Edible Wild Fruit Trees and Shrubs and Their Socioeconomic Significance in Central Ethiopia

Yigremachew Seyoum, Demel Teketay, Girma Shumi, and Melaku Wodafirash

Research

Abstract

An ethnobotanical study was conducted to investigate indigenous knowledge and socioeconomics of edible wild fruit trees and shrubs (EWFTSs) in Arsi Zone, Central Ethiopia. A total of 90 respondents were interviewed and consisted of men, women, and children who were selected by stratified random sampling. A total of 30 EWFTSs bearing species that belong to 20 families were identified. Age and gender distribution of respondents on the choice of four of the top five species were homogeneous indicating that promotion can be planned indifferently to all households. Indigenous knowledge on EWFTSs varied significantly ($P < 0.05$) with age groups and gender as well as area of respondents. Elder males appeared more familiar with EWFTSs. Income generated from sales of EWFTSs is, however, marginal. A considerable proportion of the community acknowledged food values of EWFTSs, and more than half preferred EWFTSs over cultivated commercial fruit, suggesting that efforts towards their integration into the current farming system are appealing. Realizing the resource depletion, about 54% of the respondents planted EWFTSs while 87% showed interest to participate in domestication programs. The study explored a great potential of promoting EWFTSs in Arsi Zone and assisting the country's efforts of ensuring food security.

Introduction

Forests and woodlands and the wild plants and animals they contained were the main source of food for many early hunter-gatherer societies (FAO 1989) and still are for forest-dependent communities. Edible wild plants play a critical role in ensuring food and livelihood security for countless families and communities around the world (Bell 1995, Guijt *et al*. 1995, Lulekal *et al*. 2011, Neudeck *et al*. 2012, Teketay *et al*. 2010). They are part of the diet of farm households not only during periods of food shortage but also on a daily basis and provide a number of important dietary elements that the normal agricultural production fails to provide adequately. For instance, edible wild plants have been reported to have higher fat, proteins, minerals, and vitamin contents than cultivated species. They provide in particular vitamins A and C, zinc, iron, calcium, iodine, thiamine, riboflavin, niacin, and folacin (Ohiokpehai 2003). Hence, edible wild plants are important for achieving nutritional balance in the diet and are particularly important for ensuring food security for women, children, and the poor, who heavily rely on them (Guijt *et al*. 1995, Teketay *et al*. 2010).

In addition to these, during times of stress—such as crop failure, pest attack, and drought—edible wild plants serve as major sources of food. This implies that the consumption of wild plants is a necessary part of the strategies adopted by people in order to survive in harsh environ-

Correspondence

Yigremachew Seyoum, Ethiopian Institute of Agricultural Research, Forestry Research Center, P.O. Box 30708, Addis Ababa, ETHIOPIA.
Demel Teketay, Botswana College of Agriculture, Department of Crop Science and Production, Private Bag 0027, Gaborone, BOTSWANA.
dteketay@yahoo.com
Girma Shumi, Ethiopian Institute of Agricultural Research, Melkassa Agricultural Research Center, P.O. Box 463, Adama, ETHIOPIA.
Melaku Wodafirash, Addis Ababa University, the National Herbarium, P.O. Box 3434, Addis Ababa, ETHIOPIA.

Ethnobotany Research & Applications 14:183-197 (2015)

Published: 28 June 2015

http://dx.doi.org/10.17348/era.14.0.183-197

ments and periods (Bell 1995, Guinand & Lemessa 2001, Neudeck *et al*. 2012, Teketay *et al*. 2010). For instance, many pastoralists rely on the seasonal products of natural forests, woodlands, and bushlands. Hence, the consumption of wild plants seems more common and widespread in food insecure areas, including most dryland areas, where a wide range of species are consumed, leading to the notion of "famine-foods" or plants consumed only at times of food stress (namely drought, war, and other hardship periods) (Guinand & Lemessa 2001, Teketay *et al*. 2010). Edible wild plants are an important component of coping strategies in times of severe food shortage. Furthermore, commercialization of fruits of edible wild plants is increasing because of increased demand for fruit in urban centers and as a result of limited alternative economic options for the rural people (Mithofer & Waibel 2003). An estimated 15 million people in sub-Saharan African countries earn cash income from forest-related activities (Oksanen *et al*. 2003). Ecologically, tree and shrub species that provide edible wild fruits can be used in restoration of degraded lands and in maintaining biodiversity, which, in turn, improves ecosystem productivity. Increasing the abundance of edible wild fruit trees and shrub species (EWFTSs) provides a food source to wild animals, such as birds and lemurs, which are agents of seed dispersal, thereby, enhancing regeneration of indigenous species.

In general, EWFTSs play important roles in African countries, such as Ethiopia that are known for the diversity of their flora and fauna, and communities in such countries depend on these resources for various services and products (Getahun 1974). Several studies have demonstrated the roles of EWFTSs as sources of income and as supplementary food sources during times of crisis (Balemie & Kebebew 2006, Teketay & Eshete 2004, Teketay *et al*. 2010, Wondimu *et al*. 2006). The contributions of EWFTSs in poverty eradication by enhancing ecotourism, access to improved food, and nutritional security are also well recognized (Makonda *et al*. 2003, Styger *et al*. 1999, Teketay *et al*. 2010). Thus, it is not surprising that the need for systematic assessment and documentation of EWFTSs and other non-timber forest products of the country is emphasized in the Forestry Research Strategy of the Ethiopian Institute of Agricultural Research (Anonymous 2002).

In Ethiopia, EWFTSs have distinct merits that account for their preference over cultivated commercial fruits (CCF). Since EWFTSs are adapted to local environmental conditions, they may fill food availability gaps, acclimating well during seasons of unfavorable conditions. Several wild fruits serve as useful sources of minerals and vitamins. A recent nutritional study on three indigenous fruit trees of Ethiopia by Feyessa *et al*. (2011) has shown that *Ziziphus spina-christi* (L.) Desf., *Balanites aegyptiacus* (L.) Delile, and *Grewia flavescens* Juss. are important sources of carbohydrate, protein, energy, and minerals.

In many cases the nutritional status of edible wild plants is comparable, and in some cases superior, to domesticated varieties (Maundu *et al*. 1997). The fruit of *Ziziphus jujuba* Mill. are exceptional examples in that they contain seventeen times as much vitamin C per unit weight as oranges (FAO 1989). The needs of the human body for vitamin A can be satisfied by the consumption of edible wild plants (FAO/WHO 1988), and the regular usage of vitamin A may prevent the most malicious diseases, such as leukemia and similar forms of cancer (van Dillen *et al*. 1996).

Indigenous fruit trees may be less susceptible to disease and pest attack. If so, then they demand less production input in comparison with CCFs and are probably easier to integrate into the current farming system. Moreover, their food value is probably well understood with better acceptance by different categories of rural people. Nevertheless, efforts towards sustainable exploration of valuable tree and shrub species are very much limited because of lack of systematic approaches to manage and conserve natural resources (Tadesse & Mbogga 2004). The recognition of the role of indigenous knowledge in conservation and sustainable management of resources (Lulekal *et al*. 2011, Stave *et al*. 2007) has led to a growing emphasis to ethnobotanical studies of different local communities. Traditional knowledge on EWFTSs and the extent of their use varies among different groups and individuals of the community (Mengistu & Hager 2008, 2010, Pfeiffer & Butz 2005).

Ethnobotanical information on cultural, socio-economic, and nutritional values of Ethiopian wild plants is essential to assist the country's effort towards increasing food security (Lulekal *et al*. 2011, Teketay *et al*. 2010). Such information helps Ethiopia to better utilize its diverse fauna and flora, exploit their potential in sustaining food security and creating a healthy environment. However, the few earlier studies conducted in Ethiopia were focused on investigating medicinal plants (Balemie & Kebebew 2006), which also holds true for Arsi Zone. Of the total 494 Ethiopian districts, only 5% have been explored for their ethnobotanical information of edible wild plants (Lulekal *et al*. 2011). These limited studies addressed edible wild fruits together with other indigenous edible plants, and independent comprehensive studies are scarce. Nevertheless, site-specific identification and evaluation of people's preferences, analyzing EWFTSs' potential for domestication, and assessing EWFTSs' contribution to product diversification are the primary tasks required for future conservation, expansion, and promotion of EWFTSs (Asfaw & Tadesse 2001). In this work, we have tested the hypothesis that salient EWFTSs are different across different sites of Arsi Zone. We have also tested the hypothesis that peoples' knowledge varies with demographic factors, such as site, gender, and age.

The objectives of this study were to: (i) identify salient EWFTSs; (ii) investigate the relationships of socio-eco-

Table 1. Altitudinal ranges and average rainfall of the selected **woredas** and **kebeles** for the study in central Ethiopia. PA = Peasant Association. Source: Agriculture district offices.

Woreda (District)	Kebele/PA	Altitude (m)	Average rainfall (mm)
Tiyo	Konicha and Dosha	1500–4105	900–1100
Sire	Borara and Gassela Kara	1500–2500	900–1000
Guna	Reiarba and Guna Genete	1500–3300	700–1300

nomic variables with indigenous knowledge, management, and utilization of EWFTSs; and (iii) evaluate the prospects and sustainable utilization of EWFTSs in Arsi Zone, Ethiopia.

Materials and Methods

Study area

The study was conducted in Guna, Tiyo, and Sire districts (Table 1) of Arsi Zone in Oromia National Regional State, central Ethiopia (Figure 1) during 2008–2010. Geographically, Arsi Zone lies between 6°45'–8°58'N and 38°32'–40°50'E. The mean annual temperature of the zone ranges between 20–25°C in the lowlands and 10–15°C in the central highlands (data from Arsi Zone Agricultural Office). The zone is characterized by diverse tribal groups with distinct cultural heritages. Moreover, the area is composed of a wide range of landscapes with high plateaus, mountainous relief hills encompassing high mountain peaks—such as Mountains Kaka, Beda, Chilalo, Enkolo, and Gugu with altitudes of 4245, 4170, 4005, 3850, and 3625 masl, respectively—and topographies harboring diverse flora and fauna. The landscape is composed of both undulating and flat terrain, and the zone is characterized by a mixed cropping system in which wheat is the major crop.

Sampling and formal survey

The study involved both purposive and random-and-purposive sampling procedures. The studied districts (hereafter referred to as **woreda**(s) = local administrative units), were purposively selected (Martin 1995) based on a prior discussion with experts of the Arsi Zone Agriculture Office. The selection criteria were proximity to natural forest, agroclimatic conditions, and proximity to towns, which were set in accordance with the study objectives. Similar discussion was held with **woreda** office experts to select the six studied **kebeles** (Peasant Associations = PAs, the lowest administrative unit in Ethiopia) (Table 1). A stratified random sampling technique was employed to select 90 households. Thirty respondents were selected from each of the three **woredas.** The 30 respondents were randomly picked from a separate list of names produced for women,

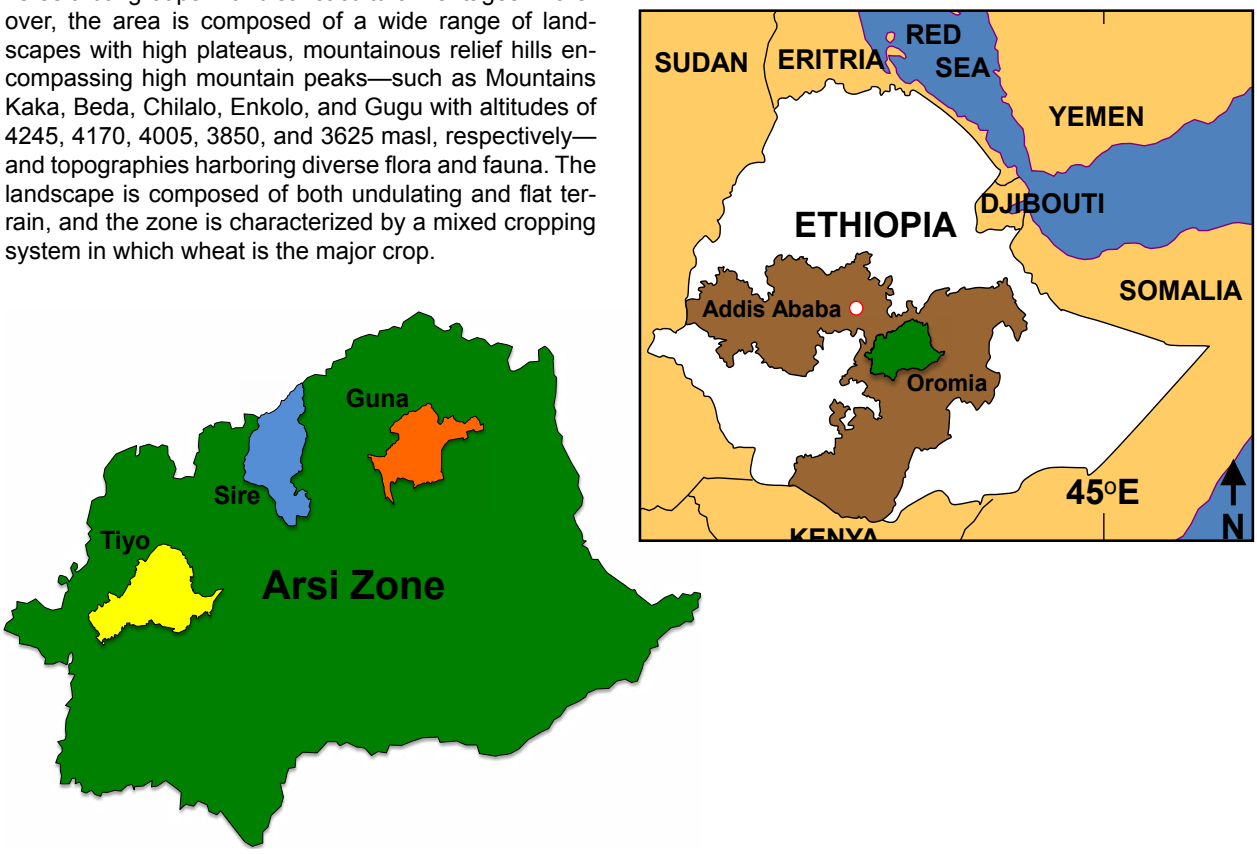

Figure 1. Study **woredas** (Guna, Sire, Tiyo) in Arsi Zone, Oromia National Regional State, central Ethiopia.

http://dx.doi.org/10.17348/era.14.0.183-197

men, and children and young groups in each PA to ensure all groups were adequately represented. Local criteria were adopted to differentiate among wealth classes of the respondents.

A formal survey composed of structured and semi-structured interviews was performed with the selected individuals. In this study, **kebeles** that represent higher altitudes were selected from Guna and Tiyo **woredas** while **kebeles** in the medium and lower altitudinal range were considered from Sire **Woreda.** Guna **Woreda** is far from the zonal town (Assela) but adjacent to the Arbagugu Forest. On the other hand, Tiyo is very close to Assela and adjacent to the Chilalo-Galema Forest. Sire is intermediate from the zonal town and adjacent or encompasses woodlands of Rift Valley. Such arrangements were made to ensure that the study represents major landscapes of the zone as well as investigate impacts of proximity to the town.

Ethnobotanical data

A free-listing method was applied to assess salient EWFTSs of the area (Alexiades 1996). Free-listing in ethnobotany is based on the notion that individuals who know more about a subject list more terms than do people who know less (Quinlan 2005). The length of list of species reveals the extent of the knowledge of the respondents while the frequency of a species list implies a cultural consensus or common knowledge (Quinlan 2005). Respondents were asked to mention by local name edible wild fruit-bearing trees and shrubs they know in their area. Group interviews were also carried out in each of the selected **woredas** with elderly people and key informants. Two to three key informant groups each with three to five informants were consulted in each **woreda**. The key informants were selected in consultation with **kebele** development agents considering their knowledge on the flora of the surroundings. Consultation with the key informant groups were conducted and guided by a pre-set checklist. Guided field walks were also performed with some of the key informants. Focus group discussions were focused on the salient EWFTSs and their values as compared with commercially available fruits. Salient EWFTSs were identified based on the proportion of respondents that mentioned each EWFTS. Additional information was gathered from markets, **woreda** professionals, and administrators.

Identification of EWFTSs

Specimens of EWFTSs listed by local name were collected during guided field walks and identified with the help of published floras and other references. Plant specimens were sent to the National Herbarium (ETH), Addis Ababa University, for identification. After identification was completed the specimens were deposited in the National Herbarium.

Data analyses

Both quantitative and qualitative analyses that included descriptions and associations among key variables were performed. Chi-square tests were performed to detect associations among different test variables. Salient EWFTSs were determined from the frequency of respondents mentioning each species. Data analyses were carried out using SPSS, Version 13.

Results

Demographic and socioeconomic characteristics of respondents

Of the 90 selected respondents, 28% were 14–18 years old, 34% were 19–40 years old, and the remaining respondents were above 40 years old. Respondents were also from different educational backgrounds, 34% being illiterate and 30% and 36% of them attaining grades from 1–6 and 7–12, respectively. Forty-four percent of them were females. Respondents represent two major religious groups. Forty-four percent of them were Muslims while 56% were Christians. Only 4% of the interviewed households were from “rich” category, hindering comparative analysis among households with different wealth status. The middle income and the poor respondents accounted for 71% and 25%, respectively. All of the respondents had inhabited the area at least for 10 years.

Ethnobotany of EWFTSs

A total of 30 EWFTSs belonging to 20 families were recorded in this study using a free-listing technique (Table 2). Two of the 30 species are used for medicinal purposes. The Rosaceae and Primulaceae were the most represented families, having four and three species, respectively. *Ficus sycomorus* L., *Rubus steudneri* Schweinf., *Rosa abyssinica* R.Br., *Dovyalis abyssinica* (A.Rich) Warb., and *Carissa spinarum* L. were the top five common EWFTSs of Arsi Zone. For Guna, *R. steudneri* (90%), *F. sycomorus* (80%), *R. abyssinica* (70%), *C. spinarum* (63%), and *Rytigynia neglecta* (Hiern) Robyns (47%) were the top five salient EWFTSs. Similarly, for Sire **Woreda,** *R. abyssinica* (47%), *C. spinarum* (47%), *Dovyalis verrucosa* (Hochst.) Lign. & Bey (43%), *Ximenia americana* L. (43%), and *D. abyssinica* (37%) were the most salient species. In Tiyo **Woreda,** *R. steudneri* (90%), *F. sycomorus* (83%), *D. abyssinica* (70%), *R. abyssinica* (53%), and *Garcinia livingstonei* T.Anderson (17 %) were the top five common EWFTSs.

Further analysis of the identified salient species was carried out to compare choices across groups of age, gender, and area of respondents. The result revealed that the salient species are representative of different gender and age groups of the population with an exception of slight

http://dx.doi.org/10.17348/era.14.0.183-197

Table 2. Relative importance of edible wild fruit-bearing tree and shrub species in three study **woredas** (Guna, Sire, Tiyo) of Arsi Zone, central Ethiopia. Seeds are dried, crushed, and then consumed against parasites. *Consumed with seeds of *Hagenia abyssinica* J.F.Gmel.

Respondents (%)				Species	Local names (Oromifa/ Amharic)	Consumption method
Total N=89	Guna N=30	Sivo N=30	Tiyo N=29			
63	80	27	83	*Ficus sycomorus* L. [Moraceae]	**Harbu, oda, shola**	Raw fruit
61	90	3	90	*Rubus steudneri* Schweinf. [Rosaceae]	**Enjori, hayena**	Raw fruit
57	70	47	53	*Rosa abyssinica* R.Br. [Rosaceae]	**Kega, gora**	Raw fruit
50	43	43	70	*Dovyalis abyssinica* (A.Rich.) Warb. [Salicaceae]	**Koshim**	Raw fruit
38	63	47	3	*Carissa spinarum* L. [Apocynaceae]	**Agam, agamisa**	Raw fruit
17	7			*Dovyalis verrucosa* (Hochst.) Lign. & Bey [Salicaceae]	**Fatafullasu**	Raw fruit
16	47			*Rytigynia neglecta* (Hiern) Robyns [Rubiaceae]	**Metagure**	Raw fruit
14				*Ximenia americana* L. [Olacaceae]	**Hudha**	Raw fruit
12		37		*Opuntia ficus-indica* (L.) Mill. [Cactaceae]	**Kulkual, bushuki**	Raw fruit
11	33			*Allophylus abyssinicus* (Hochst.) Radlk. [Sapindaceae]	**Irekemu**	Raw seeds
10	30			*Toddalia asiatica* (L.) Lam. [Rutaceae]	**Arbagube**	Raw fruit
9		27		*Acokanthera schimperi* (A.DC.) Schweinf. [Apocynaceae]	**Kerero**	Raw fruit
9		27		*Balanites aegyptiacus* (L.) Delile [Zygophyllaceae]	**Bedeno**	Raw fruit
9		27		*Cordia africana* Lam. [Boraginaceae]	**Wanza**	Raw fruit
9		27		*Ziziphus mucronata* Willd. [Rhamnaceae]	**Qurqura**	Raw fruit
7	20			*Embelia schimperi* Vatke [Primulaceae]	**Hanku, enkoko**	Seeds*
7		20		*Rhus tenuinervis* Engl. [Anacardiaceae]	**Kimosh**	Raw fruit
6			17	*Garcinia livingstonei* T.Anderson [Clusiaceae]	**Tulla**	Raw fruit
6			17	*Maesa lanceolata* Forssk. [Primulaceae]	**Abayi**	Raw fruit
6	17			*Physalis lagascae* Roem. & Schult. [Solanaceae]	**Awet**	Raw fruit
6	17			*Afrocarpus falcatus* (Thunb.) C.N.Page [Podocarpaceae]	**Birbirsa, zigba**	Oil from seeds
4	3	10		*Mimusops kummel* Bruce ex A.DC. [Sapotaceae]	**Olati**	Raw fruit
4		13		*Ficus ovata* Vahl [Moraceae]	**Warka fere**	Raw fruit
4		13		*Grewia trichocarpa* Hochst. ex A.Rich. [Malvaceae]	**Alenkuato**	Raw fruit
3		10		*Grewia mollis* Juss. [Malvaceae]	**Harroresssa**	Raw fruit
3			10	*Rubus volkensii* Engl. [Rosaceae]	**Aquqotta**	Raw fruit
2	7			*Hagenia abyssinica* J.F.Gmel. [Rosaceae]	**Heto**	Seeds*
2			7	*Myrsine africana* L. [Primulaceae]	**Qacama**	Raw seeds
2	7			*Sideroxylon oxyacanthum* Baill. [Sapotaceae)]	**Furakassa**	Raw fruit
1		3		*Syzygium guineense* (Willd.) DC. [Myrtaceae]	**Bedessa**	Raw fruit

http://dx.doi.org/10.17348/era.14.0.183-197

variations observed on *F. sycomorus*. Of all interviewed respondents that mentioned *F. sycomorus*, 60% were males (Figure 2A). Of the total male respondents, 68% mentioned *F. sycomorus* while slightly fewer (59%) interviewed females mentioned this species (Figure 3A). Similarly, about 48% mentioning *F. sycomorus* were above 40 years (Figure 2B). Likewise, of the total respondents with age of above 40 years, about 80% mentioned this species, suggesting that it is widely known by elderly people (Figure 3B). Hence, *F. sycomorus* is an important edible

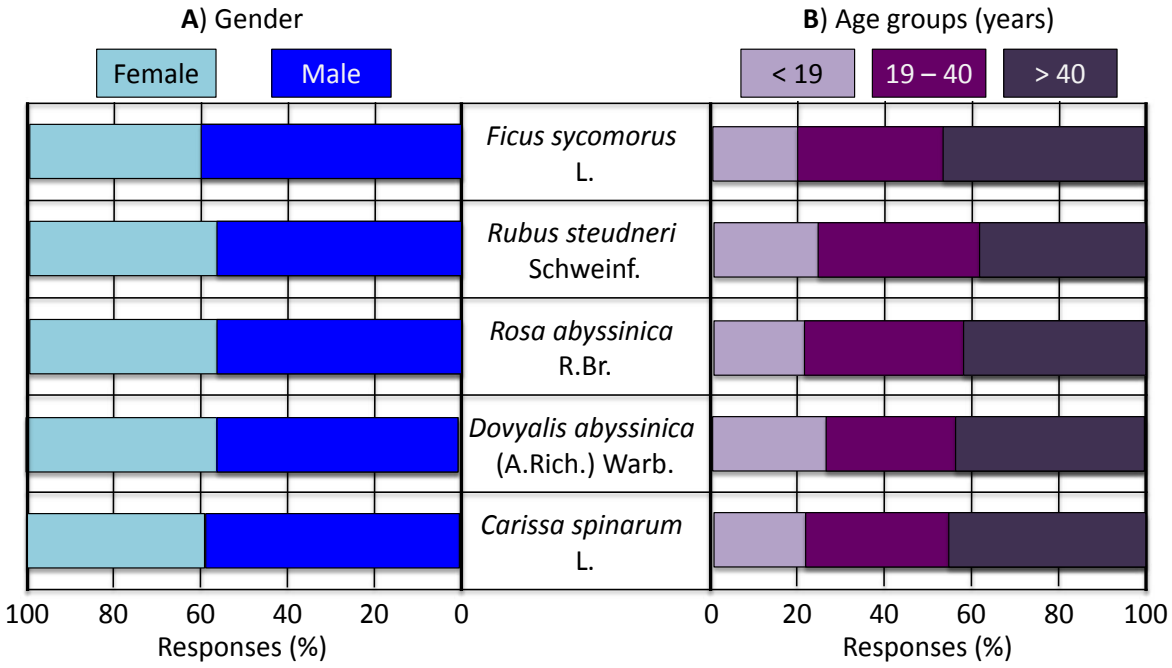

Figure 2. Distribution of the responses about edible wild fruit trees and shrubs (EWFTSs) of different social categories in Arsi zone, central Ethiopia: (**A**) gender and (**B**) age group with respect to their familiarity to five priority EWFTSs.

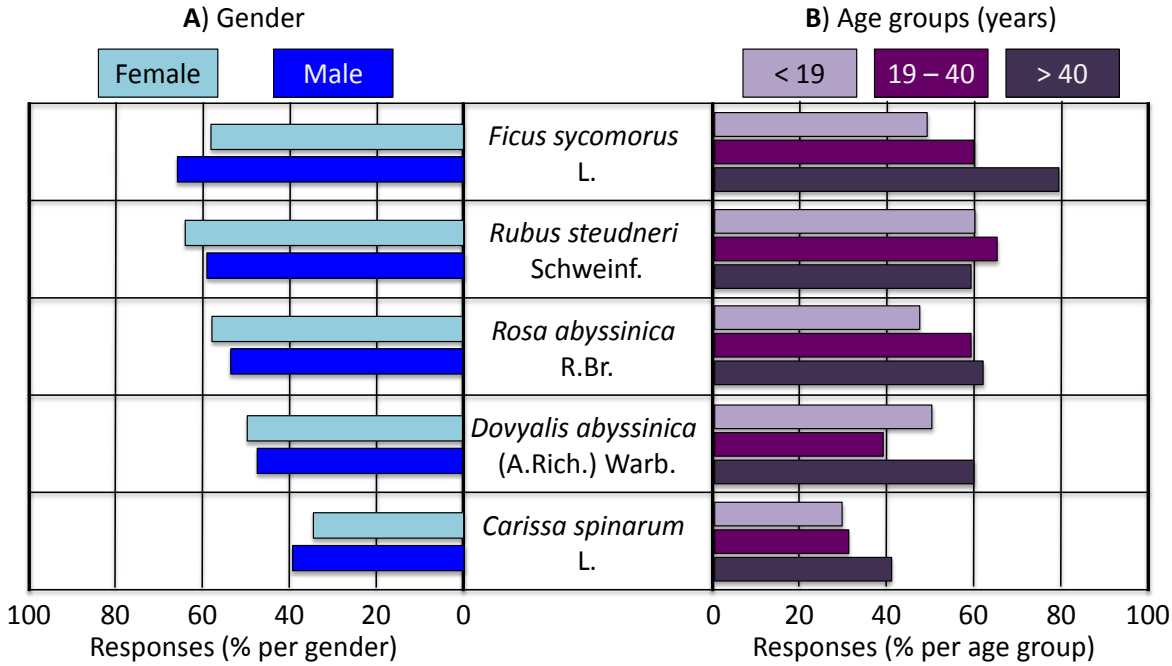

Figure 3. Proportion of respondents within each (A) gender and (B) age group that mentioned five edible wild fruit trees and shrubs (EWFTSs) in Arsi Zone, central Ethiopia.

wild fruit tree, which is particularly known by elders and males of Arsi Zone.

Correlation analysis of list strength with different social and economic categories showed that list strength is significantly ($P < 0.05$) correlated with gender, age, and area of respondents. Males knew more diverse EWFTSs than females (Figure 4A), implying males are more familiar with EWFTSs. Likewise, comparison of knowledge among the studied **woredas** revealed that a large proportion of respondents from Guna know more EWFTSs than respondents from Tiyo and Sire (Figure 4B). This may be due to the fact that Guna **Woreda** is among the **woredas** that adjoin Arbagugu Forest, which is composed of remnant indigenous species, including salient EWFTSs.

The list strength was used as a proxy to compare the level of knowledge among different social categories. The results showed that as the list strength increases, the proportion of respondents from the older age group increases (Figure 4C), suggesting the importance of age in the ethnobotanical knowledge of the community.

Socioeconomic significance of EWFTSs

All of the respondents are not only familiar with but also consume EWFTSs. While 76% of them consume when they are available, 18% consume EWFTSs at times of food shortage. About 67% of the households enjoy EWFTSs as supplementary food while 19% substitute lunch with EWFTSs during their peak fruiting periods. The remaining witnessed that EWFTSs substitute breakfast and dinner.

This study compared the choice of respondents between cultivated commercial fruits (CCFs) and EWFTSs. About 53% of the respondents preferred CCFs, 42% preferred EWFTSs, and the remaining responded that they are sim-

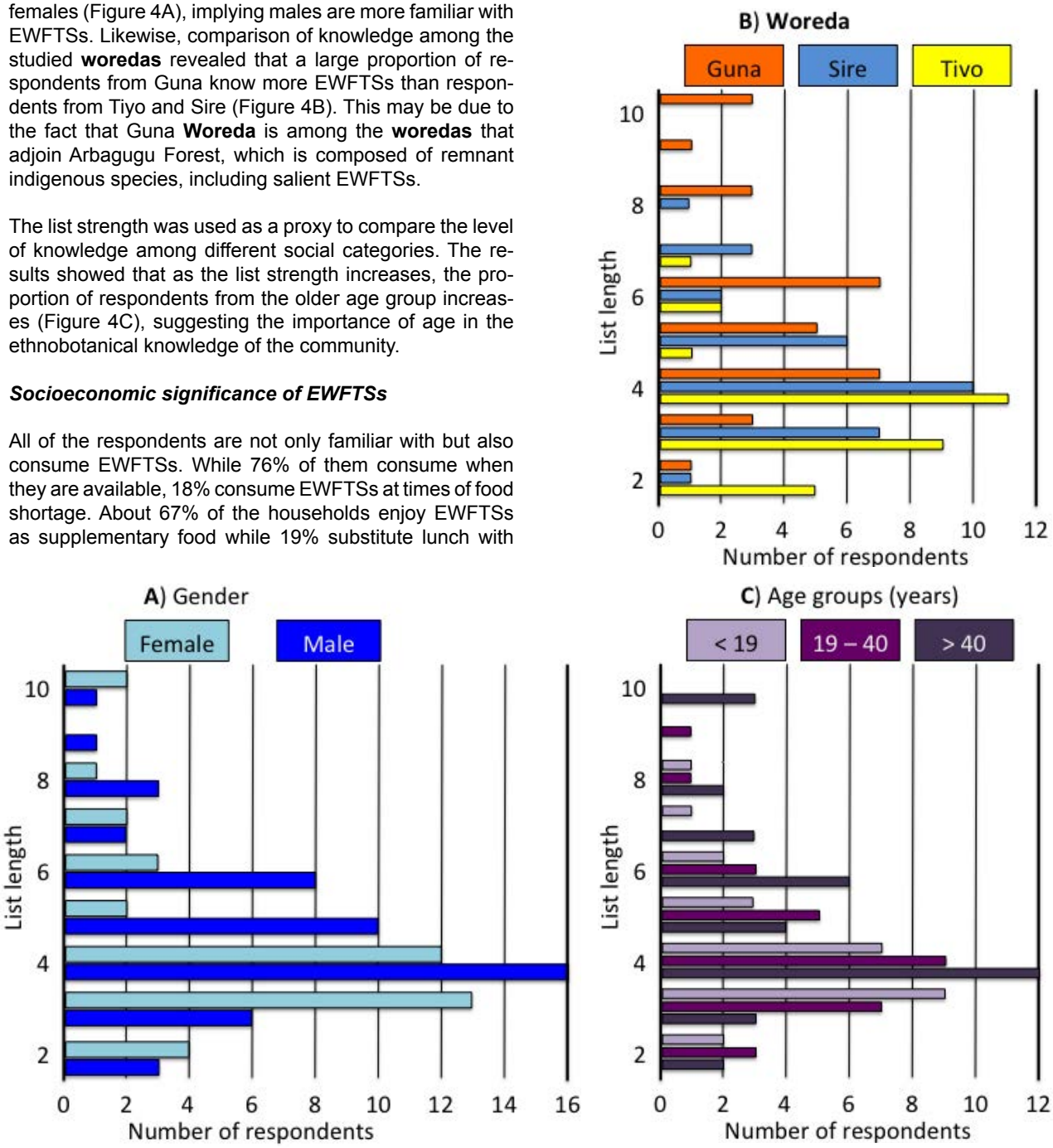

Figure 4. Edible wild fruit and shrub species listed by respondents from different (A) gender, (B) **woredas,** and (C) age groups in Arsi Zone, central Ethiopia.

http://dx.doi.org/10.17348/era.14.0.183-197

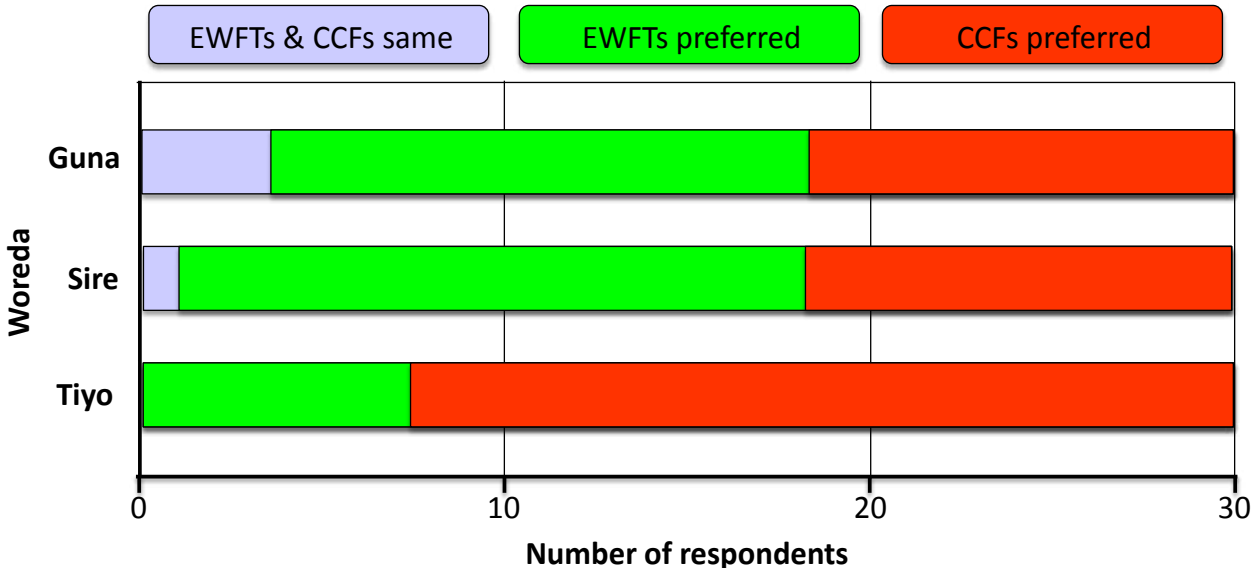

Figure 5. Preference for edible wild fruit and shrub species (EWFTs), or exotic commercially cultivated fruit (CCF), or both in study **woredas** (Guna, Sire, Tiyo), Arsi Zone, central Ethiopia.

ilar. There are reasons behind the choices of both fruit types. Respondents reported choosing EWFTSs because of their special or sweet taste, lack of easy access to CCFs, difficulty getting fresh CCFs from local markets, free access to EWFTSs, lack of options during times of food deficiency, developed tradition of consuming EWFTSs, biannual yields of EWFTSs, digestibility of EWFTSs, and the additional values (ornamental, refreshing, and medicinal) EWFTSs provide. Likewise, reasons for choosing CCFs included: better market and food value, good taste and better hunger satisfaction, juicy and comfortable to consume, assumed to represent balanced diet and medicinal value, and because they are easily accessible (can be purchased). The choice between CCFs and EWFTSs was strongly associated with location (X^2 = 11.599, df = 4, P < 0.05). A large proportion of respondents from Tiyo **Woreda** preferred CCFs over EWFTSs (Figure 5), perhaps due to their closeness to Assela and easy access to CCFs. Conversely, a larger proportion of respondents from Sire and Guna **woredas** preferred EWFTSs.

Our findings showed that only 15% of all respondents sell EWFTSs. According to respondents, sales of EWFTSs are not common because of: (1) lack of experience, (2) low return from EWFTSs, (3) limited availability of EWFTSs, (4) lack of recognition of market values of EWFTSs and buyers at the local market, (5) easy accessibility of EWFTSs, (6) the assumption that selling of EWFTSs is considered as a sign of inferiority,(7) the practice of using EWFTSs more as a food supplement than a tradable commodity, and (8) inconveniences in relation to harvesting.

The total annual income contribution of selling EWFTSs was assessed regardless of fruit type and harvest size. Out of respondents that sell EWFTSs, about 54% earn less than 50 Ethiopian Birr (ETB) per year (1 USD = 19 ETB at the time of this research work). About 31% earn between 51 and 100 ETB per year. The remaining respondents earn more than 100 but not more than 500 ETB per year.

Though the total size of the population involved in EWFTSs trading is less significant, the result provides an indication that women and children are responsible in fruit collection in 77% of the households that sell EWFTSs. The attitude of respondents regarding commercialization and domestication of EWFTSs was significantly associated with the **woreda** of respondents (X^2 = 7.01, df = 2, P < 0.05). A relatively larger proportion of respondents from Tiyo favors commercialization and domestication of EWFTSs (Figure 6A).

We have also attempted to compare the level of trading of EWFTSs among the studied **woredas**. Sales of EWFTSs significantly varied with **woreda** of respondents (X^2 = 7.013, df = 2, P < 0.05). Of the respondents that sell EWFTSs, the majority were from Tiyo (Figure 6B).

Prospects and sustainability of EWFTSs

Almost all of the households collect EWFTSs from the nearby remnant natural forest or woodland, implying that the community is heavily dependent on the relics of the natural forest and is subsequently impacting the sustainability of the resource base. Based on the knowledge of the local people, we analyzed accessibility patterns of EWFTSs over the last ten years. According to 50% of the respondents, collection of EWFTSs takes more than one hour over the last 5 years. Over the last 5 to 10 years, 44% of the respondents indicated that it took more than

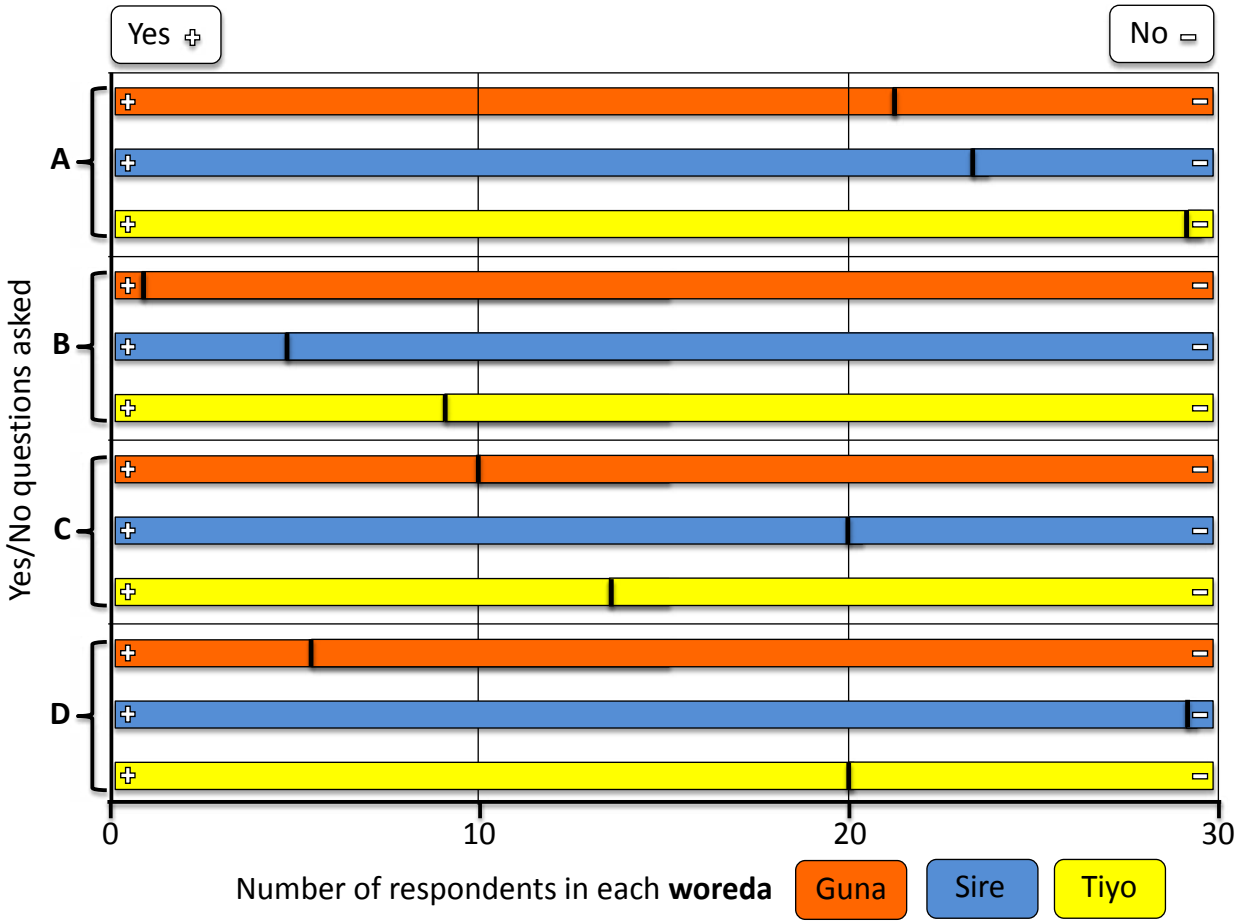

Figure 6. The association between **woreda** (Guna, Sire, Tiyo) of respondents in Arsi Zone, central Ethiopia, and their (**A**) response on whether commercialization of EWFTSs is acceptable activity or not; (**B**) response on whether they sell EWFTSs or not; (**C**) association between woreda of respondents and their response on whether they plant EWFTSs or not; and (**D**) association between woreda of respondents and their response on whether they know lost EWFTSs or not.

one hour. Forty-five percent of them agreed that collection of EWFTSs before 10 years ago took less than 15 minutes.

With regard to the practice of cultivation, about 54% tried to plant EWFTSs while the others have no planting experiences at all. Respondents that have never planted EWFTSs indicated the following as the main reasons that discourage them from cultivating EWFTSs: (1) lack of experience and culture, (2) less understanding of the value of EWFTSs, (3) fear of competition for land resource, (4) fear of exposure of their livestock to predators harbored by the bushes that can be formed by EWFTSs, (5) free access to EWFTSs, (6) thorniness of some EWFTSs, (7) recognizing EWFTSs as supplementary food, (8) lack of seedlings, (9) less attractive economical return from EWFTSs, and (10) lack of planting material as the forest with EWFTSs is already gone.

Of those respondents who do not cultivate EWFTSs, a large proportion are in the category that prefers CCFs over EWFTSs, showing significant association between the two variables (X^2 = 6.73, df = 2, P < 0.05) (Figure 7). Comparison of the practice of cultivating EWFTSs across the studied **woredas** showed significant association (X^2 = 8.49, df = 2, P < 0.05). Compared to the proportion of respondents from Sire and Tiyo, a small proportion of respondents from Guna cultivates EWFTSs (Figure 6C).

The results showed that about 87% of the respondents are willing to cultivate EWFTSs if appropriate technical and material support are provided. *Ficus sycomorus*, *R. steudneri*, and *D. abyssinica* are the most preferred species by the respondents for domestication programs. Respondents were asked why they are interested in planting EWFTSs and where they would like to cultivate them and what additional benefits they expect from EWFTSs. Their responses showed that they are interested in planting

http://dx.doi.org/10.17348/era.14.0.183-197

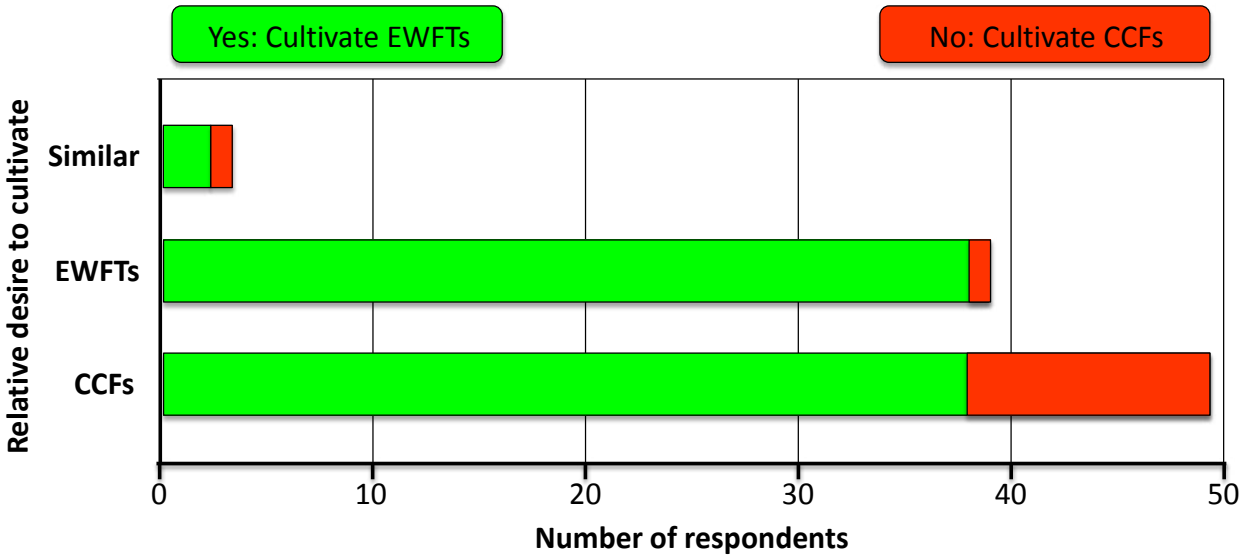

Figure 7. Relationship between respondents who do not cultivate traditional edible wild fruit and shrub species (EWFTs) and their desire to cultivate exotic commercially cultivated fruit (CCF) in **woredas** (Guna, Sire, Tiyo), Arsi Zone, central Ethiopia.

EWFTSs to benefit from their food, medicinal, and market values; cope with catastrophes of famine; and protect EWFTSs of the area from local extinction. They need to plant them at homesteads, as live fences, around farmland, and around river banks. Additional benefits that respondents wish to gain from planting EWFTSs include improved soil fertility as well as minimized soil erosion, feed for goats and cattle, ornamental value, fuel wood, bee forage, shade, construction poles, improved microclimate, and timber.

About 58% of the respondents mentioned EWFTSs that were once known to exist in the area but severely threatened to the level of local extermination. The recognition of threatened species showed strongly significant variation among **woredas** ($X^2 = 39.75$, df = 2, $P < 0.05$). A large proportion of respondents from Guna **Woreda** recognized no threatened species compared with respondents from Sire and Tiyo **woredas.** Several respondents from Sire and Tiyo **woredas** reported one or more threatened EWFTSs (Figure 6D). Of the three studied **woredas,** more respondents from Sire recognized lost species than the other two **woredas.** Perhaps relatively stronger cultivation practices of Sire respondents (Figure 6C) could be associated with better recognition of threatened EWFTSs of their area.

Threats to EWFTSs were identified by the key informants. Lack of understanding that the resources deplete with time and with increasing population pressure was the major threat. Over-emphasis on crop production, which targets increasing cultivable land area, absence of a clear communal land tenure system, and a lack of an empowered institution to put laws and regulations into practice are also among the identified threats.

Discussion

The number of species identified in the present study is comparable with the number reported from Borena pastoralists (27) by Gemedo-Dalle *et al*. (2005) in southern Ethiopia, but it is slightly lower than the number of edible wild fruit tree species (46) reported from northwest part of the country by Mengistu & Hager (2008) and much less than the 62 species of edible wild fruit trees identified in farmlands and woodlands of Kenya (Muok *et al*. 2000). Teketay and Eshete (2004) reported 182 total EWFTSs distributed over different parts of Ethiopia. Low species number identified in this study may reflect a pronounced anthropogenic pressure in the resource base. In agreement with the present findings, Rosaceae has also been reported to represent one of the major edible wild plant families in Ethiopia and elsewhere in the world (Asfaw & Tadesse 2001, Pardo-De-Santayana *et al*. 2005, Redzic 2006, Teketay *et al*. 2010). Moreover, the list of species in the present study is in agreement with the list of common edible wild plants in the country published in a book (Teketay *et al*. 2010) and a comprehensive review by Lulekal *et al*. (2011).

In this study, it was noted that the top five salient EWFTSs and the proportion of respondents that mentioned these species vary among the studied **woredas.** Site-to-site variations in salient EWFTSs are associated with differences in indigenous knowledge, economic conditions, and climate differences (Pauline & Linus 2004). *Rubus steudneri*, *F. sycomorus*, and *R. abyssinica* are key species for the highlands as they were commonly mentioned in the list of top five EWFTSs of the two **woredas** that represent the higher altitudes of Arsi Zone (Tables 3, 5).

Our observation of differing choices among the **woredas** emphasizes the fact that planning of development interventions in EWFTSs should account for the small-scale economic, biophysical, and cultural variations. Mengistu and Hager (2008) showed the overriding impact of sociocultural factors on species preference of communities.

Furthermore, salient species varied among age groups and gender. Knowledge variation as a function of age could be associated with the degree of familiarity of people to fruits of certain species. For instance, Wondimu *et al*. (2006) reported that the recently introduced *Prosopis juliflora* (Sw.) DC. was liked by children while adults lacked interest. Such variations may result from confounding variables, such as non-fruit utilities which are differently perceived by particular groups of a community (Mengistu & Hagar 2008). However, there were only slight variations among gender and age groups for the remaining four salient EWFTSs identified in the present study. More or less even distribution of the age and gender of the respondents that mentioned the four salient species (except *F. sycomorus*) implies that these EWFTSs can be promoted regardless of age and gender of households.

This study substantiated that knowledge of EWFTSs is strongly influenced by demographic variables, such as gender, age, and site. Males knew more EWFTSs than females (Figure 4A), implying males are more familiar with EWFTSs because of their day-to-day activities, mainly carried out in the field. Efforts to raise the awareness of EWFTSs by females should be emphasized, and their priorities should be addressed. Gender-based domestication programs can be used to enhance females' use of EWFTSs and optimize their benefit from food and nutritional values of EWFTSs. Young males of Ethiopian rural areas have been reported to consume more edible wild fruits (Asfaw & Tadesse 2001). However, the present result showed youngsters know relatively less than elders. Less familiarity of the youngsters disagrees with previous assumptions that consider children and youngsters to be more familiar to EWFTSs than elders because of their frequent appearance in the field and experiences in different landscapes (Mengistu & Hager 2008, 2010, Setalaphruk & Price 2007). The contrasting findings may imply that the relationships of age-groups and knowledge on EWFTSs could be reversed depending on the status of the resource base. It is not surprising to note such an age group-knowledge relationship in areas where deforestation threatens vast cover of forest land that is not only making several useful species less accessible but also causing a significant threat of extinction. In such a condition, it is conceivable that youngsters would have less opportunity of recognizing different plant types. The vulnerability of traditional knowledge with the loss of vegetation has been well-appreciated in ethnobotanical studies (Addis *et al*. 2005, Balemie & Kebebew 2006, Teketay *et al*. 2010). The fact that traditional knowledge is more often transferred orally than through archived documents (Awas & Demissew 2009, Getahun 1974, Teketay & Eshete 2004) exacerbates the impact of vegetation loss on traditional knowledge of Ethiopia.

Proximity to forest resources may result in site-to-site knowledge variations. Of the three studied sites, it is apparent that the Guna forest would have a positive contribution to the observed familiarity of the community with EWFTSs. Similar variations among sites have also been reported by Mengistu and Hager (2008) in Amhara National Regional State in northwestern Ethiopia. The knowledge of the local people could serve as a proxy indicating the resource status of the area. Guna **Woreda,** therefore, can be considered as a source of propagation materials for EWFTSs in future promotion and domestication programs. The relatively rich ethnobotanical resource of the community in Guna further suggests that the **woreda** could potentially be recognized as a representative conservation site for Arsi Zone. The need of *in situ* and *ex situ* conservation of edible wild plants of the country has been greatly emphasized (Lulekal *et al*. 2011, Teketay *et al*. 2010, Teklehaimanot & Giday 2010). The observation that *R. steudneri* and *F. sycomorus* were less recognized by Sire **Woreda** implies that salient EWFTSs vary among areas because of differences in site characteristics that determine the vegetation type. This study was conducted in the lower altitudinal range of Sire **Woreda.**

The role of edible wild plants in bridging the gap in food and energy supply, particularly to resource-poor members of the community, is significant (Asfaw & Tadesse 2001, Addis *et al*. 2005, Teketay *et al*. 2010). The present results provide evidence on the remarkable contribution of EWFTSs for the livelihood of the community in Arsi Zone, consumed as regular and supplementary food. In agreement with our observation, consumption of wild plants as supplementary food and as ingredients of common meals, including in developed countries, has been reported (Bonet & Valles 2002, Neudeck *et al*. 2012). Among many other reasons, rural people consume EWFTSs for their acceptable taste, satisfying hunger during famine, moistening mouth in the absence of drinking water, and as chewing gum (Addis *et al*. 2005, Neudeck *et al*. 2012, Teketay *et al*. 2010). Earlier ethnobotanical studies indicated that consumption of wild plants is widespread in Ethiopia and used at a higher extent in food insecure areas (Addis *et al*. 2005, Asfaw & Tadesse 2001, Getahun 1974, Teketay *et al*. 2010) and during times of civil unrest (Asfaw & Tadesse 2001, Teketay *et al*. 2010). Thus, conservation and development of EWFTSs should be considered as an integral element of the farming system to avert food insecurity problems and improve the livelihoods of the rural community in Arsi Zone. Nevertheless, because EWFTSs are being consumed by a considerable proportion of the population, the nutritional and other chemical composition of the major EWFTSs should be carefully

http://dx.doi.org/10.17348/era.14.0.183-197

assessed. There are several reports that show EWFTSs may contain undesired qualities, such as anti-nutritional factors that interfere with absorption of nutrients (Kebede *et al*. 1995, Ogle & Grivetti 1985).

The choice between CCFs and wild edible fruits was site-specific. Proximity to town centers determines access to CCFs, which could account for the observed preference variations. Moreover, some people consider wild food to be old fashioned, unprofitable, time-consuming, or a sign of low social class and, therefore, prefer to cultivate or buy their food (Pardo-De-Santayana *et al*. 2005, Toledo *et al*. 2009). It is likely that more people from towns demonstrate such behavior than the rural people. Thus, their close proximity to Assela not only provides Tiyo **Woreda** respondents an easy access to CCFs but also influences their inherent preferences. Our results also provide an indication that access to CCFs may contribute to less interest towards planting of EWFTSs (Figure 6C). The result, however, signifies profound roles of EWFTSs, specifically to the rural community with limited physical and financial access to CCFs.

The income generated from sales of EWFTSs is marginal because of several social, economic, and cultural factors. This finding suggests that future promotion efforts towards enhancing the commercialization of EWFTSs should be designed with packages that comprise cultural and social suits targeted to address specific local conditions. Though the total size of the population involved in EWFTSs trading is less significant, the result provides an indication that women and children are responsible in fruit collection in 77% of the households that sell EWFTSs. This result substantiates the considerable opportunity gained by these family members to contribute to the overall household economy. It was noted that people from areas closer to the town center tend to sell edible wild fruits more than those from distant areas. It has to be mentioned that though towns were noted to improve access to CCFs, as discussed earlier, they also provide market outlets to edible wild fruits trading. However, it also has to be emphasized that successful promotion of edible wild fruits in such areas is highly dependent on their competitiveness with CCFs that share the same market. Hence, improving access to market and increasing the quality and quantity of EWFTSs production are issues to be carefully addressed to enhance the market value of EWFTSs and facilitate their domestication. Domestication and integrating promising EWFTSs into the existing land use systems in such a manner will eventually contribute to improved rural livelihoods (Asfaw & Tadesse 2001, Teketay *et al*. 2010).

The local people are a good source of information on the natural resource base of their areas. The accessibility patterns of EWFTSs indicated that access to EWFTSs from the natural forest has been continuously diminishing and provides evidence that the degradation process is well-perceived by the people. Substantiating the high rate of resource depletion, earlier studies have also reported that several edible wild fruits of the country were under severe threat (Asfaw & Tadesse 2001, Teketay & Eshete 2004, Teketay *et al*. 2010). Despite an ongoing depletion of the surrounding resources, planting EWFTSs is less common. Interestingly, some of the factors mentioned for not planting EWFTSs are similar to the reasons mentioned for preferring CCFs. Respondents are less willing to plant EWFTSs unless they are convinced of the comparable benefits accrued by cultivation and commercialization of EWFTSs. Thus, careful selection of valuable EWFTSs with full participation of the beneficiaries is an important task to enhance the contribution of EWFTSs. In this respect, future domestication and promotion programs of EWFTSs must address the factors that have constrained farmers' practices of planting EWFTSs. The result also shows that the availability of freely accessed edible wild fruits from the surrounding vegetation discourages the practice of planting EWFTSs. However, despite their perceived availability, different discussions conducted with key informants in Guna indicated that important EWFTSs are under a huge pressure and are severely threatened.

Important technical institutional, governance, and capacity-related issues that are mentioned to constrain EWFTSs planting should be considered for realizing successful future utilization and development interventions. Observations with respect to the views of the attitude of respondents towards cultivating EWFTSs suggest strong motivation and willingness of the community to participate in domestication and development interventions aimed at ensuring sustainable utilization of EWFTSs. An integrated effort of concerned stakeholders should address these constraining factors so that the remaining EWFTSs could be conserved and sustainably used in alleviating food insecurity, promoting dietary diversity, and controlling environmental degradation (Teketay *et al*. 2010). Conservation measures that combine domestication of potential EWFTSs into the existing production systems contributes towards diversification of food sources, ensuring food security and dietary diversity as well as maintaining biodiversity and environmental integrity (Asfaw & Tadesse 2001, Teketay *et al*. 2010).

Conclusions and Recommendations

Our ethnobotanical study identified 30 EWFTSs that belong to 20 families. *Ficus sycomorus*, *R. steudneri*, *R. abyssinica*, *D. abyssinica*, and *C. spinarum* are species identified as salient EWFTSs. However, the identified salient species varied among **woredas**, which may imply impacts of site-to-site variation in biophysical as well as vegetation resources. The age group and gender distribution of respondents in the choice of four of the five salient species is uniform, suggesting promotion of these EWFTSs could be held with all households. Indigenous knowledge varied among gender, age, and area of respondents. Elder

males appeared more familiar with EWFTSs. Likewise, respondents from areas adjoining natural forests are more familiar with EWFTSs. The observation that youngsters are less knowledgeable on EWFTSs could be associated with the rapid loss of the vegetation cover, which resulted in lesser access to these species.

Almost all of the respondents are familiar with and consume EWFTSs. The majority consume EWFTSs as supplementary food. Respondents have their own set of attributes to their favorite EWFTSs. Income generated from sales of EWFTSs is marginal though it provides an opportunity for children and women to contribute to the household economy. Lack of access to market is among the factors that constrained trading of EWFTSs. A considerable proportion of the community acknowledges EWFTSs, and more than half of the respondents prefer EWFTSs to CCFs, suggesting that efforts towards their integration into the current farming system are appealing. As people from areas closer to town centers enjoy access to CCFs, which shapes their inherent habits, priority intervention sites should be rural areas with less physical and financial access to CCFs.

Our findings revealed the ongoing resource depletion, which is well perceived by the community. In an attempt to protect losses, more than half of the respondents have tried to cultivate EWFTSs, a practice showing site-to-site variation. Yet about 87% of the respondents showed their willingness to cultivate EWFTSs if the necessary support is provided. *Ficus sycomorus*, *R. steudneri*, and *D. abyssinica* are their choices for cultivation. The study explored the great opportunity to promote EWFTSs in Arsi Zone and contribute to the country's efforts of ensuring food security and dietary diversity. Improving access to market and enhancing the quality and quantity of EWFTSs production are recommended for successful domestication programs. Propagation, silviculture, management, and prioritizing of the identified salient species should be topics of future research programs. Furthermore, research targeted to identify best provenances/cultivars of the salient EWFTSs are recommended.

Acknowledgments

We are indebted to Zewge Bahiru, Eshetu Lemma, and Tesfaye Solomon who were involved in the data collection process. We extend our acknowledgment to Getachew Legesse who commented on the questionnaires. The authors would like to thank Dr. Zemede Asfaw who read the first draft and provided valuable inputs that enormously enriched the manuscript. We would like to thank the Agriculture and Rural Development office staffs and development agents of the three **woredas** for their commitment and contribution in the data collection process. The cost of this study was covered by the Ethiopian Institute of Agricultural Research, which is gratefully acknowledged.

Literature Cited

Addis, G., K. Urga & D. Dikasso. 2005. Ethnobotanical study of edible wild plants in some selected districts of Ethiopia. *Human Ecology* 33(1):83–118. dx.doi.org/10.1007/s10745-005-1656-0

Alexiades, M.N. 1996. Collecting ethnobotanical data: An introduction to basic concepts and techniques. Pp. 53–94 in *Selected Guidelines for Ethnobotanical Research: A field manual.* Edited by M.N. Alexiades. The New York Botanical Garden, Bronx, New York, U.S.A.

Anonymous. 2002. *Forestry Research Strategy*. Ethiopian Agricultural Research Organization, Addis Ababa, Ethiopia.

Asfaw, Z. & M. Tadesse. 2001. Prospects for sustainable use and development of wild food plants in Ethiopia. *Economic Botany* 55(1):47–62. dx.doi.org/10.1007/BF02864545

Awas, T. & S. Demissew. 2009. Ethnobotanical study of medicinal plants in Kafficho people, southwestern Ethiopia. Pp. 711–726 in *Proceedings of the 16th International Conference of Ethiopian Studies*. Edited by E. Svein, A. Harald, T. Birhanu & B. Shiferaw. NTNU–Trykk Press, Trondheim, Norway.

Balemie, K. & F. Kebebew. 2006. Ethnobotanical study of wild edible plants in Derashe and Kucha Districts, South Ethiopia. *Journal of Ethnobiology and Ethnomedicine* 2(1):53–61. dx.doi.org/10.1186/1746-4269-2-53

Bell, J. 1995. The hidden harvest. *Seedling, The Quarterly Newsletter of Genetic Resources International.* 1995(October). www.grain.org/e/318

Bonet, M.A. & J. Valles. 2002. Use non-crop food vascular plants in Montseny biosphere reserve (Catalonia, Iberian Peninsula). *International Journal of Food Sciences and Nutrition* 53(3):225–248. dx.doi.org/10.1080/09637480220132841

FAO. 1989. *Forestry and Food Security*. FAO Forestry Paper No. 90. Food and Agricultural Organization of the United Nations, Rome, Italy.

FAO/WHO. 1988. *Requirements of Vitamin A, Iron, Folate and Vitamin B12*. Report of a Joint FAO/WHO Expert Consultation. World Health Organization and Food and Agricultural Organization of the United Nations, Rome, Italy.

Feyessa, D.H., J.T. Njoka, Z. Asfaw & M.M. Nyangito. 2011. Wild edible fruits of importance for human nutrition in semi-arid parts of east Shewa Zone, Ethiopia: Associated indigenous knowledge and implications to food

security. *Pakistan Journal of Nutrition* 10:40–50. *dx.doi.org/10.3923/pjn.2011.40.50*

Gemedo-Dalle, T., M. Brigitte & I. Johannes. 2005. Plant biodiversity and ethnobotany of Borana pastoralists in southern Oromia, Ethiopia. *Economic Botany* 59:43–65. dx.doi.org/10.1663/0013-0001(2005)059[0043:PBAEOB]2.0.CO;2

Getahun, A. 1974. The role of wild plants in the native diet in Ethiopia. *Agroforestry Ecosystems* 1:45–56. dx.doi.org/10.1016/0304-3746(74)90006-7

Guijt, I., F. Hinchcliffe & M. Melnek. 1995. *The Hidden Harvest: The value of wild resources in agricultural systems - A summary*. International Institute of Environment and Development, London, U.K.

Guinand, Y. & D. Lemessa. 2001. *Ethiopia: Famine food guide*. United Nations Development Programme Emergencies Unit for Ethiopia. Addis Ababa, Ethiopia. www.africa.upenn.edu/faminefood/category1.htm Accessed 27 June 2004.

Kebede, B., K. Urga & A. Nigatu. 1995. Effect of processing methods on the trypsin inhibitor, tannins, phytic acid and ODAP contents of grass pea seeds. *Ethiopian Journal of Health Development* 9(1):97–103.

Lulekal, E., Z. Asfaw, E. Kelbessa & P.V. Damme. 2011. Wild edible plants in Ethiopia: A review on their potential to combat food insecurity. *Afrika Focus* 24(2):71–121.

Mkonda, A., S. Lungu, J.A. Maghembe & P.L. Mafongoya. 2003. Fruit and seed germination characteristics of *Strychnos cocculoide* an indigenous fruit tree from natural population in Zambia. *Agroforestry Systems* 58(1):25–31. dx.doi.org/10.1023/A:1025454231002

Martin, G.J. 1995. *Ethnobotany: A methods manual*. Chapman and Hall, London, U.K. dx.doi.org/10.1007/978-1-4615-2496-0

Maundu, P., G. Ngugi. G., C. Kabuye. 1999. *Traditional Food Plants of Kenya*. National Museums of Kenya, Nairobi, Kenya.

Mengistu, F. & H. Hager. 2008. Wild edible fruit species cultural domain, informant species competence and preference in three districts of Amhara Region, Ethiopia. *Ethnobotany Research and Applications* 6:487–502.

Mengistu, F. & H. Hager. 2010. Integration of indigenous wild woody perennial edible fruit-bearing species in the agricultural landscapes of Amhara region, Ethiopia. *Agroforestry Systems* 78(1):79–95. dx.doi.org/10.1007/s10457-009-9239-5

Mithofer, D. & H. Waibel. 2003. Income and labour productivity of collection and use of indigenous fruit tree products in Zimbabwe. *Agroforestry Systems* 59(3):295–305. dx.doi.org/10.1023/B:AGFO.0000005230.09714.b4

Muok, B.K., B. Owuor, I. Dawson & J. Were. 2000. The potential of indigenous fruit trees: Result of a survey in Kitui District, Kenya. *Agroforestry Today* 12(1):13–15.

Neudeck, L., L. Avelino, P. Bareetseng, B.N. Ngwenya, D. Teketay & M.R. Motsholapheko. 2012. The contribution of edible wild plants to food security, dietary diversity and income of households in Shorobe Village, northern Botswana. *Ethnobotanical Research and Applications* 10:449–462. http://journals.sfu.ca/era/index.php/era/article/view/752

Ogle, B.M. & L.E. Grivetti. 1985. Legacy of the chameleon: Edible wild plants in the Kingdom of Swaziland, Southern Africa. A cultural, ecological, nutritional study, part IV - Nutritional analysis and conclusions. *Ecology of Food and Nutrition* 17(1):41–64. dx.doi.org/10.1080/03670244.1985.9990881

Ohiokpehai, O. 2003. Promoting the nutritional goodness of traditional food products. *Pakistan Journal of Nutrition* 2(4):267–270. dx.doi.org/10.3923/pjn.2003.267.270

Oksanen, T., P. Brita & T. Tomi, eds. 2003. *Forest in Poverty Reduction Strategies: Capturing the potential.* European Forest Institute Proceeding No 47. European Forest Institute, Joensuu, Finland.

Pardo-De-Santayana, M., J. Tardío & R. Morales. 2005. The gathering and consumption of wild edible plants in the Campoo (Cantabria, pain). *International Journal of Food Sciences and Nutrition* 56(7):529–542. dx.doi.org/10.1080/09637480500490731

Pauline, M. & W. Linus. 2004. Status of indigenous fruits in Kenya. Pp. 36–62 in *Review and Appraisal on the Status of Indigenous Fruits in Eastern Africa*. Edited by B. Chikamai, O. Eyog-Matig & M. Mbogga. International Plant Genetic Resources International (IPGRI) - Sub-Saharan Africa Forest Genetic Resources (SAFORGEN) in the framework of Association of Forestry Research Institutions in Eastern Africa (AFREA/FORNESSA), Cotonou, Benin, and Nairobi, Kenya.

Pfeiffer, J.M. & R.J. Butz. 2005. Assessing cultural and ecological variation in ethnobiological research: The importance of gender. *Journal of Ethnobiology* 25(2):240–278. dx.doi.org/10.2993/0278-0771(2005)25[240:ACAEVI]2.0.CO;2

Quinlan, R. 2005. Considerations for collecting free lists in the field: Examples from ethnobotany. *Field Methods* 17(3):219–234. dx.doi.org/10.1177/1525822X05277460

Redzic, S. 2006. Wild edible plants and their traditional use in the human nutrition in Bosnia-Herzegovina. *Ecology of Food and Nutrition* 45(3):189–232. dx.doi.org/10.1080/03670240600648963

Setalaphruk, C. & L.L. Price. 2007. Children's traditional ecological knowledge of wild food resources: A case study in a rural village in Northeast Thailand. *Journal of Ethnobiology and Ethnomedicine* 3:33. dx.doi.org/10.1186/1746-4269-3-33

Stave, J., G. Oba & I. Nordal. 2007. Traditional ecological knowledge of a riverine forest in Turkana, Kenya: Implications for research and management. *Biodiversity and Conservation* 16(5):1471–1489. dx.doi.org/10.1007/s10531-006-9016-y

Styger, E., J.E.M. Rakotoarimana, R. Rabevohitra & E.C.M. Fernandes. 1999. Indigenous fruit trees of Madagascar: Potential components of Agroforestry systems to improve human nutrition and restore biological diversity. *Agroforestry Systems* 46(3):289–310. dx.doi.org/10.1023/A:1006295530509

Tadesse, W. & M. Mbogga, eds. 2004. Conservation of *Genetic Resources of Non-Timber Products in Ethiopia. Proceedings of the first national workshop on non-timer forest products in Ethiopia, 5–6 April 2004*. Forestry Research Center, Addis Ababa, Ethiopia.

Teketay, D. & A. Eshete. 2004. Status of indigenous fruits in Ethiopia. Pp. 3–35 in *Review and Appraisal on the Status of Indigenous Fruits in Eastern Africa*. Edited by B. Chikamai, O. Eyog-Matig & M. Mbogga. International Plant Genetic Resources International - Sub-Saharan Africa Forest Genetic Resources in the framework of Association of Forestry Research Institutions in Eastern Africa, Cotonou, Benin, and Nairobi, Kenya.

Teketay, D., F. Senbeta, M. Maclachlan, M. Bekele & P. Barklund. 2010. *Edible Wild Plants in Ethiopia*. Addis Ababa University Press, Addis Ababa, Ethiopia.

Teklehaymanot, T. & M. Giday. 2010. Ethnobotanical study of edible wild plants of Kara and Kwego semi-pastoralist people in Lower Omo River valley, Debub Omo Zone, SNNPR, Ethiopia. *Journal of Ethnobiology and Ethnomedicine* 6:23. dx.doi.org/10.1186/1746-4269-6-23

Toledo, B.A., L. Galetto & S. Colantonio. 2009. Ethnobotanical knowledge in rural communities of Cordoba (Argentina): The importance of cultural and biogeographical factors. *Journal of Ethnobiology and Ethnomedicine* 5:40. dx.doi.org/10.1186/1746-4269-5-40

van Dillen, J., A. de Francisco & W.C.G. Ovenrweg-Plandsoen. 1996. Long-term effect of vitamin A with vaccines. *Lancet* 347(9016):1705. dx.doi.org/10.1016/S0140-6736(96)91541-X

Wondimu, T., Z. Asfaw & E. Kelbessa. 2006. Ethnobotanical study of food plants around Dheeraa Town, Arsi, Ethiopia. *SINET: Ethiopian Journal of Science* 29(1):71–80.

http://dx.doi.org/10.17348/era.14.0.183-197