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Gender and Generational Differences in Local Knowledge and Preference for Food Trees in Central Uganda and Eastern Kenya

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Food trees contribute substantially to the food and nutrition security of millions of rural households in Africa. Farming communities prioritize tree and shrub species on farms based on a combination of factors, including their knowledge of potential uses the species' economic potential and a range of constraints and opportunities that each farmer faces depending on their position within the community and the household, in cultivating, harvesting and processing tree products. Gender and age are strong determinants of such constraints and opportunities as well as ecological knowledge and use of tree resources. This study contributes to the understanding of gender and generational preferences for food tree species that determine their use, and which contribute to food and nutrition security in Central Uganda and Eastern Kenya. Sixteen gender and age segregated focus group discussions were conducted to assess food tree species preferences. A total of 61 food tree species were listed −46 in Uganda (including 16 indigenous species) and 44 in Kenya (21 indigenous species). Results showed knowledge on food tree species differed by gender and age, with differences across gender lines found more prevalently in Uganda, and across generational lines in Kenya. Age-related differences in knowledge and preferences were clear with regard to indigenous species, whereby older women and men were found to have the most knowledge in both countries. Among key challenges for food tree cultivation, farming households mentioned knowledge of tree management, the lack of planting materials, especially for improved varieties, prolonged droughts and scarcity of land. Some of these constraints were gendered and generational, with women mostly mentioning lack of knowledge about planting and management as well as cultural restrictions, such as only having access to land when married; whereas younger men indicated management challenges such as pests, limited markets, as well as scarcity and limited ownership of land. Overall findings suggest that consulting user preferences for food tree species and constraints experienced by gender and age group could be important in the design of interventions which involve a diversity of food trees.

Keywords: food trees, gender, youth, priority setting, East Africa, livelihood and participatory research

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INTRODUCTION

Growing trees on farms diversifies crop production options for smallholder farmers and can provide a wider range of nutritious foods for healthier diets, economic revenue and ecological services (Vinceti et al., 2013; Jamnadass et al., 2015; Prabhu et al., 2015; Hughes et al., 2020). Food trees provide fruits, leaves, seeds, nuts and edible oils, which contribute to food and nutrition security (Jamnadass et al., 2015). Tree foods are often a rich source of vitamins, minerals, proteins, fats and other nutrients that can be used to diversify staple diets, thus preventing nutrient deficiencies that most often affect women and children (Kehlenbeck et al., 2013; Kehlenbeck and Jamnadass, 2014). Food trees can provide food during the "hunger gap" period or the time before the harvest of annual staples (Kehlenbeck et al., 2013; McMullin et al., 2019). Other evidence shows that tree cover has been found to be positively associated with dietary diversity and increased fruit and vegetable consumption (Ickowitz et al., 2014). Food trees can also contribute to the livelihoods of smallholder farmers through the income pathway with the sale of fruits and non-fruit products, which can also improve household food security (Jamnadass et al., 2015; Keding et al., 2017).

Due to the multiple uses and benefits of trees, farming households have used a diversity of food tree species for generations and accumulated a wealth of knowledge on their contributions to livelihoods, which may differ according to gender, age and ethnicity (Elias, 2015; Faridah et al., 2017; Hegde et al., 2017; Karambiri et al., 2017). Men and women farmers often prioritize cultivation and use according to gender and age-related needs. Yet, differences in these priorities are often not investigated and documented, which can result in inadequate agricultural development interventions.

Women have developed specific knowledge of food crops through their role as primary food producers, their social position, responsibilities, and status within their communities (Howard, 2003). However, they are often not recognized as important users and custodians of knowledge on genetic resources (Curtin, 1997; Howard, 2003). Men, who are considered the heads of households in many cultures, are often perceived as the more legitimate knowledge holders and managers of trees and other food crops and are therefore more often selected to participate in research and agricultural interventions (Howard, 2003; Kiptot and Franzel, 2012; Müller et al., 2015).

Age also shapes local ecological preferences and priorities for use. Yet, little is known about younger women's and men's preferences for food trees species, and how these relate to the specific interests and constraints younger women and men may face as they decide to engage (or not) in agricultural activities. The diversity of "youth" in terms of socio-economic, ethnic, educational, and other backgrounds (Pyburn et al., 2015) further influences their experiences, knowledge, interests, aspirations, and challenges. Understanding the preferences that youth hold in agriculture, and specifically in cultivating food trees on farms, which are a long-term investment, is particularly important for supporting younger farmers to stay engaged and motivated to pursue agriculture (Giuliani et al., 2017).

This study builds on previous gender and age-responsive research on food tree species by examining local communities' preferences for food tree species, and why they vary based on gender and age factors in selected sites in Uganda and Kenya. Three research questions are addressed: (i) how knowledge and preferences for food trees vary according to gender and age; (ii) which factors underpin the perceived value of food trees and how do these differ according to gender and age; and (iii) what motivations and constraints influence food tree preferences by women and men of different ages. The data collected in this study demonstrates how engaging a diverse range of farmer populations can generate a more relevant representation of the local knowledge and preferences of communities, and therefore inform our understanding for designing suitable programs which may involve the promotion of a diversity of food tree species for different uses. Such analyses can inform contextually appropriate interventions and more equitable agricultural production strategies to help meet the needs of smallholder farming communities in East Africa.

METHODOLOGY

Study Sites

This study covered four sites, two each in Kenya and Uganda, Kitui West and Mwingi West in Kitui County (Kenya) and Nakaseke and Nakasongola districts (Uganda). These sites were selected for this study as they were part of a wider project which was assessing agro-biodiversity for landscape restoration and food and nutrition security (**Figure 1**).

Kenya Sites

Kitui West and Mwingi West are located within Kitui County in the arid and semi-arid region of Eastern Kenya (**Figure 1**). The sites are characterized by unreliable and erratic bimodal rainfall, with mean annual rainfall ranging from 250 mm to 1050 mm. The rainfall is often poorly distributed in space and time and this results in frequent crop failures which means households experience recurrent food insecurity. The sites have mixed crop-livestock production systems, with mostly subsistence crop farming, particularly in the hills where higher amounts of rainfall occur. Despite the dry nature of the county, it holds rich plant diversity (Morimoto et al., 2010). The plant diversity is used by the local community for traditional foods and nutrition; the community members hold rich knowledge of its uses (Morimoto et al., 2010). The county is characterized by a high poverty incidence (KCIDP, 2018), has a population of 1,136,187 million people predominantly of Kamba ethnic group (KNBS, 2019).

Uganda Sites

Nakaseke and Nakasongola districts are in the central part of the cattle corridor of Uganda (FEWSNET, 2010). More than 80% of inhabitants are subsistence farmers of Baruuli, Banyankore, and Baganda ethnic groups, dependent on mixed agriculture and livestock production (Mukasa et al., 2010). The districts are characterized by low and unreliable bimodal rainfall that ranges from 500 mm to 1000 mm per annum, with Nakasongola being the driest of the sites. Prolonged dry spells are common,

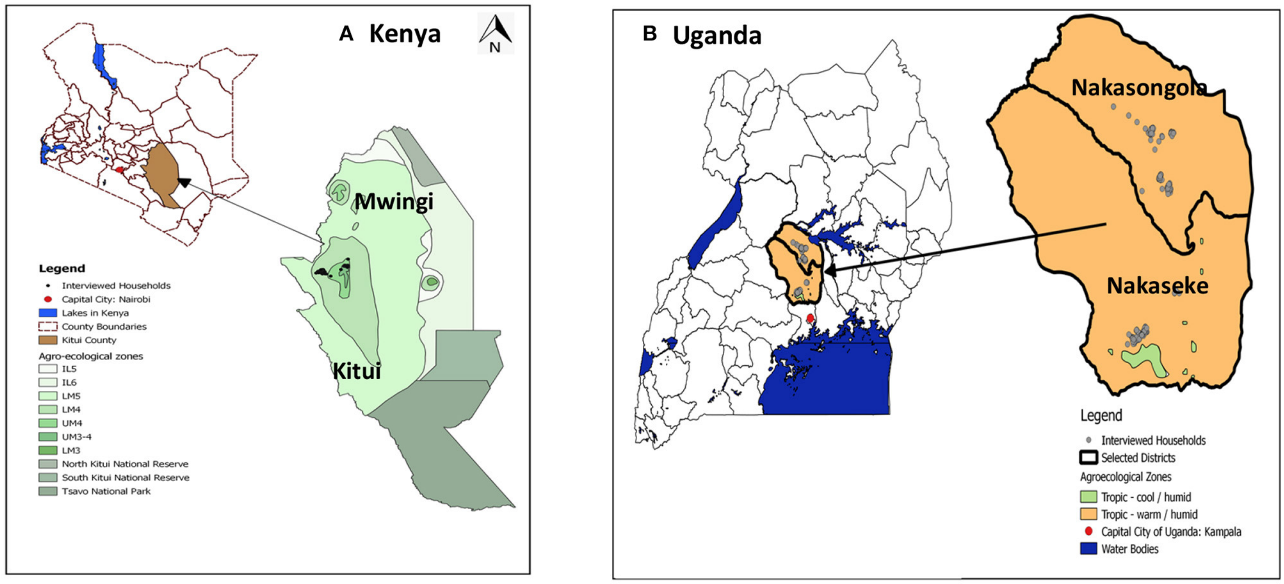

FIGURE 1 | (A) Map showing study sites and agroecological zones of Kitui West and Mwingi West in Kenya and **(B)** Nakaseke and Nakasongola districts of Uganda.

affecting agricultural and livestock production and resulting in failed harvests and outbreaks of crop and animal diseases, leaving many vulnerable to food insecurity (Mayanja et al., 2015). The zones are sparsely populated with a population of 528,126 in Nakasongola and 197,373 people in Nakaseke [Uganda Bureau of Statistics (UBOS), 2016].

Data Collection and Analysis

Participatory research was conducted between December 2018 and April 2019. Data was collected from a total of 16 focus group discussions (four per site), using species listing, uses and score-ranking techniques to capture preferences and priorities for species. For each study site, FGD participants were randomly selected from a stratified sample, and organized in four focus groups along age and gender lines: i.e., one group of younger men (aged between 15 and 35 years old) and another of younger women, and two groups of older (above 35 years of age) men and women. Age categorization was according to the East African Community policy (EAC Secretariat, 2013). Segregation by age and gender was done to allow all participants to express themselves freely and to generate data that would allow for analyses based on gender and age. A total of 80 women and 80 men participated in the focus groups. Participants started by free listing all the different types of food trees found on farms and in the wild in their areas (Quinlan, 2005; Gachuiri et al., 2017) and their main functional uses related to household consumption or income generation, the relative importance of each species according to their use and the reasons driving those uses. All trees and shrubs that provided fruit, leaves, nuts, bark, and seeds used as human food were listed as food trees. Species were listed in local dialects and names were subsequently translated into English, accompanied by botanical names using local experts and different literature sources (Katende et al., 1995; Maundu and Tengnäs, 2005).

The traditional "bao game" or "pebble method" (Kiptot and Franzel, 2014) was used to establish farmer preferences, following guidelines developed for priority setting (Franzel et al., 1996). Participants were asked to rank the 10 food tree species they preferred and explain the reasons for these preferences. Farmers allocated scores across species by placing a different number of beads, corn grains or stones in the holes of the board game (carved in wood) according to the value associated with each of the priority species. Each participant took a turn to assign a score to the named food tree species while providing their reasons for assigning that score. Scores ranged from 0 to 10, with zero representing the lowest preference and 10 the highest. An average score was then calculated for each of the identified species based on the values allocated by each participant in the group.

Additional questions focused on men and women's interests and challenges regarding food tree growing and management. Each group was asked to reflect on the experiences of people of their own gender and age group, with men referring to the experiences of men of their age group, and women, the same.

The number of tree species listed during the free listing exercise was considered a measure of a given group's knowledge of food tree species (Quinlan, 2005; Gachuiri et al., 2017). This knowledge was compared between gender and age groups, and across sites. Average scores per species were treated as a continuous variable and used to rank the tree species according to their preference (Mekoya et al., 2008). Independent samples *t*-test and a one-way analysis of variance (ANOVA) followed by *post-hoc* Bonferroni test were used to compare means and test the statistical significance in species preference scores between age-gender groups. This analysis was carried out using SPSS 26. The discussions around tree characteristics and reasons for scoring were analyzed qualitatively to identify the motivations and constraints that shape participant preferences.

RESULTS

Variation of Knowledge About Food Tree Species Diversity

A total of 61 food-tree species were listed across the two countries: 46 in Uganda (including 30 exotic species) and 44 in Kenya (23 exotics). In both countries, knowledge of food-tree species differed by gender and age, with older women knowing the greatest number of species (**Table 1**). In Kenya, older women listed 38 species and older men 33 species while younger men and women listed 26 and 21 species, respectively. In Uganda, older women listed 22 species, younger women listed 21 and older and younger men identified 17 and 15 priority species each respectively (**Table 1**).

Gender and Age-Specific Preferences for Food Trees

In Kenya, both men and women preferred exotic species such as *Mangifera indica* (mango), *Musa spp* (banana) and *Persea americana* (avocado), and we found differences in prioritization of food trees across gender and age groups (**Table 2**). The ANOVA test revealed statistically significant differences in species preference scores across age-gender groups ($p < 0.05$) for *Azanza garckeana* (Azanza), *Carica papaya* (pawpaw), *Carissa spinarum* (bush plum), *Citrus limon* (lemon), *Citrus reticulata* (tangerine), *Grewia tembensis* (nduva), *Psidium guajava* (guava), *Syzygium cumini* (java plum), and *Ximenia americana* (yellow plum). Older and younger men preferred mango, avocado, and *Citrus sinensis* (orange) (**Table 2**)—three exotic species. Older women in Kenya ranked indigenous species such as java plum, yellow plum and *Tamarindus indica* (tamarind), and *Vitex payos* (chocolate berry) higher than men and their younger counterparts ($p < 0.05$). For younger women, there was a statistically significant higher preference ($p < 0.05$) for species like pawpaw, lemon and *Passiflora edulis* (passion fruit) (**Table 2**). Generally, the scores given for indigenous species were lower than those of exotic species except for tamarind, but older women ranked them higher than the other groups.

In Uganda, both men and women preferred exotic species such as mango, *Artocarpus heterophylla* (jack fruit) and avocado, but species like avocado were scored higher by men (**Table 3**). The ANOVA test revealed a statistically significant difference in species preference scores across age-gender groups ($p < 0.05$) for *Annona muricata* (soursop), *Canarium schweinfurthii* (African elemi/olive) and passion fruit. Older women ranked species such as mango, passion fruit, java plum, guava and pawpaw higher than the younger women and men, while younger women had a statistically higher preference for species like soursop and African elemi/olive when compared to their older counterparts ($p < 0.05$). Only three indigenous food trees species, African elemi/olive, java plum and *Vangueria apiculata* (wild medlar), appeared in the list of the 10 most preferred species identified by participants and they received the highest scores from younger and older women.

Factors Influencing Local Preferences for Food Trees

Diverse factors were identified by farmers during the valuation of a given food tree species. In general, these were related to potential uses, market value, household consumption, and the species characteristics (phenology, yields, and growth characteristics or requirements) (**Tables 4**, **5**). Men and women of different ages across sites preferred exotic species such as mango, orange and avocado because of the perceived market potential and wider availability of planting materials. These species are highly preferred because they provide households with both food for consumption and cash income. Mango in Kenya is grown by most households and it is available during the lean months of December to February, providing growers with a source of food when highly needed. Avocado was also preferred for its nutritional value and high fat content, used very commonly in the study area as part of meals and as a spread for bread. Pawpaw was also highly regarded due to its fast growth and year-round availability which enables households to sell and consume the fruits any time of the year.

Although both men and women valued food trees for their contribution to improved health and nutrition, in both study sites, women of all ages had a higher preference for species that were year-round producers, easily accessible, and readily consumed by households, whereas men of all ages showed a higher preference for species that could generate income and provide other tree products such as timber and fuel. Java plum and yellow plum were highly preferred by older women in Kenya because of their cultural value, and their contribution as a food for young children. Traditionally, these fruits are not sold and are reserved for the consumption of children during the lean season. Tamarind was highly regarded by older women in Kenya due to its multiple uses: the branches are used as firewood and the fruits are used to flavor dishes or to make juice that children can carry to school. The fruits are also sold but the market for it is not well-developed in the area. In Uganda, older women also preferred guava and java plum due to their consumption by children, and passion fruit and pawpaw due to their year-round availability.

Younger women and men generally preferred species that were more marketable, fast growing and easier to manage, although there were specific gender and site differences. Older women in Kitui, Kenya, preferred species such as pawpaw, guava, java plum, lemon and tamarind that could be sold in small quantities because they make the decisions around this activity. Species that are sold in smaller quantities were of less interest to men, who preferred food tree species such as mango, avocado, banana and orange that could be sold in larger quantities (kilograms or crates), and potentially generate higher income. Women in Kitui, Kenya reported that men control the sale of the main exotic fruits which have market value, at the peak of the season, while women sell surplus or off-season fruit which generate smaller earnings. Older men's food tree species preferences were mainly related to uses other than food. For

TABLE 1 | List of 61 food trees, shrubs, and other perennials (32 indigenous and 29 exotics) used as sources of food, fuelwood, fodders, and other uses by men and women interviewed in Kenya and Uganda.

Species	Parts fed	Source of edible part	Uses	Kenya				Uganda			
				Old		Young		Old		Young	
				W	M	W	M	W	M	W	M
(a) Exotic species											
Anacardium occidentale	Fruit/nuts	Farm	Nut/oil/timber/firewood	0	0	0	0	0	0	1	0
Annona spp.	Fruit	Farm	Fruit/timber/firewood/charcoal	1	1	0	1	1	0	1	1
Artocarpus heterophylla	Fruit	Farm	Fruit/timber/firewood/charcoal	0	0	0	0	1	1	1	1
Borassus aethiopum	Fruit/seeds	Farm	Fruit/oil/pole/fodder/fiber/shade/ornamental	0	0	0	0	0	0	1	0
Carica papaya	Fruit/leaves	Farm	Fruit/vegetable	1	1	1	1	1	1	1	1
Casimiroa edulis	Fruit	Farm	Fruit/timber/firewood	1	1	1	1	0	0	0	0
Citrullus lanatus	Fruit	Farm	Fruit/firewood	1	1	1	1	1	1	1	1
Citrus aurantiifolia	Fruit	Farm	Fruit/firewood	0	0	0	0	0	0	0	1
Citrus limon	Fruit	Farm	Fruit/firewood/medicine	1	1	1	1	1	0	1	1
Citrus microcarpa	Fruit	Farm	Fruit/firewood	1	0	0	0	0	0	0	0
Citrus reticulata	Fruit	Farm	Fruit/firewood	1	1	1	0	1	1	1	1
Citrus sinensis	Fruit	Farm	Fruit/firewood	1	1	1	1	1	1	1	1
Coffea arabica	Fruit/seeds	Farm	Fruit/flavor/beverage/firewood	0	0	0	0	0	1	0	0
Cucumis metuliferus	Fruit	Farm	Fruit	1	0	0	0	0	0	0	0
Cyphomandra betacea	Fruit	Farm	Fruit	0	0	0	0	0	0	1	0
Dovyalis caffra	Fruit	Farm	Fruit/fence	1	1	0	1	1	0	0	0
Eriobotrya japonica	Fruit	Farm	Fruit/firewood	0	0	0	1	1	0	0	0
Lantana spp.	Fruit	Farm, Wild	Fruit/fence	1	0	0	0	0	0	0	0
Mangifera indica	Fruit	Farm	Fruit/timber/firewood	1	1	1	1	1	1	1	1
Moringa oleifera	Pod, leaves/seeds	Farm	Fruit/vegetable/medicine/firewood	1	1	0	1	0	0	0	0
Morus alba	Fruit/leaves	Farm	Fruit/vegetable/fence/firewood	0	0	1	0	0	1	1	0
Musa spp.	Fruit	Farm	Fruit/fodder	1	1	1	1	1	1	1	1
Opuntia spp.	Fruit/stem	Wild	Fruit/vegetable/fodder/fence	1	0	0	0	0	0	0	0
Passiflora edulis	Fruit	Farm	Fruit	1	0	1	1	0	0	0	1
Persea americana	Fruit/seeds	Farm	Fruit/timber/firewood/fodder	1	1	1	1	1	1	1	1
Physalis peruviana	Fruit	Farm/Wild	Fruit/medicine	0	0	0	0	0	0	1	0
Psidium guajava	Fruit	Farm	Fruit/timber/firewood/fodder	1	1	1	1	1	1	1	1
Punica granatum	Fruit	Farm	Fruit/medicine	1	1	1	1	0	0	0	1
Rubus pinnatus	Fruit	Farm/Wild	Fruit/fence	1	0	0	0	0	0	0	0
Syzigium cumini	Fruit	Farm	Fruit/timber/firewood/charcoal/shade	1	1	1	1	1	1	0	1
Theobroma cacao	Bean	Farm	Fat/butter/drinking chocolate/firewood	0	0	0	0	0	0	0	1
Vitex payos	Fruit	Farm	Fruit/timber/firewood/charcoal	1	1	1	1	0	0	0	0
(b) Indigenous species											
Adansonia digitata	Fruit/leaves	Farm/Wild	Fruit/vegetable/fiber/apiculture/ornamental	0	1	0	0	0	0	0	0

(Continued)

TABLE 1 | Continued

Species	Parts fed	Source of edible part	Uses	Kenya				Uganda			
				Old		Young		Old		Young	
				W	M	W	M	W	M	W	M
Azanza garckeana	Fruit	Farm	Fruit/timber/firewood/charcoal/fodder/tool/medicine/shade	1	1	1	1	0	0	0	0
Balanites aegyptiaca	Fruit	Farm/Wild	Fruit/fodder/medicine	1	1	1	1	0	0	0	0
Berchemia discolor	Fruit	Wild	Fruit/fodder/medicine/firewood/timber/charcoal	0	0	1	0	0	0	0	0
Canarium schweinfurthii	Fruit	Farm	Fruit/medicine/firewood/timber/charcoal	0	0	0	0	1	1	1	0
Carissa edulis	Fruit	Wild	Fruit/medicine/firewood/tool	1	0	0	0	0	0	0	0
Carissa spinarum	Fruit	Wild	Fruit/medicine/firewood/tool	1	1	1	1	0	0	0	0
Cordia monoica	Fruit	Wild	Fruit/medicine/firewood/tool/pole/timber	1	1	0	1	0	0	0	0
Elaeis guineensis	Fruit	Farm/Wild	Fruit/oil/fodder/fiber/shade/ornamental	0	0	0	0	1	0	0	0
Eugenia capensis	Fruit	Wild	Fruit/fence	0	0	0	0	1	0	0	0
Ficus spp.	Fruit	Farm/Wild	Fruit/timber/firewood/charcoal/fodder/medicine/shade	1	1	0	0	0	0	0	0
Garcinia livingstonei	Fruit	Wild	Fruit/fodder/medicine/firewood/timber/charcoal	1	1	0	0	0	0	0	0
Grewia villosa	Fruit	Wild	Fruit/fodder/medicine/firewood/timber/charcoal	1	1	0	0	0	0	0	0
Grewia bicolor	Fruit	Wild	Fruit/fodder/medicine/firewood/timber/charcoal	1	1	0	0	1	0	0	0
Grewia tembensis	Fruit	Wild	Fruit/fodder/medicine/firewood/timber/charcoal	1	1	1	1	0	0	0	0
Lannea triphylla	Fruit	Wild	Fruit/fodder/firewood/timber/charcoal	1	0	0	0	0	0	1	0
Meyna tetraphylla	Fruit	Wild	Fruit/medicine	1	0	0	0	0	0	0	0
Mimusops kummel	Fruit	Wild	Fruit/timber/firewood/charcoal	0	0	0	0	1	1	0	0
Pappea capensis	Fruit	Wild	Fruit/firewood	1	1	1	0	1	0	0	0
Searsia pyroides	Fruit	Wild	Fruit/medicine/tool/firewood	0	0	0	0	0	0	1	0
Rhus vulgaris	Fruit	Wild	Fruit/medicine/tool/firewood	1	1	0	1	0	0	0	0
Sclerocarya birrea	Fruit	Wild	Fruit/medicine/firewood	1	1	1	1	0	0	0	0
Strychnos madagascariensis	Fruit	Farm/Wild	Fruit/medicine/firewood	0	0	0	0	0	1	0	0
Tamarindus indica	pod	Farm	Fruit/flavor/medicinal/timbre/firewood/charcoal	1	1	1	0	1	1	1	0
Vangueria apiculata	Fruit	Farm/Wild	Fruit/timber/firewood/charcoal	0	0	0	0	0	1	1	0
Vangueria madagascariensis	Fruit	Farm/Wild	Fruit/medicine/tool/firewood	1	1	0	1	0	0	0	0
Vitex doniana	Fruit	Farm	Fruit/timber/firewood/charcoal	0	0	0	0	1	0	0	0
Ximenia caffra	Fruit	Wild	Fruit/medicine/firewood/fence	0	0	1	0	0	0	0	0
Ximenia americana	Fruit	Farm/Wild	Fruit/medicine/firewood/fence	1	1	0	1	0	0	0	0
Exotic species = 29				20	16	15	16	15	10	16	16
Indigenous species = 32				19	16	9	10	6	5	5	0
Total species = 61				39	32	24	26	21	15	21	16

1 = mentioned; 0 = not mentioned; W, women; M, men.

TABLE 2 | Score ranking of the 10 most preferred food trees according to different gender and age groups in both Kitui West and Mwingi West of Kenya.

Scientific names	Common names	Mean (s.d) score: Older		Mean (s.d) score: Younger		Mean (s.d) score groups ($n = 80$)	Rank
		Women ($n = 20$)	Men ($n = 20$)	Women ($n = 20$)	Men ($n = 20$)		
Mangifera indica	Mango	7.8 (1.4)	8.7 (1.2)	7.4 (2.1)	8.1 (0.7)	7.8 (1.7)	1
Musa spp.	Banana	7.8 (1.6)	7.5 (1.7)	7.9 (2.0)	7.5 (1.7)	7.7 (1.7)	2
Persea americana	Avocado	7.2 (1.6)	7.7 (1.9)	6.7 (1.9)	7.5 (1.8)	7.4 (1.9)	3
*Tamarindus indica**	Tamarind	7.2 (1.5)	6.3 (2.6)	6.3 (2.0)	6.7 (2.0)	6.7 (2.0)	4
Citrus sinensis	Orange	6.4 (1.4)	6.7 (1.7)	5.7 (2.0)	6.7 (2.0)	6.6 (1.9)	5
Carica papaya	Pawpaw	**7.6 (1.4)**	**2.9 (1.9)**	**9.2 (0.8)**	**6.9 (1.9)**	6.4 (2.8)	6
Citrus limon	Lemon	6.1 (1.4)	5.2 (2.5)	**8.3 (2.4)**	**6.2 (1.9)**	6.4 (2.1)	6
Citrus reticulata	Tangerine	7.3 (1.3)	0[a]	**4.2 (1.0)**	**6.6 (1.9)**	5.4 (1.8)	7
Passiflora edulis	Passion fruit	3.9 (1.5)	0[a]	6.7 (3.1)	4.4 (2.1)	5.2 (2.6)	8
Casimiroa edulis	White Sapote	6.3 (3.7)	4.4 (2.1)	4.5 (1.4)	5.7 (1.4)	5.2 (2.1)	8
*Ximenia americana**	Yellow plum	**8.6 (0.9)**	**4.3 (1.2)**	5.5 (2.0)	4.7 (0.7)	5.1 (2.0)	9
*Syzygium cumini**	Java plum	7.5 (2.6)	5.5 (0.7)	3.0 (1.5)	5.0 (1.9)	5.0 (2.6)	10
*Balanites aegyptiaca**	Desert date	5.2 (1.2)	4.8 (2.5)	4.6 (1.4)	4.7 (1.6)	4.9 (1.8)	11
Annona reticulata	Custard apple	0[a]	5.3 (2.2)	0[a]	4.5 (1.7)	4.7 (1.9)	12
*Azanza garckeana**	Azanza	6.6 (3.7)	4.9 (11.7)	3.1 (2.6)	4.1 (1.8)	4.7(2.6)	12
*Carissa spinarum**	Bush plum	**6.4 (1.7)**	**4.5 (1.5)**	**3.4 (2.3)**	**4.6 (1.5)**	4.6 (1.8)	13
*Vitex payos**	Chocolate berry	5.6 (2.9)	3.9 (1.6)	3.7 (2.4)	4.0 (2.0)	4.5 (2.5)	14
*Grewia tembensis**	Nduva	**5.3 (0.9)**	**4.0 (1.0)**	4.9 (0.9)	3.1 (1.5)	4.4 (1.4)	15
*Pappea capensis**	Jacket plum	**5.6 (0.8)**	**3.8 (1.1)**	4.0 (1.2)	0[a]	4.3 (1.3)	16
Psidium guajava	Guava	**4.7 (1.9)**	**2.5 (1.6)**	4.4 (2.4)	5.1 (1.9)	4.2 (2.2)	17
*Vangueria madagascariensis**	Wild medlar	3.0 (0.0)	0[a]	3.5 (1.4)	3.9 (1.9)	3.7 (1.6)	18

*Average scores; score 10 = most preferred; 0 = least preferred; *Indigenous species; 0[a] = No scored data for the in that category; s.d, standard deviation, n = sample size; values across a row in bold are significantly different at P > 0.05 level.*

TABLE 3 | Score ranking of the 10 most preferred food trees according to different gender and age groups in Nakaseke and Nakasongola districts of Uganda.

Scientific names	Common names	Mean score (s.d) Older		Mean score (s.d) Younger		Mean score (s.d) across groups ($n = 80$)	Ranks
		Women ($n = 20$)	Men ($n = 20$)	Women ($n = 20$)	Men ($n = 20$)		
Mangifera indica	Mango	9.0 (1.3)	8.9 (1.5)	7.6 (3.1)	8.4 (2.0)	8.4 (2.2)	1
Artocarpus heterophylla	Jackfruit	7.2 (1.6)	7.5 (1.9)	6.9 (1.9)	7.5 (1.8)	7.4 (2.0)	2
Persea americana	Avocado	6.4 (2.4)	7.4 (1.8)	6.4 (2.9)	8.0 (1.6)	7.3 (2.2)	3
Citrus sinensis	Orange	**7.7 (0.8)**	**5.9 (2.3)**	7.1 (2.9)	7.2 (2.5)	6.9 (2.4)	4
Citrus reticulata	Tangarine	6.2 (1.1)	5.4 (2.3)	7.4 (1.4)	5.9 (2.3)	6.1 (2.0)	5
*Canarium schweinfurthii**	African elemi/olive	1.8 (0.6)	3.7 (3.0)	8.1 (2.7)	5.5 (4.6)	5.6 (3.7)	6
Passiflora edulis	Passion	7.3 (1.3)	0[a]	**4.2 (1.0)**	**6.6 (1.9)**	5.4 (1.8)	7
Carica papaya	Pawpaw	**6.2 (2.4)**	**4.6 (2.1)**	5.1 (1.8)	5.2 (1.8)	5.4 (2.6)	7
Psidium guajava	Guava	**6.6 (1.8)**	**4.2 (2.1)**	4.3 (3.0)	3.6 (2.8)	4.4 (2.6)	8
*Syzygium cumini**	Java plum	6.8 (3.9)	3.0 (1.6)	**4.0 (2.3)**	**2.4 (2.3)**	4.0 (7.6)	9
Anacardium occindentale	Cashew	3.0 (3.4)	1.2 (0.4)	5.0 (3.3)	0[a]	3.4 (3.2)	10
*Vangueria apiculata**	Wild medlar	1.6 (0.5)	1.8 (0.4)	3.7 (3.4)	5.0 (2.7)	3.4 (2.7)	11
Annona muricata	Soursop	1.3 (0.5)	2.3 (3.2)	4.5 (2.9)	3.5 (2.1)	3.3 (2.7)	13

*Average scores; score 10 = most preferred; 0 = least preferred; *Indigenous species; 0[a] = species was not scored or mentioned for scoring by any FGD in that category; s.d, standard deviation, n = sample size; values across a row in bold are significantly different at P > 0.05 level.*

TABLE 4 | Number of times each valuation factors was mentioned for each of the top 10 food trees by different gender and age groups in both Kitui West and Mwingi West of Kenya.

Valuation factors	Older		Younger		Average
	Women	Men	Women	Men	
Timber, fuel wood provision	32	38	35	15	30
Market potential	29	38	31	19	29
Provides products for home consumption	40	30	21	6	24
Propagation and establishment considerations (Easy to propagate, high availability of germplasm, fast growth/maturity, value as rootstock)	29	14	31	19	23
Seasonality of production	32	21	28	10	23
Production characteristics (compatibility with crops, resistance to pests and diseases)	24	35	17	13	22
Inputs demands	23	29	25	8	21
Food value	22	22	27	9	20
Medicinal value	21	36	11	6	19
Other uses	19	28	8	8	16
Role as livestock feed	17	23	8	4	13
Role as children food	16	10	15	2	11
Fruit shelf life qualities	10	14	14	4	11
Nutritional properties	12	9	13	1	9

TABLE 5 | Number of times each valuation factors was mentioned for each of the top 10 food trees by different gender and age groups both Nakaseke and Nakasongola districts, Uganda.

Factors	Older		Younger		Average
	Women	Men	Women	Men	
Provides products for home consumption	29	16	23	9	19
Market potential	17	20	11	16	16
Production characteristics (Compatibility with crops, resistance to pests, and diseases)	16	12	12	8	12
Medicinal value	13	10	14	4	10
Food value	8	5	12	5	8
Role as children food	14	4	12	3	8
Propagation and establishment considerations (Easy to propagate, high availability of germplasm, fast growth/maturity, value as rootstock)	10	2	9	6	7
Timber, fuel wood provision	7	3	2	5	4
Seasonality of production	6	2	4		4
Nutritional properties	7	5	2	2	4
Other uses		5	2	2	3
Role as livestock feed	3			1	2
Inputs demands	1	1	3	2	2
Fruit shelf life qualities	1	1	3	1	2

instance, in Kitui, they preferred mango, avocado and orange due to their potential market and income value. In Uganda, older men also preferred more marketable species and those that could be used for other products like timber and charcoal, such as jack fruit and avocado.

Farmers' criteria for evaluating food tree species were also related to different tree attributes including ease of propagation and establishment, accessibility of planting material, speed of growth, compatibility with other (understory) crops, drought tolerance, and input demands in term of pesticides and fertilizers.

Constraints and Challenges to Growing Food Trees

Farmers in both countries valued and were interested in planting food trees because they provide food an opportunities for income, as well as other products useful for the household such as medicinals, fuelwood, timber and fodder. Participants also referred to the contribution of trees to ecosystem services such as shade for crop production, soil fertility, water catchment and for supporting biodiversity. When asked about constraints to growing food trees, farmers in both countries referred to a lack of quality planting material, especially for improved varieties, and of seedlings of indigenous species. Women and youth in Kenya mentioned the lack of knowledge and technical skills in propagation and management of trees, and the limited availability of (and access to) trained government extension agents to support them. One of the men in a youth group stated, "*we do not know how to propagate trees and manage them, most of the agriculture information focuses on (staple) crops.*" Lack of technical assistance in general was reported as a major constraint as there are limited government programs promoting agroforestry in the sites, and the few government extension agents that visit them are trained on field crops but not trees. Farmers reportedly rely on the forest service department for tree-related information, but forestry extension agents are not easily accessible, and their expertise is timber species. Scant information and knowledge on fruit tree propagation and management were reported as restricting the establishment of fruit tree seedlings. Participants in Kenya also reported that agriculture trainings mainly target the most vocal and educated farmers in the community. As one woman explained "*mostly, it is men who are much involved in training: especially, the most vocal in the community like retired government staff, community leaders, and if you are in a vibrant group or an association*" [sic].

Other constraints and limitations mentioned by farmers had gender and age-related implications. **Table 6** summarizes the most commonly mentioned challenges, and the groups that are mostly affected by each of them. Younger women seem to face more challenges than the other groups, as their position in the community places them at a difficult intersection of various structural barriers. They are constrained by insecure land tenure systems and a lack of financial capital, that particularly affects rural youth. Labor and time availability constrained food tree growing, especially for women due to other gender related domestic tasks. Also lack of motivation, especially for youth and women due many factors such as insecure land and tree tenure system.

At the same time, they face gender-based constraints like the need to receive approval from men to plant trees even when they are the ones taking care of the seedlings, limited participation in species selection and in agricultural extension training, and other related activities.

DISCUSSION

Building on previous research on local ecological knowledge, our findings provide three key insights for understanding food tree growing and management in agroforestry systems. First, our study confirms previous research illuminating differences in farmer knowledge of, and preferences for food tree species based on gender and other factors of social differentiation. Although variations across gender and age groups are consistently reported (Elias et al., 2018), these differences may be more significant across gender lines, as in Uganda, or across generational lines, as in Kenya, and the direction of the relationship may vary. For instance, in our study, older women in Kenya identified more food tree species than other groups; a finding also seen in Malaysia, where women were more conversant with fruit trees (Faridah et al., 2017), and in the coastal provinces of Kenya, where older men and women had more knowledge of indigenous fruit trees (Fukushima et al., 2010). Such local ecological knowledge is closely tied to gender-specific roles, including responsibilities related to use and management of trees and the processing and selling of tree products (Elias and Carney, 2007). Women are primarily responsible for providing food for their families (Ureta et al., 2016), and their knowledge of food trees is especially critical during lean months, when food supplies are limited.

Second, our findings show that differences in knowledge and preferences are particularly significant with regard to indigenous species. In Kenya, younger men and women had the least knowledge of indigenous food tree species. Similar results have been noted in Ethiopia (Seyoum et al., 2015). Young people's lack of knowledge on indigenous food tree species may be associated with their limited presence in present-day farming systems and in the wild, as compared to the past. The erosion of traditional knowledge brought about by the loss of vegetation (Lengkeek and Carsan, 2004; Teketay et al., 2010) and of wild fruit tree species (Asfaw and Tadesse, 2001) have been well-documented.

The low economic value of many indigenous food tree species is also partly responsible for younger people's dwindling knowledge of these species. In other studies of Coastal Kenya and Ethiopia, income generated from the sale of food tree products harvested from the wild was reportedly marginal because of several social, economic, and cultural factors (Fukushima et al., 2010; Seyoum et al., 2015). In this study, younger men and women as well as older men associated their low preference for indigenous food trees to low or null economic value. In all study sites, a strong preference for exotic species such as mango, avocado, pawpaw and citrus were associated with their economic value and their role as food. Men and women participants noted, as also reported elsewhere, that sales of food tree products increase their household's purchasing power to buy staples and legumes for the family (Keding et al., 2017) and to cover other household costs such as school fees (Schreckenberg et al., 2006). Moreover, the slow growth of local varieties and indigenous food trees compared to the faster growth rates of popular exotic trees, which have been domesticated and improved over time (Lengkeek and Carsan, 2004), discouraged some younger farmer participants who are most interested in short-term cash income. This is conveyed in the words of a younger man from Kitui west, who stated that: "*Growing indigenous food trees is not profitable, it takes a long time to mature, and has no good income returns.*"

Nonetheless, at both study sites, women–especially older groups–were more favorable to indigenous food trees than men due to their contribution to meeting household and children's nutritional needs and their other uses as firewood and medicine. This interest in indigenous species, despite their lack of economic value, can be attributed to rural women's food provisioning responsibilities, but also to women's often disadvantaged position in the household that limits their income generating activities to those disregarded by men due to their low earning potential. As an older woman in Kitui put it "*Indigenous fruits are ready during drought seasons when other fruits are not in season and some fruits like java plum and tamarind we normally sell in small quantity*

TABLE 6 | Most mentioned constraints and challenges of growing food tree species according to different gender and age groups in both Kenya and Uganda.

Challenges/constraints	Older		Younger		Description
	Women	Men	Women	Men	
Lack of tree management know how	**X**		**X**	**X**	Women and youth reported lack of technical skills in propagation and management of tree species and limited support from extension services
Small farm sizes		**X**		**X**	Men reported that land is mostly inherited and shared among male siblings, which contributes to small farms that limit the space for establishing fruit tree orchards or planting diverse fruit species.
Land tenure uncertainty			**X**	**X**	Young women are not given land unless they are married, and young men are uncertain of whether and when they will receive land. According to participants, food tree farming requires secure tenure as trees take time to mature and if the land changes ownership during that time, the new owner may fell or appropriate the trees.
Labor and time availability	**X**		**X**		This is especially the case for women, who are heavily burdened by both productive and reproductive responsibilities
Financial capital restrictions			**X**	**X**	Fruit tree farming was reported to have a high production cost due to the need to purchase quality tree seedlings and inputs.
Lack of an organized market	**X**	**X**	**X**	**X**	Brokers dominate and dictate fruit prices, waiting until fruits are very ripe to negotiate low prices, thereby bringing producer profits down. Poor road infrastructure additionally constrains the transport of fresh, perishable fruits to market outlets. Investments in high value food trees are only worth if there is easy access to markets for their products
Pest and disease outbreaks			**X**	**X**	Most commonly affecting exotic fruit tree species such as mangoes, oranges and passion fruit. They are aggravated by poor tree management skills that allow infestation by pests and diseases.
Climate change and prolonged drought	**X**	**X**	**X**	**X**	Farmers are concerned about the effects of climate and rainfall unreliability on yields, changes in fruiting patterns (e.g., some mango trees are fruiting thrice in a year), incidence of pests and diseases, and frost. They reported that they do not have information to help them cope with these impacts.
Lack of processing or value addition of fruits	**X**		**X**		Most farmers sell fresh fruit immediately after harvesting contributing to low prices during peak season. Processing fruit in the form of juice and jam for value-addition and to extend their shelf life was particularly of interest to women, but lack of money and knowledge, as well as difficulties obtaining product certification, limit them
Lack of awareness of nutritional value			**X**	**X**	Young farmers reported having little information on the nutritional value of indigenous and wild fruit species, favoring the few common exotic fruit species with which they are familiar.
Slow growth			**X**	**X**	Young women and men reported that the slow growth of indigenous species discouraged them.
Unequal participation in decisions about trees	**X**		**X**		Gender relations and decision-making dynamics influence the choice of fruit tree species planted. Women reported that their husband had a stronger say about which trees species to plant on the farm and had to provide approval to plant trees even when women were the ones taking care of the seedlings.

Bold X denote the most mentioned challenges per gender and age.

and we do not need to seek permission to utilize or sell." As other studies have shown, many indigenous fruit trees are particularly beneficial for women in harsh environments with frequent crop failures, pest attacks, and droughts (Schreckenberg et al., 2006; Seyoum et al., 2015).

The third important point is that despite their interest in growing food trees, farmers in the study sites face common, as well as gender and age-specific constraints in this regard. Study participants identified several barriers to the cultivation of food trees that echo previous studies. For example, nearly all farmers indicated that they have limited access to quality planting material and rely on a narrow offer of species diversity—a concern shared across many parts of Africa (Jamnadass et al., 2011; Nyoka et al., 2011). Participants also reported a lack of knowledge of tree cultivation and management practices; a known constraint affecting expansion of fruit tree production on smallholder farms (Snelder et al., 2007). The absence of a well-organized, stable and reliable market for food tree products, despite their local and international market potential, which was flagged as a constraining factor in our study, has also been noted as an important determinant of species choice in other research (Degrande et al., 2006). Land size and ownership was also identified as a key constraint, other studies have described how this influences decisions about whether to plant and/or retain trees on farms (Degrande et al., 2006; Ureta et al., 2016; Gachuiri et al., 2017), how many trees to plant, and which species to plant (Lengkeek et al., 2005).

The gender- and age-specificity of these constraints, which has received less attention in the literature, were obvious in our study. For example, land tenure considerations were mentioned mainly by women and young men. Young women are particularly affected since, unlike young men who may outgrow this constraint, traditional land and tree tenure systems in Kenya and Uganda do not allow women to own land, but rather to access it through marriage (Degrande et al., 2006; Musangi, 2017). This was conveyed in the words of a young woman participant: *"only men inherit land once they reached that age of 18 or when they marry."* Another example relates to lack of knowledge and skills in food tree propagation and management that were also more often cited by women and youth in both study sites, possibly due to oversight from governmental and non-governmental rural extension agents. The perception shared by participants that most agriculture training opportunities target a few better resourced farmers possibly reflects the commonly used figure of "lead farmers" in extension activities. Lead famers have been found to concentrate among elder, better educated men who are well-regarded in the community (Chinsinga and Chasukwa, 2012; Ragasa, 2020).

Crucially, women and young men also experienced a lack of time and motivation to plant food trees. Women's domestic responsibilities (e.g., cooking, cleaning, and caring for children) associated with traditional gender roles, in addition to their farming activities, limit their time for tree management. As a case in point, Villamor et al. (2015) substantiate that female farmers generally manage smaller parcels of land near their homestead due to labor and time constraints. In terms of motivations, we found that these were also closely related to gender and generational roles and interests. In Kitui, where men usually control the sales of the most marketable fruits during the peak season while women are often responsible for selling surplus fruit off-season, women were more interested in food tree species that were available throughout the year and could be sold in small quantities. A woman in Kitui stated, "*we prefer farming agriculture crops that take less time or fruit such as pawpaw, lemon, guava, that are normally sold in small quantity and we do not need to seek permission to sell*" (sic). In the case of younger men and women, the lower interest in growing food trees was consistent with the literature on youth and rural transformation, which identifies a general apathy among younger generations toward rural farming and rural futures (White, 2012; Clendenning et al., 2019), as illustrated by a young woman in Nakaseke, Uganda, who aspired to leave her rural community and find work in an urban town: "*I don't want to plant trees. It is tedious work. I better do business.*"

Financial constraints that often hinder farmers from practicing agroforestry (Ureta et al., 2016) were more often reported by women and younger men in our study. Kenyan women participants, for example, were interested in options to add value to fruit produce, including processing the fruits into juices, but they were limited by lack of skills and training, and critically by their low access to capital. Rural women have not only fewer income-generating opportunities than their male counterparts (Jabeen et al., 2020), but also less access to credit (FAO, 2019). Rural youth, in turn, are often under-employed in low paying activities and predominantly provide labor for their own households and farms (Bennell, 2007).

The complex interactions between the diversity of preferences, constraints and challenges described above shapes knowledge of food trees and their uses. But predominant gender norms still curtail the level of participation and voice of different household members in the selection of tree species to be planted, or cared for, and mediate how farming land is used to satisfy household and family needs. In Uganda, among the Baganda community, and as a result of their position as landowners, men dominate tree planting and are also responsible for deciding where and which trees women plant (Kiptot, 2015). Similarly, among the Kamba people of Eastern Kenya, tree planting and felling have traditionally been seen as a male's domain and while women enjoy use and access rights to fodder, fuelwood, fruits and mulch, more valuable tree products like charcoal and timber are still under men's control (Kiptot and Franzel, 2012). Recent research in Kenya points to a tendecy toward more joint decision-making regarding farming and land use decisions, in large part as a result of women's increased participation in agricultural trainings and development initiatives, as well as larger regulatory (e.g., constitutional recognition of the right to inherit land; laws against domestic violence) and societal (increased out-migration of men in search of off-farm work) changes. Yet, women's priotities and preferences are still seen as secondary to their husband's and men are still seen as the household heads and final decision makers (Bullock and Tegbaru, 2019; Crossland et al., 2021). Increasing women's and youth's participation and voice in the selection of food trees on farm would thus require going beyond identifying their preferences and attempting to transform the gender norms that designate men as final decision-makers and undervalue women's priorities and needs (Bullock and Tegbaru, 2019; Crossland et al., 2021).

CONCLUSION

The study demonstrates the need to unpack knowledge, preferences, and constraints in relation to food trees according to gender and age. These different priorities and preferences along with other important variables such as presence of markets or seed availability, that were not examined here, affect the interest and ability of farmers to grow food trees, as well as their choice of species.

Diverse gender- and age-related sets of knowledge, preferences and challenges in relation to food trees underpin complex decisions about which food tree species to grow or use. Differences in knowledge and preferences are distinct not only across gender lines but also generational lines. They are shaped by gender and generational roles, such as those related to child rearing and household food provisioning, and responsibilities related to the use and management of trees, and the processing and selling of tree products. The diversity of preferred species mentioned by all groups was high, however dominated by exotic species. Indigenous food trees are perceived to be of a low or null economic value and were only highly appreciated by older women due to their children's nutritional needs and use as firewood and medicinal properties. Men and younger women gave priority to species with high economic value due to the sale of their fruit and the potential for income. The study also identified several barriers to the cultivation of food trees, some of which were gendered, with more, younger women mentioning lack of knowledge about planting and management, as well as cultural restrictions, such as only having access to land when married, and a lack of time due domestic responsibilities associated with traditional gender roles. Younger men faced different challenges related to limited markets, and land scarcity and ownership.

Indigenous food trees, which often are slower growing and don't have well-developed market opportunities, were not identified as preferred species across different gender and generational groups, expect by older women who value them for their food contribution, particularly for children, and during lean seasons. These species do have the potential to contribute in local food systems because of their nutritional value, seasonal availability and because they are adapted to their landscapes. More research and investment are needed to assess the potential of these species, and a good starting point is to identify which one's local communities do use, and for what reasons. Also, sensitization to increase knowledge on their usefulness and nutritional value. Knowledge gaps which need to be addressed are how to improve the delivery mechanism for inputs such as high quality and diversity of seedlings for exotic and indigenous species and capacity development of farmers on food tree growing and management and agriculture extension services to support better distribution and delivery systems of quality seedling.

Sensitization efforts should target the youth and older men to allow them to better understand the benefits of these food trees. In addition, there is a need to support collective action, access to market information, linkages to markets and value chain development for both exotic and indigenous tree species to expand marketing opportunities for farmers.

Overall, our findings suggest that consulting farming communities about their preferences for food tree species and the constraints they experience in growing them, by gender and age group, is important to inform the design of project strategies for promoting a diversity of food tree species to meet the multiple interests and needs of smallholder farmers.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

AG prepared manuscript and carried out data collection and fieldwork. All authors contributed ideas and text, provided input for the literature review, development of the methodology, manuscript preparation, proofreading, and critical analysis of the submitted review.

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