrich, C. Inocencio, A. Verde & J. Fajardo 2006. Gathered Mediterranean food plants: Ethnobotanical investigations and historical development. Pp. 18-74 in *Local Mediterranean Food Plants and Nutraceuticals.* Edited by M. Heinrich, W.E. Müller & C. Galli. Karger. Basel, Switzerland.

Romney, A.K. & S. Weller. 1984. Predicting informant accuracy from patterns of recall among informants. *Social Networks* 6 (1): 59–77.

Sambatti, J.B.M., P.S. Martins & A. Ando. 2001. Folk taxonomy and evolutionary dynamics of cassava: A case study in Ubatuba, Brazil. *Economic Botany* 55 (1): 93-105.

Subramanyam, R., S.G. Newmaster, M. Murugesan, V. Balasubramaniam & M.M. Ul-Huda. 2008. Consensus of the 'Malasars' traditional aboriginal knowledge of medicinal plants in the Velliangiri holy hills, India. J*ournal of Ethnobiology and Ethnomedicine*. 4: 8. doi:10.1186/1746-4269-4-8

Sturtevant W.C. 1964. Studies in ethno-science. Part Three: Anthropological Approaches. *American Anthropologist* 66(3): 99-131.

Teklehaymanot, T. 2009. Ethnobotanical study of knowledge and medicinal plants use by the people in Dek Island in Ethiopia. *Journal of Ethnopharmacology* 124 (1): 69-78.
Thrupp, L. 1989. Legitimizing local knowledge: From displacement to empowerment for third world people. *Agriculture and Human Values* 6 (3): 13-24.

Tourangeau, R. 1984. *Cognitive Science and Survey Methods.* National Academy Press, Washington.

UBOS. 2006. *Statistical Abstracts*. Uganda Bureau of Statistics, Ministry of Finance and Economic Planning, Kampala, Uganda.

Volpato, G., R. Marcucci, N. Tornadore & M.G. Paoletti. 2004. Domestication process of two *Solanum* section *Lasiocarpa* species among Amerindians in the upper Orinoco, Venezuela, with special focus on Piaroa Indians. *Economic Botany* 58: 184-194.

Warton, D.I. & H.M. Hudson. 2004. A MANOVA statistic is just as powerful as distance-based statistics, for multivariate abundances. *Ecology* 85 (3): 858-874.

Wood, J.C.M. 2008. *The impact of globalisation on education reform: a case study of Uganda.* PhD Thesis, University of Maryland.