Fruit tree species in the wilderness: Species composition and level of use in western Amhara

Fentahun Mengistu[1] and Herbert Hager[2]

[1]Amhara Regional Agricultural Research Institute(ARARI), P.O.Box 527, Bahir Dar, Ethiopia

Email: fentahunmen@yahoo.com

[2]Boku University of Natural Resources and Applied Life Sciences, Peter-Jordan Street 82, A-1190 Vienna, Austria

Email: Herbert.hager@boku.ac.at

Abstract

The study was undertaken in selected areas of Adiarkay, Debark and Dejen districts of Amhara Region to assess the species composition and diversity and sate of use of wild fruit species. Data were gathered through interviews administered to 90 randomly chosen household heads and inventory of fruit trees. Results revealed the availability of 48 wild fruit species for use in different land use types and niches. Species diversity is generally low in agricultural settings where only 17 species were recorded. Species retention in farmlands appears to be governed by species relative importance and compatibility with annual crops where farm edges recorded a higher ethno-ecological importance score. Nonetheless, the current state of fruit utilization appears insignificant which is mainly accounted for peoples' cereal-based alimentation habit, cultural perceptions and attitudes. Fruit bearing species are retained primarily for non-fruit utilities like fuel wood and construction. Consequently, the potential contribution of wild fruits in peoples' diet remains largely unexploited. For a wider acceptance and achievement of sustainable behavioral changes, rigorous promotion and mainstreaming are required.

Key words: Domestication, diversity, utility, wild fruits.

Introduction

Edible wild plants have sustained people throughout history and their consumption has been documented from antiquity into the Common Era (Grivetti and Ogle, 2000). Gathered in the wild, wild fruits provide cheap food, add variety to diets, improve palatability, and provide essential vitamins, minerals, protein and calories. They also form an important component of coping strategies in times of severe famine (Guinand and Dechassa, 2000). Many of the wild edible fruit species have also great potential for processing. In an agroforestry system they often offer multipurpose advantages (Shrestha and Dhillion, 2006) and can help in soil and water conservation. Given that they are adapted to the local environment, wild fruits can grow easily with few requirements for external input and be integrated into sustainable farming systems. Since the distant past, Ethiopian people have also widely used wild and semi-wild plants that are estimated over 200 species (Edwards, 1992; Getachew *et al*., 2005). Despite this fact, wild plants especially fruit bearing species suffer notable disregard from research and development plans of Ethiopia. Consequently, they remain inadequately documented and are becoming unfortunate victims of deforestation and prone to extinction. This article examines fruits gathered in the wilderness with respect to species diversity, level of domestication and state of exploitation in the Western Amhara region of Ethiopia.

Materials and methods

The study was conducted in Adiarkay, Debark and Dejen districts of the Amhara region in Ethiopia between 2006 and 2008. Details of geographical location, climate, soils and agro-ecological coverage of the study Woredas are presented in Tables 1 and 2. Both qualitative and quantitative approaches were employed for data collection. Structured and semi-structured interviews were administered to document informants' attributes, enumerate floristic composition and understand people's practices and preferences. By reaching all farms of randomly selected households, assessment of wild fruits' species richness and diversity at the working landscape was carried out by counting all available species.

Data processing and analysis were done in various ways. Total species richness was calculated by counting the number of species. Average species richness was calculated using sample-based exact species accumulation curves as per Kindt and Coe (2005). Shannon Diversity Index (H) was used as diversity indicator and was calculated as (Magguran, 1988):

$$H = -\sum Pi * \ln Pi$$

where, H = Shannon Diversity Index, Pi = proportion of individuals found in the ith species, *ln* = is the natural logarithm of this proportion.

Table 1. Geographical location, climate and soils of the study *Woreda*s.

Woreda

Table 2. Percent agro-climatic zone coverage of the study *Woredas* based on the contemporary and traditional classification systems.

Woreda	% agro-climatic zone coverage under the new classification system									% agro-climatic zone coverage under the traditional classification system				
	SM1	SM2	SH3	M1	M2	M3	SH1	SH2	Tepid moist	Kolla (500-1500 m)	Woina Dega (1500-2300m)	Dega (2300-3200m)	Wurch (3200-3600m)	(3600-4400m)

SM1 = Hot to warm sub-moist; SM2 = Tepid to cool sub-moist; M1= Hot to warm moist; M2 = Tepid to cool moist; M3 = Cold to very cold moist; SH1 = Hot to warm sub-humid; SH2 = Tepid to cool subhumid; SH3 = cold to very cold sub-humid

Evenness (E) was calculated as the ratio of observed diversity to maximum diversity as Pielou (1969):

$$E = \frac{H'}{\ln S}$$

where, H' = Shannon diversity index, S = species richness

To order communities in diversity, Rényi diversity profiles were used and calculated as Kindt *et al*. (2006):

$$H\alpha = \frac{\ln\left(\sum Pi\alpha\right)}{1-\alpha}$$

where, Hα = Rényi diversity profile, *Pi* = proportional abundance of a species, α = scale parameter with values 0, 0.25, 0.5, 1, 2, 4, 8 and ∞. The values at α = 0, 1, 2 and ∞ correspond to species richness, Shannon diversity index, reciprocal Simpson and Berger-Parker diversity indices.

Species and tree density were calculated (both at farm and site level) dividing the total number of species or trees by the size of the farm and total area of all farms of a site, respectively. Species composition similarities and differences of sampling sites were compared based on ecological distances where species similarity of sites (Beta Diversity) was judged using Sorenson index proposed for qualitative data as (Magurran, 1988):

$$D = \frac{2j}{a+b}$$

where, D = distance, j = the number of species found in both sites, a = the number of species in site A, and b = number of species in site B. The results were then subtracted from unity to show in terms of distance or dissimilarity value.

To linking the cultural information to ecological data, Ethno-ecological Importance Value (EIV) was calculated following Castaneda and Stepp (2007) as:

$$EIV = \sum_{x=1}^{N} (S)\left(\frac{nx}{Nx}\right)$$

where, N = total number of species in all niches; S = Smith's Saliency Index, nx = total number of individuals of species "x" found in one niche, Nx = the sum of species "x" found in all niches.

Statistical softwares, SPSS for windows version 15 and Biodiversity R. (Kindt and Coe, 2005) built on the free R 2.1.1 statistical program and its contributing packages (R Development Core Team, 2005), were employed for data analysis.

Results and discussion

Species composition, life forms and habitats

The study documented a total of 48 species of wild edible fruit bearing plants that are classified among 32 genera and 24 families (Table 3). The greatest contribution of edibles comes from Moraceae family, represented by five species, the runner-ups being Rhamnaceae and Tiliaceae each represented by four species.

Table 3. Lists of species recorded across the study sites.

Botanical Name	Family	Common / English name	Life form
Acacia etbacia Schweinf	Fabaceae	Red thorn	tree
Carissa edulis (Forsk.) Vahl	Apocynaceae	Smple-spined carissa	shrub/tree
Carissa spinarum Linn.	Apocynaceae		shrub/tree
Cordia africana Lam.	Boraginaceae	East African Cordia	tree
Cordia ovalis R.Br.	Boraginaceae		shrub/tree
Diospyros mespilliformis Hochst. Ex. A. DC.	Ebenaceae	African Ebony, Jackal-berry	tree
Dovyalis abyssinica (A.Rich.) Warb.	Flacourtiaceae	Kei Apple	shrub/tree
Ekebergia capensis Sparrm	Meliaceae		tree
[illegible]	[illegible]	[illegible]	[illegible]

Thirteen families (30%) are represented by only one species. The richest genus was Ficus that comprised of five species followed by Grewia and Ziziphus with three species at par. It was also noted that species known in cultivation like *Citrus* spp. and *Coffee* sometimes grow in the wilderness especially in churchyard and monastery forests and regarded as wild by the community. Most of the recorded species were trees (45.5%) while a quarter of them occur as shrubs and another quarter opportunistically either as shrubs or trees. Wild fruit species appeared to occupy various habitats and ecological niches. Some species naturally inhabit forests and scrubs (e.g. *Rosa abyssinica*) or often open forests and heaths (*Ziziphus spina-christi*). Species such as *Ximenia americana* were frequent on highly degraded sites. Other species like S*yzygium guineense* are characteristically riparian. Some others such as *Fluggea virosa were* frequently found on roadsides and disturbed areas.

Species distribution by altitude and traditional agro-ecological zones

The majority of wild fruit species were recorded in the low to mid altitude continuum. Barring the naturalized domesticated species, out of the total species recorded, 31, 38 and 7 species occurred in the 1200-1500 m, 1500-2300 m and 2300-3300 m altitudinal ranges, respectively. By and large, at altitudes of 3300m and above or in the mountain tops, *Rosa abyssinica* appears to be prominent species. *Rubus steduneri* and *Dovyalis abyssinica* follow at about 2800 m a.s.l and 2600 m a.s.l, respectively. *Tamarindus indica, Ximenia americana, Ziziphus mucronata* and *Grweia* species were dominant at the lower altitude in the study area, 1200 m a.s.l in the Blue Nile Gorge.

Variability in species composition of sites

The study sites appear to differ substantially in their number and type of edible fruit species. Adiaregay, Dibbahir and Bermariam sites had generally closer species compositions (Table 4). Species composition variability can be attributed to differences in elevation and thus climate among sites that provide a wide array of niches for different species. As one goes from lower towards the higher altitudes, both the level of domestication and the number of species and trees per farm progressively and then sharply dwindles. This can be interpreted by both natural and man-made factors. Highlands like the Debir area (Table 1) that at times experience freezing temperatures could restrict the occurrence of several species. On the other hand, the highlands are the most populated sites where anthropogenic factors culminated in severe land degradation and deforestation which could also have direct bearing on indigenous fruit species populations. As a result, the poor natural vegetation backdrop of the higher altitudes might not offer farmers a wider chance to find trees to be retained which would ultimately result in low diversity on those sites located at higher elevations.

Table 4. Sorenson distance and number of species shared between sites (agglomerative coefficient = 0.48).

Species	Distance				Number (percent) of species shared			
	Dibbahir	Bermariam	Adiaregay	Kurar	Dibbahir	Bermariam	Adiaregay	Kurar
Debir	0.49	0.67	0.55	0.74	9(20.5)	6(13.6)	7(15.9)	5(11.4)
Dibbahir	0	0.18	0.13	0.47	0	21(47.7)	20(45.5)	14(31.8)
Bermariam	*	0	0.19	0.56	*	0	19 (43.2)	12(27.3)
Adiaregay	*	*	0	0.55	*	*	0	11(25.0)

Species composition in the agricultural landscape

The study revealed that, despite at low level, indigenous fruit bearing species are domesticated in the realm of anthropogenic ecosystems through mainly retaining natural regenerants. Accordingly 17 fruit bearing species were recorded in the working (agricultural) landscape (Table 5). Over the total study area, 74.5 % (n = 90) of the informants were found to possess one or more of these species in their plots. Nonetheless, species richness and abundance is very low. The mean number of species per household, density per farm and per site is 2.3, 2.6 and 1.6, respectively (Table 6). On a site basis, Bermariam appears to be superior with all the above parameters while Debir recorded the lowest number of species. The lowest density per farm and per site was at Dibbahir. Pertaining species abundance, the total number of trees of all species of all sites (N = 70) was calculated at 754 with an average of 10.8± 11.89 trees per household. The mean tree density per farm and per site was 10.7±15.11 and 7.6, respectively (Table 6).

Table 5. Relative and mean species abundance of indigenous fruit species in the agricultural landscapes.

			Species abundance		Mean number of fruit tree species per household by site				
Species	Family	English name	Abundance	Proportion	Adiaregay	Bermariam	Debir	Dibbahir	Kurar
Flueggea virosa (Roxb. ex Willd.)	Euphorbiaceae	Snowberry tree	227	30.1	7.6	5.7	0.0	0.3	0.0
Ziziphus spina-christi (L.) Desf	Rhamnaceae	Christ thorn, Jujube	177	23.5	6.6	3.9	0.0	0.0	0.0
Cordia africana Lam.	Boraginaceae	East African Cordia	173	22.9	2.2	2.4	0.0	5.1	2.4
Ficus species	Moraceae	Figs	48	6.4	0.8	1.7	0.0	0.1	0.2
Rosa abyssinica R. Br.	Rosaceae	Abyssinian rose	37	4.9	0.0	0.0	3.1	0.0	0.0
Carissa species	Apocynaceae	Carissa plum	28	3.7	0.8	0.6	0.0	0.4	0.0
Diospyros mespiliformis Hochst. ex A. DC.	Ebenaceae	Jackal-berry	18	2.4	0.9	0.2	0.0	0.0	0.0
Tamarindus indica L.	Fabaceae	Tamarind	11	1.5	0.0	0.0	0.0	0.0	1.1
Ficus thonningii Blume	Moraceae	Bark-cloth fig	10	1.3	0.1	0.5	0.0	0.0	0.0
Rhus species	Anacardiaceae		10	1.3	0.2	0.3	0.0	0.1	0.0
Syzygium guineense (Willd.) DC.	Myrtaceae	Water berry	7	0.9	0.0	0.0	0.0	0.5	0.0
Dovyalis abyssinica (A. Rich.) Warb.	Flacourtiaceae	Kei Apple	2	0.3	0.0	0.0	0.2	0.0	0.0
Phoenix reclinata Jacq.	Arecaceae	Wild date palm	2	0.3	0.0	0.0	0.0	0.1	0.0
Ximenia americana L	Olacaceae	Wild plum	1	0.1	0.0	0.1	0.0	0.0	0.0
Opuntia ficus-indica (L.) Mill.	Cactaceae	Indian fig	1	0.1	0.0	0.0	0.1	0.0	0.0
Ziziphus abyssinica Hochst. ex A. Rich.	Rhamnaceae	Jujube	1	0.1	0.0	0.1	0.0	0.0	0.0
Vangueria madagascariensis J.F. Gmelin	Rubiaceae		1	0.1	0.0	0.0	0.0	0.1	0.0

Table 6. Mean species richness, abundance and diversity of individual sites and entire the study area.

Sites	Number of species household^{-1} (± Sd*)	Number of trees household^{-1} (± Sd)	Tree density (± Sd)		Species density (±Sd)		Diversity Index		Landholding household^{-1} (± Sd)
			Density farm^{-1}	Density site^{-1}	Density farm^{-1}	Density site^{-1}	Shannon Diversity	Evenness	
Adiaregay(N=16)	2.8±1.17	19.1±16.14	16.6±15.60	9.6	3.1±3.19	1.4	1.46	0.54	1.98±1.56
Bermariam(N=18)	3.3±1.41	15.4±12.24	17.2±23.30	11.1	3.4±2.25	2.4	1.66	0.52	1.39±0.89
Debir(N=12)	1.3±0.45	3.3±2.50	5.3±3.70	4.4	2.3±1.80	1.5	0.31	0.46	0.76±0.44
Dibbahir(N=14)	1.6±0.93	6.7±4.61	5.1±3.00	3.9	1.5±1.25	1.0	0.98	0.33	1.73±1.50
Kurar(N=10)	1.6±0.50	3.7±2.50	4.0±1.90	3.8	2.0±0.93	1.6	0.80	0.74	0.98±0.58
All sites(N=70)	2.3±1.32	10.8±11.89	10.7±15.11	7.6	2.6±2.21	1.6	1.86	0.38	1.43±1.19

* *Sd = standard deviation*

A lower figure with the later might mean that farms are less evenly stocked across households. Besides, species abundance appeared to differ by site as did the species richness. The highest and lowest relative species abundances were recorded at Adiaregay (19.1±16.11 trees per farm) and Debir (3.3±2.50 trees per farm), respectively. However, mean tree density per farm and site was highest at Bermariam than Adiaregay signifying that despite their large sizes farms at the latter are less adequately stocked. Kurar recorded the lowest density of trees both at the farm and site levels which could be accounted for the extreme environment that prevents agroforestry practice in the area.

Species diversity and pattern

The Shannon diversity index for the entire study area was calculated at 1.86 (Table 6), which is about 65.7% of the maximum possible value that would have been obtained had all species occurred at equal frequency (2.83). This suggests that the study area has a moderate level of diversity. Looking at only species richness the five sites can be grouped into two; those with relatively higher species richness (Bermariam, Adiaregay and Dibbahir) and those with lower species richness (Kurar and Debir) (Figure 1). In terms of diversity, by having consistently higher profiles than other sites, Bermariam followed by Adiaregay appeared to have higher species diversity. By the same analogy, Debir appeared least diverse by recording the lowest profile. On the other hand, Dibbahir could not be ordered in diversity with Kurar as they had corresponding diversity profiles that intersect. This happened because Dibbahir had higher species richness but lower evenness than the Kurar site. Kurar is relatively species even while Dibbahir is less even.

This can be explained by the fact that Dibbahir being a transitional zone favorable to accommodate various ranges of species, the probability of some species to dominate is higher resulting in uneven species composition at the total landscape level. This would in turn govern farm species richness and people's choice of species for retaining. Conversely, the harsh climate at Kurar could limit the ability of any single or group of species to dominate in the natural milieu that would consequently narrow species choice for farm integration resulting in even species distribution.

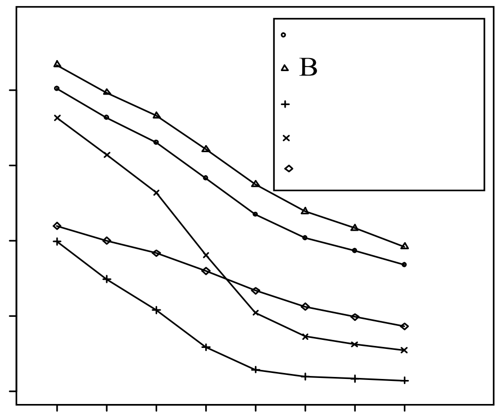

Figure 1. Rényi species diversity profile for study sites (based on 100 randomizations).

The inter-site differences in farm species richness seem largely governed by the overall species richness setting of the respective localities. This means that the more parent trees present in the natural environment the higher the probability that farmers retain more trees in their farms. For instance, at Bermariam where there is a better vegetation cover in the natural milieu (partly for its proximity to the Waldba Monastery) so is a higher level of species integration in the agricultural landscapes while the opposite is true at Debir site. However, at the Kurar site where there is relatively lower species richness in the natural environment the level of farm integration is low. This could probably be explained by its extremely dry climate that appears unattractive for agroforestry development or the tradition of tree retention by the community is low.

Fruit species diversity by land use type

Comparison of the different land use types revealed that the average species richness declines in the following order: farm edges (12), grazing and uncultivated lands (11), farmlands (10), and homesteads (8). However, in terms of diversity farmlands (1.71) followed by uncultivated lands (1.65) are more diverse than homesteads (1.29). With regard to evenness, farmlands tend to be even while the farm edges are less even. Farm edges (1.49) appear to be ethno-ecologically very important suggesting that these sites are important sources of indigenous fruit bearing species to the people. Besides, the different land use types differ by species type. Generally, farmlands and homesteads are dominated by *Z. spina-christi* and *C. africana* which seems related to relative importance and compatibility of species for inter-cropping (Table 7). Highly frequent and high utility species for the major part overlap with the most abundant species demonstrating that most people are growing species of higher preferences in large numbers that can be taken affirmative in view of sustainability of species.

Utilization

The extant level of wild fruit consumption was found to be infrequent and limited to casual encounters; 52.2% of informants stated that consumption was sporadic. Wild fruit gathering is interpreted as being famished and its consumption connotes indignity and social stigma. Children are the major consumers as the majority of informants conceded (70.7%, n=92) which is in a good agreement with previous findings (Guinand and Dechassa, 2000; Getachew *et al*., 2005). Particularly, twelve fruit species are considered children category (*F.virosa, Ficus spp., F.thonningi, Rhus spp., O.spinosa, S.africana, S.innocua, Rubus spp., E.ventricosum, C.africana, Grewia spp., P.reclinata*). Adults regard wild fruits diminutive food value and avoid their consumption. This is certainly because grown-ups get succumb into the culture of the society that regards wild fruits a low status and their consumption a source of shame. It was also found out that the intensity of use of some wild fruits as *Z.spina-christi* increase as a response to adversity. Specifically people recount the widespread drought of the year 1984/85 and the subsequent famine where several people especially the poor populace survived of increased consumption of wild fruits. Especially memories of reliance on *Z.spina-christi*, which had intensively been consumed, bartered and sold during that time are still alive among people. This shows the prospective role of wild fruits as a local response to adaptation and mitigation of the impending capricious climate.

Most of the edible fruits were found to be eaten fresh and raw and sometimes dried as snacks as was widely reported elsewhere (Van den Eynden, 2003). Nevertheless, in some seven fruit species a sort of home processing is practiced. They are commonly processed into either a form of refreshing juice (*Carissa* spp., tamarind, *C.africana* Lam. and *Zspina-christi*) or brewed into local beers with or without the addition of a fermenting agent (*Rhamnus prinoides* L'Hér.), or are added as flavorings (*C.africana* and *Carissa* species) to local drinks.

Table 7. Comparison of the ethno-ecological importance value of the different land use types of the agricultural settings as a source of indigenous fruit bearing plant species.

	Species saliency score	Proportional abundance				Species saliency X abundance			
		Farmland	Homestead	Farm edge	Grazing/ uncultivated land				
Species	A	B	c	D	e	a X b	a X c	a X d	a X e
Cordia africana Lam.	0.51	0.18	0.65	0.14	0.02	0.09	0.33	0.07	0.01
Ficus species	0.43	0.19	0.21	0.42	0.19	0.08	0.09	0.18	0.08
Diospyros mespiliformis Hochst. ex A. DC.	0.27	0.00	0.56	0.22	0.22	0.00	0.15	0.06	0.06
Ziziphus spina-christi (L.) Desf	0.40	0.23	0.38	0.31	0.08	0.09	0.15	0.12	0.03
Flueggea virosa (Roxb. ex Willd.)	0.26	0.06	0.00	0.72	0.22	0.02	0.00	0.19	0.06
Rhus species	0.17	0.00	0.00	0.80	0.20	0.00	0.00	0.14	0.03
Carissa species	0.56	0.11	0.00	0.43	0.46	0.06	0.00	0.24	0.26
Ficus thonningii Blume	0.06	0.20	0.10	0.60	0.10	0.01	0.01	0.03	0.01
Ziziphus abyssinica Hochst. ex A. Rich.	0.04	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.04
Ximenia americana L	0.29	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.29
Rosa abyssinica R. Br.	0.33	0.08	0.62	0.30	0.00	0.03	0.21	0.10	0.00
Syzygium guineense (Willd.) DC.	0.28	0.14	0.00	0.86	0.00	0.04	0.00	0.24	0.00
Phoenix reclinata Jacq.	0.06	0.00	0.00	1.00	0.00	0.00	0.00	0.06	0.00
Vangueria madagascariensis J.F. Gmelin	0.12	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.12
Dovyalis abyssinica (A. Rich.) Warb.	0.12	0.50	0.50	0.00	0.00	0.06	0.06	0.00	0.00
Opuntia ficus-indica (L.) Mill.	0.03	0.00	1.00	0.00	0.00	0.00	0.03	0.00	0.00
Tamarindus indica L.	0.14	0.64	0.00	0.36	0.00	0.09	0.00	0.05	0.00
Total ethno-ecological importance value						0.57	1.03	1.49	1.00

When they are fermented with the addition of *R. prinoides* leaves *Z.spina-christi*, *R.abyssinica*, *Rubus* spp., tamarind, *Ficus* spp. and *C. africana* are brewed into local beers "*Tela*" and "*Tej*" (a Mead) or without it to prepare "*Beerz*" (a Hydromel) or fruit infusion (tamarind) that is regarded as "*Areke*". There is, however, a significant potential for the improvement of the contribution of some of the wild fruits through processing into salable products.

The study also revealed that some wild fruits are article of commerce at the close by rural markets and serve a source of income. Some fruits as *Z.spina-christi* are transported to distant markets like Addis Ababa and even to Sudan. For the most part wild fruit market disposal is done by women than men. Likewise, retailers as well as customers are for the most part women and children. The study further revealed that when wild fruit species are planted or retained in agricultural settings except in a few species they are primarily used for non-fruit functions and services overshadowing their fruit uses. Even then, the incorporation of these species on their present usage form can still be taken positive as it can help relieve the dwindling of these fruit species while at the same time increases biodiversity in the agricultural landscapes. For 13 species across the study areas more than 21 non-food use categories were documented. Comparison of species of more than one utilities showed that fuel wood (19.4%) followed by construction and fence at par (13%) are dominant use categories. On a species basis, *Z. spina-christi* has the greatest number of uses (11, 15.07%) followed by *C.africana* and *T. indica* (10, 13.7%) at par (Figure 2).

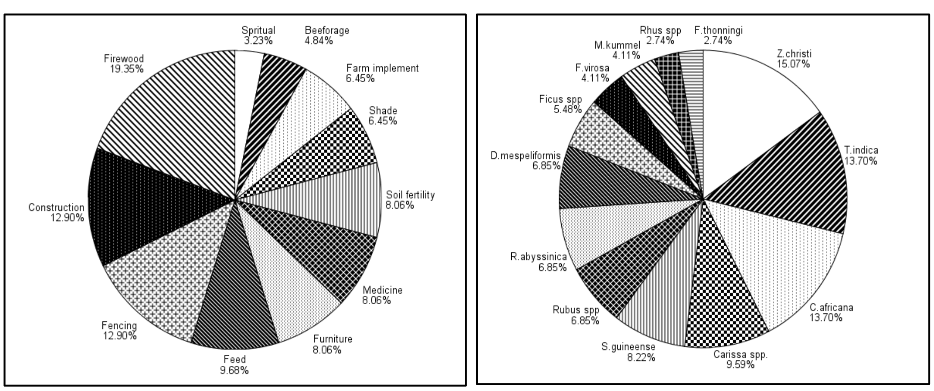

Figure 2. Percent contribution of species to the total use category (left) and Percent non-fruit use category of indigenous fruit species (right).

The multiple uses of these species attest to the enduring importance of these resources to local communities for subsistence and as part of their cultural heritage (Shrestha and Dhillion, 2006) while it can lead to better chances for their conservation (Etkin, 2002). Conversely, the harvesting of species with multiple uses can also put them under threat unless simultaneous balancing measures are taken. Therefore, should the wild fruit venture crowned with success, the study emphatically stress the necessity to promote value addition techniques. There is also a possibility to look for novel market opportunities. For instance, there is unexploited potential of targeting wild fruits to tourists around the Semen Mountains National Park area. Marketing of fruits like *Z.spina-christi* can also be thought of for livestock feed in the event of mounting animal feed scarcity.

Although the poorest sections of the communities in the study areas do make part of their living out of the collection and trading of wild fruits, their potential has hardly begun to be realized owing to food habits, cultural perceptions and attitudes. Therefore, in order to exploit the benefits of wild fruits to the full capacity, there is a need to foster their consumption through measures that ensure wider acceptance and to achieve sustainable behavioral changes. These may include vigorous promotion, public awareness campaigns and social marketing. It was also found that some species do not appeal to people because of their transitory undesirable characteristics. These warrant research in order to understand and improve the underlying anti-nutritional factors and compatibility to other agricultural activities.

Conclusion

Notwithstanding the marginal environment, the study area harbors a rich floral diversity of wild fruit plants. Albeit low and primarily for non-fruit utilities, indigenous edible fruit bearing species are domesticated in the agricultural settings. However, species diversity is low and too uneven among the different land use types, farms and sites. As a result, only few species of higher utilities and compatibility occur at higher frequencies in greater abundances. This is suggestive that as several agricultural land use types and sites are as yet less stocked, there is still a great scope to enhance farm species diversity by filling the existing deficiency of richness and or evenness. Generally, introduction of indigenous fruit trees in the working landscape can be taken as positive development in view of conservation-through-use of the species. On the other hand, the current practice of retaining indigenous fruit species primarily for non-fruit uses means that their contribution to food and nutritional supplement of the households is far unexploited. Peoples´ dietary habit, cultural perceptions and attitudes form the major part of the explanation for not using them as food. Should fruit trees in agricultural settings are additionally exploited for their fruits proper and make up part of peoples' livelihood, there is a need of creating farmers awareness and assisting them in appropriate tree management techniques and intercropping regimes. By doing so, it should be possible to evolve them from a practice of inadvertent tree growing exclusively for non-fruit uses to deliberate indigenous fruit tree agro-forestry development for both fruits and a range of other uses. The challenge would, however, be to justify the benefits that indigenous fruit production accrues to the producers' and make it profitable to adopt, which underpins the need for giving prime attention to create markets. There is generally a need for incorporating wild fruits in the region's development plan as part of a strategy to support farmers in their pursuit of ensuring food and nutritional security and poverty alleviation.

Acknowledgements

This paper is an output from a PhD dissertation of the first author funded by Austrian Exchange Service for which we are grateful. We are also highly indebted to BOKU University for hosting the first author for a PhD study. Our great thanks are due to the Amhara Regional Agricultural Research Institute for logistic and financial support. We give special thanks to farmers, district agricultural and rural development offices and several individuals who have been helpful in many ways during the fieldwork.

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