# Qualitative assessment of the agricultural biodiversity managed by farm households in northern Ghana

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Working paper 01

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Published by International Institute of Tropical Agriculture

November 2018

www.africa-rising.net

The Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) program comprises three research-in-development projects supported by the United States Agency for International Development as part of the U.S. government's Feed the Future initiative.

Through action research and development partnerships, Africa RISING will create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base.

The three regional projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads the program's monitoring, evaluation and impact assessment. http://africa-rising.net/



This document was made possible with support from the American people delivered through the United States Agency for International Development (USAID) as part of the US Government's Feed the Future Initiative. The contents are the responsibility of the producing organization and do not necessarily reflect the opinion of USAID or the U.S. Government.

# Acknowledgement

This research was supported by a grant by the International Institute of Tropical Agriculture (IITA) to Bioversity International in the context of the project “Sustainable Intensification of Key Farming Systems in the Sudano-Sahelian Zone of West Africa” under the sub-project “Impact of sustainable intensification technologies on on-farm agricultural diversity in Africa RISING communities of Ghana.” We thank Dr. Carlo Azzarri from IFPRI for access to the data of the Africa RISING Baseline Evaluation Survey, Irmgard Hoeschle-Zeledon for facilitating the implementation and funding of this research, as well as Jonathan Odhong for supporting the publication process. We also thank Atinga David who was the supervisor during the field work and the team of data collectors for their great contributions. We are particularly grateful to all the farmers who participated in the Focus Group Discussions for their time and contributions to this effort.

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| | |
|---|---|
| **ABD** | Agricultural Biodiversity |
| **Africa RISING** | Africa Research In Sustainable Intensification for the Next Generation |
| **ARBES** | Africa RISING Baseline Evaluation Survey |
| **FDGs** | Focus Group Discussions |
| **IFPRI** | International Food Policy Institute |
| **ISSER** | Institute of Statistical, Social and Economic Research |
| **Ha** | hectare |
| **SDI** | Simpson Diversity Index |

# Executive summary

This paper presents the methodology and results of a qualitative exercise to elicit the local knowledge about the agricultural and useful wild plant biodiversity grown or collected by households in selected communities where the Africa Research In Sustainable Intensification for the Next Generation (Africa RISING) program is being implemented in three regions of northern Ghana. The hypothesis was that households in marginal areas rely on many more species than conventional socioeconomic surveys reveal. Results were compared with data on crop and tree species grown by rural households collected as part of the Africa RISING Baseline Evaluation Survey (ARBES) in the same communities. They show that in those communities, households grow or collect a higher number of plant species compared to those included in the baseline survey. By ignoring many of the species that are part of this diversity, we may be failing to take into consideration important sources of food and income for rural households.

# Introduction

The Africa Research In Sustainable Intensification for the Next Generation (Africa RISING) is an innovative research-for-development program that has been implemented in Ghana, Mali, Tanzania, Malawi, and Zambia since 2012. In Ghana, a project has been carried out in the Northern, Upper West, and Upper East regions. The project pays particular attention to the diversity of crops present in the agricultural systems in target regions, bringing together a wide range of research and development partners to develop management practices and technology combinations to integrate better crops (cereals, legumes and vegetables), livestock (including poultry), trees and shrubs in mixed-farming systems, in order to improve whole-farm productivity, human nutrition, and incomes of smallholder families, while conserving the environment and improving the links of farmers to markets and input suppliers (Larbi et al. 2014).

As a complement to this project in Ghana, Bioversity International in collaboration with the International Institute of Tropical Agriculture carried out a series of Focus Group Discussions (FGDs) during the earlier part of 2016 in 12 communities out of 50 where the project has been taking place. The methodology used for the FGDs implementation is part of a broader agricultural biodiversity (ABD) assessment method (Bellon 2017). The purpose of the FGDs was to elicit the local knowledge among rural households in those communities regarding the agricultural and useful wild plant biodiversity they grow or collect. This was done by generating: (a) an ordered inventory (list) of all useful plants used by local communities for human food, animal feed, medicine, fuel, etc. and their local names; and (b) an inventory of plant species and other products bought and sold in markets that people attend. The aim was to have a subjective assessment of the overall diversity of species households use and derive benefits from, how important each species is and how it contributes to the household's food and income, as well as how it is used. Key results of this study were compared with data on crop and tree species grown by rural households collected as part of the Africa RISING Baseline Evaluation Survey (ARBES) (IFPRI 2015) in the same communities where the FGDs took place. The hypothesis of our study is that households in marginal rural areas rely on many more species than conventional socioeconomic surveys reveal. Ignoring this diversity could lead to a biased analysis of their lives and livelihoods and of the costs and benefits of technological change. Results show that indeed, households in studied communities grow or collect a higher number of plant species compared to those included in the baseline survey carried by Africa RISING. The study presented here is exploratory; assessing the significance and implications of these results is beyond its scope and merits further research.

# The agricultural biodiversity assessment

The Agricultural Biodiversity Assessment (Bellon 2017) is a methodology that combines qualitative and quantitative approaches to assess the biodiversity of plant and animal species both domesticated and wild used for food by rural households in specific locations, as well as information on markets attended and general socioeconomic household characteristics. The Assessment aims at characterizing three dimensions of ABD: (1) the diversity of plant and animals species present on farm (including semi-domesticated species in home gardens and species collected from the wild), (2) the diversity of foods consumed in diets (included both local and exotic products, locally produced or imported, processed and industrialized); and (3) the diversity of plants and animal species and foods sold and purchased by households in markets (Figure 1).

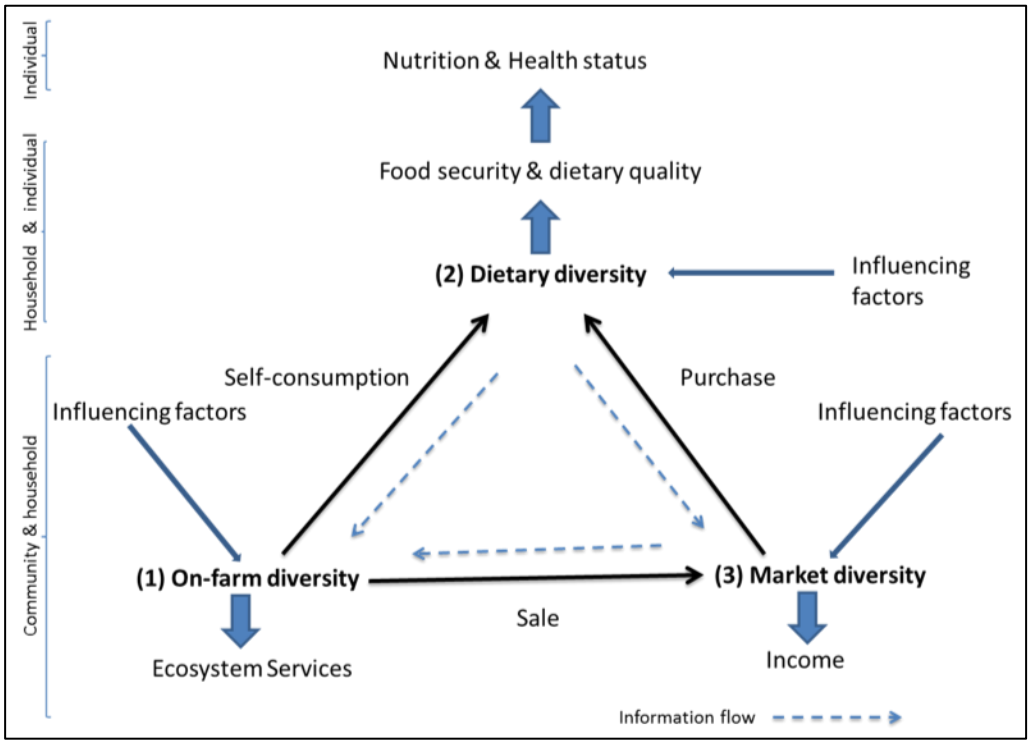


Figure 1. Conceptual model of the relationships among three dimensions of ABD.

Source: Bellon, M.R., Ntandou-Bouzitou, G. and Caracciolo, F. 2016. On-farm diversity and market participation are positively associated with dietary diversity of rural mothers in southern Benin, West Africa. PLoS ONE 11(9): e0162535 dbi:10.137V. http://dx.doi.org/10.1371/journal.pone.0162535

The ABD Assessment consists of two parts: (a) series of FGDs to elicit the local knowledge about the agricultural and wild biodiversity present in the study areas; and (b) a household survey with a representative random sample of households in multiple communities to elicit information on the agricultural biodiversity used by households; information on foods consumed by specific members of the household; and general information on household socioeconomic characteristics, food security and risk preferences. The data generated provide a basis for analyzing the roles of ABD in the lives and livelihoods of these rural populations in order to identify entry points for designing and implementing interventions that contribute to improving their well-being. As this was an exploratory study, only the first part of the methodology was implemented here.

# Methodology

Twelve communities were selected from among the fifty included in the Africa RISING project in Northern Ghana to represent high and low levels of crop interspecific diversity (Table 1). The levels of crop interspecific diversity were determined using data from the Africa RISING Baseline Evaluation Survey (ARBES) report (IFPRI 2015). For each community, we calculated two common measures of crop diversity: (1) a count of all crops grown (a measure of species richness), and (2) a Simpson Diversity Index, that combines indicators of crop richness and abundance [1] and is based on the proportion of households growing a crop. Based on species richness and the Simpson Diversity Index we ranked communities according to the levels of crop diversity present in each of them from high to low. From them, we selected six communities with contrasting levels of crop diversity that were being surveyed as part of a monitoring effort during the earlier part of 2016. An additional six communities were selected that were part of the project, but not of the monitoring effort, and that were located relatively close to the six monitored communities.

Table 1. Communities where the FGDs took place by region and level of crop diversity

| | Crop Diversity | |
|---|---|---|
| Region | High | Low |
| Northern | Duko | Tibali |
| Northern | Nabogu | Tindan |
| Upper East | Nyangua | Bonia |
| Upper East | Shia | Yenduri |
| Upper West | Gyilli | Zanko |
| Upper West | Naro | Tanina |

In total 24 FGDs were carried out from April to May of 2016. In each community, two FGDs were carried out: one with a group of males only and the other with females only. Participants were selected to represent a cross-section of households within the community. Each group included approximately 10 participants, ranging in age from their early 20s to their 70s, and in the case of two groups, up to their 90s. Participants were mostly farmers, but there were also traders. In total 225 persons participated in the focus groups, 108 males and 117 females. Local teams were recruited and trained in the methodology used.

During the FGD, participants were asked to make a list of all plant species they use divided into three types of species: (1) domesticated annual species, (2) domesticated trees and perennial species, and (3) wild and semi-wild plants. For each species within each of these groups, participants were asked to place the species into one of four categories drawn as a four cell diagram, depending on the number of households that grow or use a species and how common it is. The former category was always the same while the latter was adjusted depending on the type of species, e.g. a cultivated annual species (area occupied), a domesticated tree or perennial (number of trees/plants), or for the role of a species in markets, its frequency of sale or purchase respectively. For example, for domesticated annual species the categories/cells are:

1. Many households and occupying a large area in the community;
2. Few households and occupying a large area in the community;
3. Many households and occupying a small area in the community;
4. Few households and occupying a small area in the community.

[1] $SDI_i = 1-\sum\alpha_{ij}^2$, where $\alpha_{ij}$ is the area share occupied by the j-species among all species grown by household i.

Each category can be interpreted as a subjective assessment of the abundance of the species and how widespread it is sold or purchased. In addition, participants were asked to indicate the different parts of the plant that were used (grain, fruits, leaves, stems, roots) and their uses (food, fodder, medicine, construction). The main idea was to elicit as much diversity as possible and to have a subjective, but systematic, assessment of their role in households´ lives and livelihoods. The plant species elicited were compared to the list of crops and trees species included in the ARBES survey that was carried out in 2014 (IFPRI 2015). This list was compiled from other previous surveys in the country: the Ghana Living Standards Survey 6 (Ghana Statistical Service, 2014) and the Northern Ghana Agricultural Survey 2011 (IFPRI/ISSER, 2012).

# Results

## Domesticated annual species

Results from the FGDs regarding domesticated annual species are presented in Table 2, organized in the same categories used in ARBES survey (cereals, pulses & nuts, roots & tubers, vegetables and other crops). The table shows the scientific and common names of the different species, the total number of FGDs that mentioned each species, as well as the number of male and female groups. The data are organized by gender group.

The column “abundance” refers to the weighted score[2] of subjective abundance of a species; the maximum score is four, the minimum is one, and zero indicates that the species was not mentioned by any group of a particular gender but was mentioned by at least by one group of the other gender. The column “own” is the percentage of groups that indicated that the species was used for self-consumption. The column “sale” is the weighted score of the subjective assessment of how widespread the species was used for sale, while the column “purchased” refers to the weighted score of the subjective assessment of how widespread the species was purchased. The last two columns present data on the number of farmers and area planted from the ARBES survey for the 12 studied communities.

Domesticated annual species are ordered from high to low using first the total number of FGDs that mentioned the species and then by the sum of the weighted abundance scores of male and female groups. The FGDs identified 36 species, with the male groups identifying more species (34) than the female groups (29); five species were only identified by male groups and two exclusively by female groups. This contrasts with the ARBES survey where there was information only for 18 annual species (not counting unknown crops listed under the category of "other.”), so an additional 18 species were identified by the FGDs.

[2] The weighted score is the sum of the scores that each group gave to a crop species divided by the number of groups that provided a score. The scores were coded as follows: 4=many farmers, large area, 3=few farmers, large area, 2=many farmers, small area; 1=few farmers, small area. For other types of species and for sale and purchase the scores were adjusted regarding number of trees and frequency of sale or purchased. The score is not meant to provide a quantitative number but to provide an ordering.

Table 2. Results of FGDs on annual species by gender.

| Scientific name | Common name | All | males | males | males | males | males | females | females | females | females | females | Farmers | Area (ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. Groups | No. groups | Abundance[1] | Own (%)[2] | Sale[3] | Purchase[4] | No. groups | Abundance[1] | Own (%) | Sale[2] | Purchase[3] | | |
| **Cereals** | | | | | | | | | | | | | | |
| *Zea mays* | Maize | 24 | 12 | 3.7 | 100 | 2.1 | 1.9 | 12 | 4 | 100 | 2.8 | 3.3 | 292 | 355 |
| *Oryza sativa* | Rice | 22 | 10 | 3.5 | 100 | 3.2 | 2.3 | 12 | 3.4 | 100 | 3.2 | 2.8 | 169 | 170.3 |
| *Pennisetum glaucum* | Pearl millet | 22 | 11 | 2.2 | 100 | 2 | 1.9 | 11 | 3.4 | 100 | 2.3 | 2.6 | 78 | 43.6 |
| *Sorghum bicolor* | Sorghum | 21 | 10 | 3.4 | 100 | 1.6 | 2.4 | 11 | 4 | 100 | 2 | 3 | 53 | 28.5 |
| **Pulses & nuts** | | | | | | | | | | | | | | |
| *Glycine max* | Soybean | 23 | 11 | 2.2 | 100 | 1.9 | 1.6 | 12 | 2.9 | 100 | 2.3 | 2.4 | 56 | 49.7 |
| *Vigna unguiculata* | Cowpea | 22 | 11 | 2.6 | 100 | 2.1 | 1.4 | 11 | 3.2 | 100 | 2.3 | 2.4 | 16 | 6.4 |
| *Arachis hypogaea* | Groundnut | 21 | 11 | 2.8 | 100 | 2.4 | 2 | 10 | 4 | 90 | 2.7 | 3 | 198 | 180.7 |
| *Vigna subterranea* | Bambara nut | 19 | 10 | 1.7 | 100 | 1.5 | 1.4 | 9 | 3 | 100 | 2.3 | 3 | 48 | 13.6 |
| *Sesamum indicum* | Sesame | 1 | 1 | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| **Roots & Tubers** | | | | | | | | | | | | | | |
| *Ipomoea batatas* | Sweet potato | 15 | 10 | 1.2 | 100 | 1 | 1.4 | 5 | 1.4 | 100 | 1.5 | 1.8 | 2 | 0.3 |
| *Dioscorea rotundata* | Yam | 14 | 8 | 2.6 | 100 | 1.8 | 1.8 | 6 | 3.3 | 100 | 2.4 | 2.3 | 84 | 29.5 |
| *Manihot esculenta* | Cassava | 14 | 7 | 2.6 | 100 | 1.4 | 1.5 | 7 | 2.6 | 100 | 1.5 | 2 | 12 | 4.3 |
| *Solenostemum rotundifolius Po* | Frafra potato | 5 | 3 | 1.3 | 100 | 0 | 2 | 2 | 1 | 100 | 1 | 1 | | |
| *Cyperus esculentus* | Tiger nut | 4 | 4 | 1.3 | 100 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | | |
| *Allium cepa* | Onion | 4 | 2 | 1 | 100 | 2 | 2 | 2 | 1.5 | 100 | 4 | 3 | 0 | 0 |
| *Dioscorea bulbifera* | Aerial Yam | 4 | 2 | 1 | 100 | 0 | 1 | 2 | 1 | 100 | 3 | 2 | | |
| **Vegetables** | | | | | | | | | | | | | | |
| *Abelmoschus esculentus* | Okra | 22 | 11 | 2.3 | 100 | 1.8 | 2.9 | 11 | 3.2 | 100 | 2.5 | 2.8 | 7 | 2.2 |
| *Capsicum spp* | Pepper | 22 | 11 | 1.9 | 100 | 2.1 | 3.1 | 11 | 2.9 | 100 | 2.7 | 3.2 | 14 | 3.7 |
| *Solanum lycopersicum* | Tomato | 20 | 13 | 1.3 | 100 | 1.3 | 2.6 | 7 | 2.4 | 100 | 3 | 3.9 | 4 | 1.3 |
| *Hibiscus cannabinus* | Kenef | 14 | 9 | 1.7 | 100 | 1.5 | 1.8 | 5 | 3.6 | 100 | 3.2 | 2.8 | | |
| *Amaranthus cruentus* | Amaranthus | 13 | 6 | 1.3 | 100 | 1.5 | 1.3 | 7 | 2.9 | 100 | 2 | 2.3 | | |
| *Corchorus olitorious* | Ayoyo | 10 | 4 | 1 | 100 | 1 | 1 | 6 | 2 | 100 | 2.3 | 2.8 | | |
| *Hibiscus sabdariffa* | Roselle | 9 | 3 | 1.7 | 100 | 1 | 1 | 6 | 2.3 | 100 | 1.2 | 2.3 | | |
| *Cajanus cajan* | Pigeon pea | 7 | 4 | 1.3 | 100 | 1.5 | 2.3 | 3 | 1.7 | 100 | 1.3 | 1.3 | 1 | 0.2 |
| *Solanum melongena* | Eggplant | 6 | 3 | 1.7 | 100 | 3 | 1.5 | 3 | 2 | 100 | 2.7 | 2.7 | 1 | 0.4 |
| *Cucurbita maxima* | Pumpkin | 5 | 3 | 2.3 | 100 | 2 | 3 | 2 | 2.5 | 100 | 1 | 2.5 | | |
| *Cucumis metuliferus* | Africa Cucun | 3 | 1 | 1 | 100 | 1 | 1 | 2 | 1.5 | 100 | 2 | 3.5 | | |
| *Citrullus lanatus var. lanatus* | Watermelon | 2 | 2 | 2 | 100 | 1.5 | 1.5 | 0 | 0 | 0 | 0 | 0 | 1 | 0.4 |
| *Solanum aethiopicum* | Eggplant | 1 | 1 | 2 | 100 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | | |
| *Citrullus lanatus* | Nairee | 1 | 1 | 1 | 100 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | | |
| *Cucumis melo Indorus Group* | Yellow melor | 1 | 1 | 1 | 100 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | | |
| *Cucumis sativus* | Cucumber | 1 | 1 | 1 | 100 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | | |
| *Brassica oleracea* | Cabbage | 1 | 0 | 0 | 0 | 0 | 0 | 1 | | | | | | |
| *Daucus carota subsp. sativus* | Carrot | 1 | 0 | 0 | 0 | 0 | 0 | 1 | | | | | | |
| **Other crops** | | | | | | | | | | | | | | |
| *Nicotiana tabacum* | Tobacco | 4 | 3 | 1 | 100 | 2.7 | 1.3 | 1 | 4 | 100 | 4 | 1 | 3 | 3.03 |
| *Lagenaria siceraria* | Gauge | 2 | 1 | 1 | 100 | 0 | 0 | 1 | 4 | 100 | 4 | 0 | | |

[1]Subjective score of the abundance of the species, the higher the score the more

Table 2 shows the domesticated annual species not included in the ARBES survey. We should add that there were two species identified in the ARBES survey that FGDs did not identify: finger millet and beans. The main differences between the species elicited in the FGDs and the baseline survey are among the vegetables, since they comprise 12 out of the 18 species exclusively identified by FGDs. The baseline survey provided information only for six. This is followed by the category roots and tubers, where the FGDs identified seven species, but the baseline provided information only for three. Not surprisingly the crop species identified by FGDs, but not in the baseline survey, tend to have low weighted scores of abundances (usually below 2) and were mentioned by few groups. However, some of these species while having a low score were mentioned by many FGDs, such as *Hibiscus cannabinus*, *Amaranthus cruentus* and *Hibiscus sabdariffa*. Many of the crop species with low scores are what one could term as "neglected and under-utilized" species, such as *Solenstemum rotundifolious*, *Discorea bulbifera*, *Cyperus esculentum*, *Solanum aethiopicum,* and *Cucumis metuliferus*. Almost all species identified by the focus groups are used for self-consumption (surprisingly including *Nicotiana tabacum*, probably used as a stimulant). Almost all are traded regardless of their abundance, because households sell and/or buy them. In general, the domesticated annual species included in the ARBES survey received higher ratings than those not included, meaning that they were considered to be more abundant and traded than the species that were not included. Furthermore, women groups gave higher scores than male groups to all domesticated annual species.

These results can be presented in the context of the conceptual model of the relationships among three dimensions of agricultural biodiversity (Figure 2) showing that communities maintain many crop species, though there are variations among communities and by gender. Almost all species contribute to the households' food self-consumption in all communities and all are sold as well as purchased, but in different proportions according to village and gender.

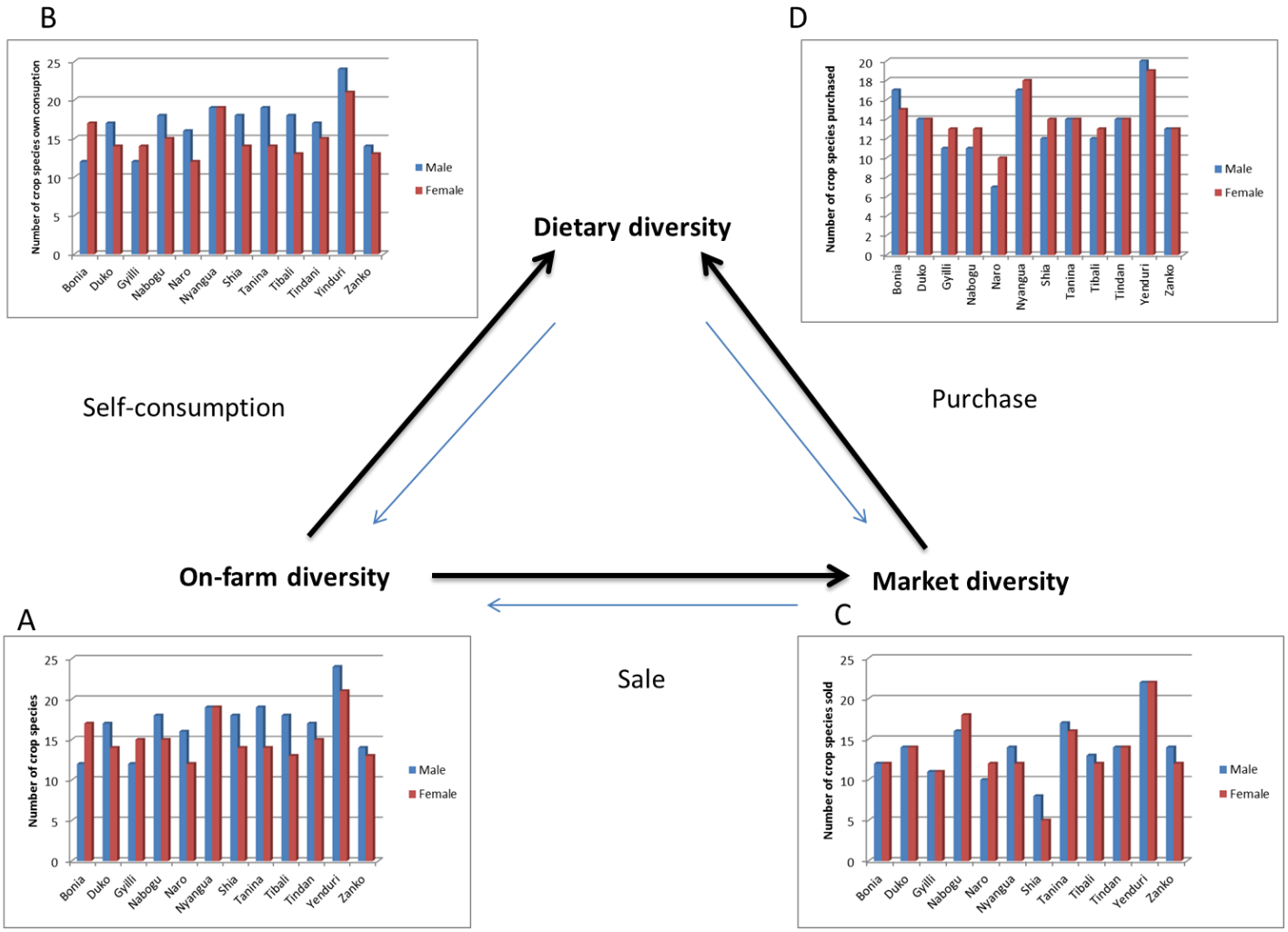


Figure 2. Results of the FGDs by gender. For annual species overlaid on the conceptual model of the relationships among three dimensions of ABD. The graph on on-farm diversity (A) shows the number of crop species that the focus groups identified in each of the 12 communities by gender. The graph on species used for self-consumption (B) shows the number of crop species produced that are consumed directly by the farming households according to the focus groups for each of the communities by gender. The graph on species sold (C) shows the number of the crops species that were sold according to the focus groups for each of the communities by gender. The graph on species purchased (D) shows the number of the crops species that were purchased according to the focus groups for each of the communities by gender.

## Trees and perennial species

Tables 3 and 4 show key results for the male and female FGDs respectively, regarding trees and perennial species. Each table shows the scientific and common names (for the latter in English, if available), followed by the total number of groups that mentioned a species (only in Table 3), and specifically for male and female groups (depending on the table), the "abundance" weighted score[3], the percentages of groups that said the species was used for their own consumption as food, sold, purchased, used for fodder, medicine, fuel, and construction, and what part of the plant was used: leaves, fruits/seeds, stem/trunk, root/tuber. The data are organized by gender group and are ordered from high to low using first the total number of groups that mentioned the species and then by the sum of the weighted abundance scores of male and female groups. FGDs identified a total of 48 species (male groups 38 and female groups 37). The list of tree species includes several common fruit trees such as cashew (*Anacardium occidentale*), mango (*Mangifera indica*), banana (*Musa* spp.), orange (*Citrus sinensis*), coconut (*Cocos nucifera*), guava (*Psidium guajava*) lemon (*Citrus x limon*), and papaya (*Carica papaya*). However many of the species are important African trees such as the Shea tree (*Vitellaria paradoxa*), the Baobab tree (*Adansonia digitate*), the African locus bean tree (*Parkia biglabosa*), as well as the Neem tree (*Azadirachta indica*). Some species while mentioned by many FGDs, were given low "abundance" scores indicating that either they are scarce in the environment or are not used frequently. Table 6 summarizes the number of perennial species mentioned by the focus groups for a particular use, and the parts of the plant used. It shows for example, that more than two thirds of the species were used as food (e.g. 24 and 29 species mentioned by male and female groups respectively). About half of the species were traded, either being sold or purchased, and have many uses, not only as food, but also as fodder, fuel, medicine and for construction, however specific uses varied by species. Furthermore, different parts of the plant were used to different extents in the case of each species. Except for Baobab, Shea nut, mango, bananas, papaya, and oil palm, in the baseline survey many of the species identified by the FGDs were not taken into consideration in the ARBES survey.

Table 3. Annual species not included in the baseline survey

| Scientific name | Common name | No. groups |
|---|---|---|
| **Pulses & nuts** | | |
| *Sesamum indicum* | Sesame | 1 |
| **Roots & Tubers** | | |
| *Solenostemum rotundifolius Poir* | Frafra potato | 5 |
| *Cyperus esculentus* | Tiger nut | 4 |
| *Allium cepa* | Onion | 4 |
| *Dioscorea bulbifera* | Aerial Yam | 4 |
| **Vegetables** | | |
| *Hibiscus cannabinus* | Kenef | 14 |
| *Amaranthus cruentus* | Amaranthus | 13 |
| *Corchorus olitorious* | Ayoyo | 10 |
| *Hibiscus sabdariffa* | Roselle | 9 |
| *Cucurbita maxima* | Pumpkin | 5 |
| *Cucumis metuliferus* | Africa Cucumber | 3 |

[3] In this context the scores have been coded as follows: 4=many farmers, used frequently; 3=few farmers, used frequently; 2=many farmers, used infrequently; 1=few farmers, used infrequently.

| | | |
|---|---|---|
| *Solanum aethiopicum* | Eggplant | 1 |
| *Citrullus lanatus* | Nairee | 1 |
| *Cucumis melo Indorus Group* | Yellow melon | 1 |
| *Cucumis sativus* | Cucumber | 1 |
| *Brassica oleracea* | Cabbage | 1 |
| *Daucus carota subsp. sativus* | Carrot | 1 |
| **Other crops** | | |
| *Lagenaria siceraria* | Gauge | 2 |

Table 4. Results of the male FGDs for trees and perennial species

| Scientific name | Common name | No. Groups | No.Groups | Abundance[1] | Own food[2] | Sold[2] | Purchased[2] | Fodder[2] | Medicine[2] | Fuel[2] | Construction[2] | Leaves[3] | Fruit/seed[3] | Stem/ trunck[3] | Root tuber[3] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Mangifera indica* | Mango | 23 | 12 | 2.1 | 100 | 75 | 92 | 67 | 50 | 75 | 25 | 25 | 75 | 75 | 8 |
| *Azadirachta indica* | Neem tree | 22 | 12 | 2.5 | 8 | 8 | 0 | 8 | 83 | 83 | 92 | 50 | 8 | 83 | 42 |
| *Adansonia digitata* | Baobab | 19 | 9 | 2.4 | 100 | 56 | 56 | 67 | 67 | 33 | 11 | 78 | 100 | 67 | 0 |
| *Moringa olefera* | Moringa | 19 | 9 | 1.2 | 100 | 78 | 56 | 67 | 89 | 56 | 0 | 67 | 67 | 44 | 11 |
| *Diospyros mespiliformis* | Ebony (jackalberry) | 17 | 9 | 1.9 | 100 | 44 | 22 | 11 | 89 | 100 | 44 | 44 | 44 | 78 | 22 |
| *Ceiba pentandra* | Kapok tree | 16 | 10 | 2.0 | 70 | 50 | 50 | 40 | 60 | 90 | 60 | 70 | 40 | 90 | 10 |
| *Anacardium occidentale* | Cashew | 13 | 7 | 2.6 | 100 | 57 | 29 | 29 | 29 | 86 | 0 | 29 | 71 | 57 | 14 |
| *Vitellaria paradoxa* | Shea tree | 13 | 6 | 3.7 | 100 | 100 | 100 | 83 | 100 | 100 | 33 | 50 | 50 | 67 | 0 |
| *Parkia biglobosa* | African locust bean | 12 | 6 | 2.7 | 100 | 100 | 83 | 50 | 83 | 100 | 33 | 50 | 50 | 67 | 0 |
| *Carica papaya* | Papaya (pawpaw) | 10 | 4 | 1.0 | 100 | 25 | 50 | 0 | 100 | 25 | 0 | 25 | 100 | 0 | 0 |
| *Tectona grandis* | Teak | 10 | 5 | 1.8 | 0 | 40 | 60 | 0 | 40 | 100 | 80 | 20 | 20 | 80 | 20 |
| *Blighia sapida* | Akee-apple | 9 | 6 | 1.7 | 83 | 33 | 40 | 50 | 67 | 100 | 0 | 0 | 83 | 100 | 0 |
| *Lannea microcarpa* | | 8 | 4 | 2.0 | 100 | 0 | 0 | 50 | 100 | 75 | 0 | 100 | 0 | 25 | 0 |
| *Acacia auriculiformis* | Acasia | 7 | 3 | 1.3 | 0 | 0 | 0 | 33 | 0 | 67 | 33 | 0 | 0 | 100 | 0 |
| *Dialium guineense* | African velvet tamarind | 5 | 1 | 1.0 | 100 | 100 | 100 | 100 | 100 | 100 | 0 | 100 | 0 | 0 | 0 |
| *Khaya senegalensis* | Mahogany | 5 | 5 | 1.4 | 0 | 20 | 40 | 80 | 100 | 100 | 100 | 20 | 40 | 100 | 40 |
| *Anigeissus latifolia* | | 4 | 2 | 4.0 | 0 | 50 | 0 | 0 | 100 | 100 | 0 | 0 | 50 | 50 | 0 |
| *Elaeis guineensis* | African oil palm tree | 4 | 2 | 1.0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 100 | 0 | 0 |
| *Pseudocedrela kotschyi* | | 4 | 2 | 1.5 | 50 | 0 | 0 | 50 | 100 | 100 | 50 | 0 | 50 | 100 | 0 |
| *Ficus glumosa* | Afrotropical tree | 3 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ficus gnaphalocarpa* | | 3 | 2 | 1.0 | 0 | 0 | 0 | 100 | 100 | 100 | 50 | 0 | 100 | 100 | 0 |
| *Maerua angolensis* | | 3 | 2 | 3.5 | 50 | 50 | 0 | 100 | 100 | 0 | 0 | 100 | 50 | 50 | 0 |
| *Musa spp.* | Banana | 3 | 2 | 1.0 | 100 | 50 | 100 | 50 | 0 | 0 | 0 | 50 | 50 | 0 | 0 |
| *Psidium guajava* | Guava | 3 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pterocarpus erinaceus* | | 3 | 2 | 2.0 | 0 | 100 | 0 | 100 | 100 | 100 | 50 | 0 | 100 | 100 | 0 |
| *Annona senegalensis* | African custard apple | 2 | 2 | 2.5 | 50 | 50 | 0 | 50 | 100 | 50 | 0 | 50 | 50 | 50 | 0 |
| *Balanites aegyptiaca* | Desert date | 2 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Citrus sinensis* | Orange | 2 | 1 | 1.0 | 100 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| *Cocos nucifera* | Coconut | 2 | 1 | 1.0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| *Daniellia oliveri* | African balsam tree | 2 | 1 | 4.0 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 0 | 100 | 100 |
| *Delonix regia* | Flamboyan | 2 | 1 | 1.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Piliostigma thonningii* | | 2 | 2 | 3.0 | 50 | 50 | 50 | 50 | 50 | 50 | 0 | 0 | 50 | 0 | 0 |
| *Synsepalum dulcificum* | | 2 | 1 | 3.0 | 100 | 0 | 0 | 100 | 100 | 100 | 0 | 0 | 100 | 100 | 0 |
| *Acacia dudgeoni* | | 1 | 1 | 4.0 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 0 | 100 | 100 |
| *Acacia nilotica* | Gum arabic tree | 1 | 1 | 1.0 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 100 | 0 |
| *Amaranthus spinosus* | | 1 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Arachis hypogaea* | | 1 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Bombax ceiba* | Bombax tree | 1 | 1 | 4.0 | 0 | 0 | 0 | 0 | 100 | 100 | 100 | 0 | 0 | 100 | 0 |
| *Citrus × limon* | Lemon tree | 1 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Detarium microcarpum* | | 1 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dioscorea alata* | Water yam | 1 | 1 | 4.0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ficus iteophylla* | | 1 | 1 | 1.0 | 0 | 0 | 0 | 100 | 100 | 100 | 100 | 0 | 100 | 0 | 0 |
| *Icacina oliviformis* | | 1 | 1 | 4.0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 100 |
| *Gardenia erubscens* | | 1 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rubus spp.* | Berry | 1 | 1 | 3.0 | 100 | 0 | 0 | 100 | 100 | 100 | 0 | 0 | 100 | 100 | 0 |
| *Scerocaraya birrea* | Marula | 1 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Smilax spp* | | 1 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Vitex doniana* | Blackberry | 1 | 1 | 2.0 | 100 | 0 | 0 | 100 | 100 | 100 | 0 | 100 | 0 | 0 | 0 |

[1]Subjective score of the abundance of the species, the higher the score the more abundant a species was rated by the focus groups
[2]Percentage of focus groups that indicated the species was sold or purchased, or a particular part of the plant was used
[3]Percentage of focus groups that indicated a particular part of the plant species was us.

Table 5. Results of the female FGDs for trees and perennial species

| Scientific name | Common name | No.Groups | Abundance[1] | Own food[2] | Sold[2] | Purchased[2] | Fodder[2] | Medicine[2] | Fuel[2] | Construction[2] | Leaves[3] | Fruit/seed[3] | Stem/ trunck[3] | Root tuber[3] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Mangifera indica* | Mango | 11 | 2.5 | 100 | 82 | 100 | 91 | 82 | 82 | 18 | 70 | 70 | 60 | 0 |
| *Azadirachta indica* | Neem tree | 10 | 3.0 | 40 | 10 | 10 | 40 | 90 | 100 | 90 | 60 | 40 | 100 | 10 |
| *Adansonia digitata* | Baobab | 10 | 3.4 | 100 | 90 | 80 | 40 | 30 | 40 | 0 | 78 | 100 | 56 | 11 |
| *Moringa olefera* | Moringa | 10 | 2.8 | 100 | 40 | 20 | 70 | 90 | 20 | 0 | 90 | 50 | 30 | 0 |
| *Diospyros mespiliformis* | Ebony (jackalberry) | 8 | 2.6 | 100 | 75 | 63 | 50 | 63 | 100 | 38 | 13 | 88 | 100 | 13 |
| *Ceiba pentandra* | Kapok tree | 6 | 2.5 | 83 | 67 | 33 | 83 | 33 | 83 | 0 | 83 | 50 | 67 | 0 |
| *Anacardium occidentale* | Cashew | 6 | 2.0 | 100 | 83 | 33 | 17 | 33 | 83 | 0 | 50 | 67 | 83 | 0 |
| *Vitellaria paradoxa* | Shea tree | 7 | 3.6 | 100 | 86 | 57 | 71 | 71 | 71 | 57 | 71 | 29 | 57 | 14 |
| *Parkia biglobosa* | African locust bean | 6 | 2.5 | 100 | 83 | 100 | 100 | 50 | 83 | 83 | 17 | 67 | 83 | 33 |
| *Carica papaya* | Papaya (pawpaw) | 6 | 1.3 | 100 | 33 | 100 | 33 | 83 | 0 | 0 | 33 | 67 | 17 | 0 |
| *Tectona grandis* | Teak | 5 | 2.2 | 0 | 20 | 20 | 0 | 40 | 100 | 80 | 20 | 20 | 80 | 0 |
| *Blighia sapida* | Akee-apple | 3 | 1.0 | 100 | 67 | 0 | 33 | 67 | 67 | 0 | 0 | 100 | 67 | 0 |
| *Lannea microcarpa* | | 4 | 1.8 | 100 | 75 | 50 | 100 | 75 | 75 | 25 | 25 | 75 | 100 | 25 |
| *Acacia auriculiformis* | Acasia | 4 | 2.8 | 25 | 0 | 0 | 25 | 50 | 75 | 25 | 50 | 0 | 75 | 0 |
| *Dialium guineense* | African velvet tamarind | 4 | 2.5 | 100 | 100 | 25 | 50 | 100 | 100 | 0 | 50 | 100 | 100 | 25 |
| *Khaya senegalensis* | Mahogany | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Anigeissus latifolia* | | 2 | 2.5 | 0 | 50 | 0 | 50 | 50 | 100 | 0 | 50 | 0 | 100 | 0 |
| *Elaeis guineensis* | African oil palm tree | 2 | 1.0 | 100 | 50 | 100 | 50 | 0 | 50 | 0 | 0 | 100 | 0 | 0 |
| *Pseudocedrela kotschyi* | | 2 | 2.5 | 100 | 0 | 0 | 50 | 50 | 50 | 0 | 0 | 50 | 50 | 0 |
| *Ficus glumosa* | Afrotropical tree | 3 | 2.0 | 100 | 0 | 0 | 67 | 0 | 0 | 0 | 0 | 0 | 67 | 0 |
| *Ficus gnaphalocarpa* | | 1 | 4.0 | 0 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 100 | 100 | 0 |
| *Maerua angolensis* | | 1 | 2.0 | 100 | 100 | 0 | 100 | 100 | 100 | 0 | 100 | 100 | 100 | 100 |
| *Musa spp.* | Banana | 1 | 3.0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 100 | 100 | 0 |
| *Psidium guajava* | Guava | 3 | 1.0 | 100 | 33 | 67 | 100 | 100 | 33 | 0 | 33 | 67 | 33 | 0 |
| *Pterocarpus erinaceus* | | 1 | 1.0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 |
| *Annona senegalensis* | African custard apple | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Balanites aegyptiaca* | Desert date | 2 | 1.0 | 100 | 50 | 0 | 100 | 50 | 50 | 0 | 100 | 50 | 100 | 0 |
| *Citrus sinensis* | Orange | 1 | 1.0 | 100 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 100 | 100 | 0 |
| *Cocos nucifera* | Coconut | 1 | 1.0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| *Daniellia oliveri* | African balsam tree | 1 | 1.0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 |
| *Delonix regia* | Flamboyan | 1 | 1.0 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 100 | 0 | 100 | 0 |
| *Piliostigma thonningii* | | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Synsepalum dulcificum* | | 1 | 2.0 | 0 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 0 |
| *Acacia dudgeoni* | | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Acacia nilotica* | Gum arabic tree | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Amaranthus spinosus* | | 1 | 4.0 | 0 | 100 | 0 | 0 | 100 | 100 | 0 | 100 | 0 | 100 | 100 |
| *Arachis hypogaea* | | 1 | 2.0 | 100 | 100 | 100 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 |
| *Bombax ceiba* | Bombax tree | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Citrus × limon* | Lemon tree | 1 | 1.0 | 100 | 100 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 |
| *Detarium microcarpum* | | 1 | 2.0 | 100 | 100 | 100 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 |
| *Dioscorea alata* | Water yam | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ficus iteophylla* | | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Icacina oliviformis* | | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Gardenia erubscens* | | 1 | 2.0 | 100 | 100 | 100 | 100 | 0 | 0 | 0 | 0 | 0 | 100 | 0 |
| *Rubus spp.* | Berry | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Scerocaraya birrea* | Marula | 1 | 1.0 | 100 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 100 | 0 |
| *Smilax spp* | | 1 | 2.0 | 100 | 0 | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| *Vitex doniana* | Blackberry | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

[1]Subjective score of the abundance of the species, the higher the score the more abundant a species was rated by the focus groups
[2]Percentage of focus groups that indicated the species was sold or purchased, or a particular part of the plant was used
[3]Percentage of focus groups that indicated a particular part of the plant species was used

Table 6. Summary of the number of perennial species by use.

| | Males | | Females | |
|---|---|---|---|---|
| | No. Groups | % | No. Groups | % |
| No. Groups | 38 | | 37 | |
| Own food | 24 | 63.2 | 29 | 78.4 |
| Sold | 21 | 55.3 | 24 | 64.9 |
| Purchased | 15 | 39.5 | 22 | 59.5 |
| Fodder | 25 | 65.8 | 25 | 67.6 |
| Medicine | 32 | 84.2 | 23 | 62.2 |
| Fuel | 30 | 78.9 | 29 | 78.4 |
| Construction | 15 | 39.5 | 9 | 24.3 |
| Leaves | 19 | 50.0 | 21 | 56.8 |
| Fruit/seed | 28 | 73.7 | 25 | 67.6 |
| Stem/ trunck | 26 | 68.4 | 32 | 86.5 |
| Root tuber | 11 | 28.9 | 9 | 24.3 |

## Wild plant species

Key results regarding wild plant species for the male and female FGDs respectively are presented in Tables 7 and 8. FGDs identified a total of 49 species (male groups 40 and female groups 32), of those, 36 were the same as those identified in the section on trees and perennial species. Thirteen species were unique to this exercise: *Afzelia africana, Calotropis procera, Chrysophyllum albidum, Cyperus esculentus, Combretum molle, Faidherbia albida, Ficus platyphylla, Gardenia spp., Jatropha curcas, Prosopis africana, Securidaca longipedunculata, Sesamum indicum, Tamarindus indica.* It is noteworthy that these groups also identified domesticated species such as mango, guava, and tamarind in the group of wild species. Table 9 summarizes the number of wild species mentioned by the focus groups for a particular use and parts of the plant used. It shows for example, that about two thirds of the species were used as food (e.g. 23 and 22 species mentioned by male and female groups respectively). Most of the species were traded—either being sold or purchased—and, as mentioned for the previous categories, have many uses, not only as food, but also as fodder, fuel, and medicine, and for construction, but uses varied by species. Furthermore, different parts of the plant were used to different extents in the case of each species.

Table 7. Results of the male FGDs for wild plant species.

| Scientific name | Common name | No. Groups | No.Groups | Abundance[1] | Own food[2] | Sold[2] | Purchased[2] | Fodder[2] | Medicine[2] | Fuel[2] | Construction[2] | Leaves[3] | Fruit/seed[3] | Stem/ trunck[3] | Root tuber[3] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Parkia biglobosa* | African locus bean | 18 | 9 | 2.7 | 100 | 100 | 100 | 33 | 78 | 100 | 33 | 33 | 67 | 78 | 11 |
| *Vitellaria paradoxa* | Shea tree | 18 | 10 | 3.6 | 100 | 90 | 70 | 50 | 90 | 100 | 50 | 40 | 70 | 70 | 0 |
| *Lannea microcarpa* | | 11 | 7 | 2.4 | 100 | 14 | 0 | 43 | 71 | 86 | 0 | 57 | 43 | 43 | 0 |
| *Diospyros mespiliformis* | Ebony (jackalberry) | 10 | 6 | 2.2 | 83 | 33 | 17 | 0 | 100 | 100 | 33 | 67 | 33 | 50 | 17 |
| *Vitex doniana* | Blackberry | 10 | 6 | 2.5 | 100 | 33 | 17 | 50 | 67 | 100 | 17 | 50 | 67 | 50 | 0 |
| *Adansonia digitata* | Baobab | 9 | 5 | 1.0 | 100 | 100 | 60 | 40 | 80 | 20 | 20 | 40 | 100 | 80 | 0 |
| *Chrysophyllum albidum* | | 8 | 4 | 3.5 | 100 | 25 | 25 | 0 | 25 | 50 | 25 | 25 | 100 | 75 | 0 |
| *Azadirachta indica* | Neem tree | 6 | 3 | 3.3 | 0 | 33 | 0 | 33 | 67 | 100 | 67 | 33 | 33 | 67 | 33 |
| *Synsepalum dulcificum* | | 6 | 3 | 3.7 | 100 | 33 | 33 | 100 | 67 | 100 | 67 | 33 | 100 | 100 | 0 |
| *Ceiba pentandra* | Kapok tree | 5 | 2 | 1.0 | 50 | 50 | 50 | 0 | 100 | 100 | 100 | 100 | 0 | 100 | 0 |
| *Ficus gnaphalocarpa* | | 5 | 4 | 1.5 | 50 | 0 | 0 | 75 | 50 | 75 | 25 | 0 | 75 | 75 | 25 |
| *Khaya senegalensis* | Mahogany | 5 | 5 | 1.6 | 0 | 20 | 60 | 40 | 100 | 100 | 80 | 20 | 40 | 100 | 80 |
| *Detarium microcarpum* | | 4 | 1 | 2.0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 100 | 100 | 0 |
| *Mangifera indica* | Mango | 4 | 1 | 1.0 | 100 | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 0 | 100 | 0 |
| *Anigeissus spinosa* | | 3 | 2 | 4.0 | 0 | 50 | 0 | 0 | 100 | 100 | 0 | 0 | 0 | 100 | 0 |
| *Balanites aegyptiaca* | Desert date | 3 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Maerua angolensis* | | 3 | 2 | 3.5 | 50 | 50 | 0 | 100 | 100 | 0 | 0 | 50 | 100 | 50 | 0 |
| *Moringa olefera* | Moringa | 3 | 1 | 1.0 | 100 | 100 | 0 | 100 | 100 | 0 | 0 | 0 | 100 | 0 | 0 |
| *Securidaca longipedunculata* | | 3 | 2 | 1.0 | 0 | 0 | 0 | 50 | 100 | 50 | 50 | 0 | 100 | 100 | 0 |
| *Tamarindus indica* | Tamarind | 3 | 2 | 1.5 | 100 | 50 | 0 | 50 | 100 | 100 | 0 | 0 | 100 | 100 | 0 |
| *Annona senegalensis* | African custard apple | 2 | 2 | 3.5 | 67 | 33 | 0 | 33 | 100 | 67 | 0 | 33 | 33 | 67 | 0 |
| *Daniellia oliveri* | African balsam tree | 2 | 1 | 4.0 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 0 | 100 | 0 |
| *Faidherbia albida* | | 2 | 1 | 1.0 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 0 | 100 | 0 |
| *Ficus platyphylla* | | 2 | 1 | 1.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Gardenia erubscens* | | 2 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Jatropha curcas* | Jatropha | 2 | 1 | 1.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 |
| *Pterocarpus erinaceus* | | 2 | 1 | 2.0 | 0 | 100 | 0 | 100 | 100 | 100 | 100 | 0 | 100 | 100 | 0 |
| *Tectona grandis* | Teak | 2 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Acacia dudgeoni* | | 1 | 1 | 4.0 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 0 | 100 | 0 |
| *Acacia auriculiformis* | Acacia | 1 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Afzelia africana* | | 1 | 1 | 1.0 | 100 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Amaranthus spinosus* | | 1 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Blighia sapida* | Akee-apple | 1 | 1 | 1.0 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 0 | 100 | 0 |
| *Bombax ceiba* | Bombax tree | 1 | 1 | 4.0 | 0 | 0 | 0 | 0 | 100 | 100 | 100 | 0 | 0 | 100 | 0 |
| *Calotropis procera* | | 1 | 1 | 1.0 | 100 | 0 | 0 | 100 | 100 | 100 | 0 | 100 | 100 | 100 | 0 |
| *Cyperus esculentus* | | 1 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Combretum molle* | | 1 | 1 | 4.0 | 100 | 0 | 0 | 100 | 100 | 100 | 0 | 100 | 0 | 100 | 0 |
| *Delonix regia* | Flamboyan | 1 | 1 | 1.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dialium guineense* | African velvet tamarind | 1 | 1 | 2.0 | 100 | 0 | 0 | 100 | 100 | 100 | 0 | 0 | 100 | 100 | 0 |
| *Dioscorea alata* | Water yam | 1 | 1 | 4.0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 0 |
| *Ficus iteophylla* | | 1 | 1 | 1.0 | 0 | 0 | 0 | 100 | 100 | 100 | 100 | 0 | 100 | 0 | 0 |
| *Icacina oliviformis* | | 1 | 1 | 4.0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 100 |
| *Gardenia spp* | | 1 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Piliostigma thonningii* | | 1 | 1 | 4.0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 |
| *Psidium guajava* | Guava | 1 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Prosopis africana* | | 1 | 1 | 2.0 | 100 | 100 | 100 | 100 | 0 | 100 | 0 | 0 | 100 | 100 | 0 |
| *Pseudocedrela kotschyi* | | 1 | 1 | 2.0 | 100 | 0 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 0 |
| *Scerocaraya birrea* | | 1 | 1 | 1.0 | 100 | 0 | 0 | 100 | 0 | 100 | 100 | 0 | 100 | 100 | 0 |
| *Sesamum indicum* | | 1 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

[1]Subjective score of the abundance of the species, the higher the score the more abundant a species was rated by the focus groups
[2]Percentage of focus groups that indicated the species was sold or purchased, or a particular part of the plant was used
[3]Percentage of focus groups that indicated a particular part of the plant species was used

Table 8. Results of the female FGDs for wild plant species.

| Scientific name | Common name | No.Groups | Abundance[1] | Own food[2] | Sold[2] | Purchased[2] | Fodder[2] | Medicine[2] | Fuel[2] | Construction[2] | Leaves[3] | Fruit/seed[3] | Stem/ trunck[3] | Root tuber[3] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Parkia biglobosa* | African locus bean | 9 | 3.0 | 100 | 0 | 100 | 22 | 56 | 89 | 44 | 11 | 78 | 78 | 22 |
| *Vitellaria paradoxa* | Shea tree | 8 | 3.6 | 100 | 0 | 88 | 75 | 75 | 100 | 88 | 25 | 75 | 88 | 0 |
| *Lannea microcarpa* | | 4 | 2.5 | 100 | 50 | 25 | 25 | 50 | 100 | 0 | 25 | 100 | 100 | 0 |
| *Diospyros mespiliformis* | Ebony (jackalberry) | 4 | 4.0 | 100 | 0 | 100 | 50 | 100 | 100 | 0 | 50 | 100 | 100 | 0 |
| *Vitex doniana* | Blackberry | 4 | 3.0 | 75 | 25 | 50 | 50 | 50 | 100 | 25 | 50 | 75 | 100 | 0 |
| *Adansonia digitata* | Baobab | 4 | 3.3 | 100 | 25 | 50 | 75 | 50 | 75 | 25 | 75 | 100 | 75 | 25 |
| *Chrysophyllum albidum* | | 4 | 3.5 | 100 | 0 | 50 | 100 | 0 | 25 | 0 | 25 | 75 | 25 | 0 |
| *Azadirachta indica* | Neem tree | 3 | 3.3 | 0 | 67 | 33 | 100 | 100 | 67 | 67 | 33 | 0 | 67 | 0 |
| *Synsepalum dulcificum* | | 3 | 3.3 | 100 | 100 | 67 | 0 | 0 | 67 | 33 | 0 | 100 | 67 | 0 |
| *Ceiba pentandra* | Kapok tree | 3 | 2.0 | 67 | 33 | 33 | 33 | 33 | 33 | 33 | 100 | 33 | 67 | 0 |
| *Ficus gnaphalocarpa* | | 1 | 4.0 | 0 | 100 | 0 | 100 | 0 | 100 | 100 | 0 | 0 | 100 | 0 |
| *Khaya senegalensis* | Mahogany | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Detarium microcarpum* | | 3 | 3.0 | 100 | 0 | 67 | 0 | 33 | 67 | 0 | 67 | 67 | 67 | 0 |
| *Mangifera indica* | Mango | 3 | 3.7 | 100 | 0 | 67 | 0 | 100 | 100 | 0 | 67 | 33 | 33 | 0 |
| *Anigeissus spinosa* | | 1 | 4.0 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 100 | 0 | 100 | 0 |
| *Balanites aegyptiaca* | Desert date | 3 | 3.0 | 67 | 33 | 33 | 33 | 33 | 33 | 0 | 67 | 33 | 67 | 33 |
| *Maerua angolensis* | | 1 | 2.0 | 100 | 0 | 0 | 0 | 100 | 100 | 0 | 100 | 100 | 100 | 100 |
| *Moringa olefera* | Moringa | 2 | 3.0 | 100 | 50 | 0 | 100 | 100 | 0 | 0 | 0 | 100 | 0 | 0 |
| *Securidaca longipedunculata* | | 1 | 4.0 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 0 | 0 | 100 | 100 |
| *Tamarindus indica* | Tamarind | 1 | 3.0 | 100 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 100 | 100 | 0 |
| *Annona senegalensis* | African custard apple | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Daniellia oliveri* | African balsam tree | 1 | 4.0 | 0 | 0 | 100 | 0 | 100 | 100 | 100 | 100 | 0 | 100 | 0 |
| *Faidherbia albida* | | 1 | 4.0 | 100 | 100 | 0 | 0 | 0 | 100 | 100 | 0 | 100 | 100 | 0 |
| *Ficus platyphylla* | | 1 | 1.0 | 100 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 |
| *Gardenia erubscens* | | 2 | 3.0 | 100 | 50 | 100 | 0 | 0 | 50 | 0 | 0 | 50 | 100 | 0 |
| *Jatropha curcas* | Jatropha | 1 | 1.0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pterocarpus erinaceus* | | 1 | 4.0 | 0 | 100 | 100 | 0 | 100 | 100 | 0 | 100 | 0 | 100 | 100 |
| *Tectona grandis* | Teak | 2 | 3.0 | 0 | 50 | 50 | 100 | 50 | 100 | 100 | 0 | 0 | 100 | 0 |
| *Acacia dudgeoni* | | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Acacia auriculiformis* | Acacia | 1 | 4.0 | 0 | 100 | 0 | 100 | 100 | 100 | 100 | 0 | 0 | 100 | 0 |
| *Afzelia africana* | | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Amaranthus spinosus* | | 1 | 4.0 | 0 | 0 | 0 | 100 | 100 | 100 | 0 | 100 | 0 | 100 | 100 |
| *Blighia sapida* | Akee-apple | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Bombax ceiba* | Bombax tree | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Calotropis procera* | | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cyperus esculentus* | | 1 | 4.0 | 100 | 0 | 0 | 0 | 100 | 100 | 0 | 100 | 100 | 100 | 0 |
| *Combretum molle* | | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Delonix regia* | Flamboyan | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dialium guineense* | African velvet tamarind | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dioscorea alata* | Water yam | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ficus iteophylla* | | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Icacina oliviformis* | | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Gardenia spp* | | 1 | 4.0 | 100 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| *Piliostigma thonningii* | | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Psidium guajava* | Guava | 1 | 1.0 | 100 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Prosopis africana* | | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pseudocedrela kotschyi* | | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Scerocaraya birrea* | | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Sesamum indicum* | | 1 | 4.0 | 100 | 0 | 100 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 |

[1]Subjective score of the abundance of the species, the higher the score the more abundant a species was rated by the focus groups

[2]Percentage of focus groups that indicated the species was used in a particular way, or a particular part of the plant was used

[3]Percentage of focus groups that indicated a particular part of the plant species was use

Table 9. Summary of the number of wild species by use

| | Males | | Females | |
|---|---|---|---|---|
| | No. Groups | % | No. Groups | % |
| No. Groups | 39 | | 32 | |
| Own food | 23 | 59.0 | 22 | 68.8 |
| Sold | 19 | 48.7 | 18 | 56.3 |
| Purchased | 11 | 28.2 | 21 | 65.6 |
| Fodder | 24 | 61.5 | 19 | 59.4 |
| Medicine | 30 | 76.9 | 22 | 68.8 |
| Fuel | 29 | 74.4 | 26 | 81.3 |
| Construction | 17 | 43.6 | 13 | 40.6 |
| Leaves | 18 | 46.2 | 19 | 59.4 |
| Fruit/seed | 25 | 64.1 | 19 | 59.4 |
| Stem/ trunck | 32 | 82.1 | 27 | 84.4 |
| Root tuber | 6 | 15.4 | 7 | 21.9 |

Total number of species: 48

# Discussion

Results support our hypotheses that households in marginal areas rely on many more species than conventional socioeconomic surveys, in this case the ARBES survey, reveal. The ARBES survey only elicited information on about half of the species elicited by the FGDs. This was particularly true for vegetables. However, the species included in the ARBES survey in general were considered more abundant and widely traded than those not included, so the survey was able to capture the most common domesticated annual species, but not the least common ones. This omission could be significant given the contribution of vegetables to a diversified and balanced diet. However, we do not have data to assess this, which merits further study. This issue is particularly important since some of the studies that are looking into the relationship between agricultural biodiversity and diets are based on Living Standard Surveys (e.g. Sibathu et al. 2015, Jones et al. 2014; Jones 2017), such as the ones used to define the crop list of the ARBES survey, that rely on standardized list of species. Although this is practical and reduces errors, it may miss relevant species. While almost all species are used for self-consumption, almost all species are also traded, regardless of their abundance, with households both selling and/or buying them. Thus markets are playing an important role in the decisions of household whether or not to produce these species, even the least abundant. The higher scores women groups gave to species compared to male groups to all species suggest that there is a gendered perception of abundance and use of the different domesticated annual species maintained in these systems.

In terms of trees and perennial species, there is a wide gap between the species included in the baseline survey and those identified by the FGDs. The number and importance of the latter is substantial and show that trees are important for the lives and livelihoods of these households. Most of these species are used as food, but also traded and multiple parts of the plant are used by these households. While the focus of Africa RISING is clearly on domesticated annual species, useful trees are part of the lives and livelihoods of target households and may merit further attention, particularly since foods derived from trees, such as fruits and leaves can make important contributions to diets and incomes (Reed et al. 2017).

Regarding wild species, it is interesting to note that most of them are the same as those identified in the trees and perennial species, and many of the species in fact can be considered domesticated, such as mango, guava and tamarind. Probably this is because they are produced on common lands where the trees are present. These species are also mainly used as food and for self-consumption, with multiple uses and also are traded. These results reinforce the importance of trees in the lives and livelihoods of households in the study areas. Furthermore, there is evidence of the importance of the diversity of wild and cultivated food plants for food security under environmental conditions in Mali, similar to the ones in Northern Ghana (N´Danikou et al. 2017).

Our results show the great diversity of species used and their importance as food as well as other uses. While self-consumption is fundamental, most species, regardless of their type, were traded as well. For instance, rice, eggplant and tobacco are notable cash crops according to male respondents, whereas vegetables (onions), legumes (groundnut and bambara nut) and rice are important according to women. This may show that utilization is differentiated by gender implying who should be targeted for which species in biodiversity conservation programs.

Results also show that the three dimensions of agricultural biodiversity proposed in the conceptual model that underpins the Agricultural Biodiversity Assessment methodology are relevant in these communities, suggesting the need to explore in further detail the roles played by crop diversity in the lives and livelihoods of these households.

# Conclusion and policy implication

Our results confirmed that households in marginal rural areas rely on many more species than conventional socioeconomic surveys reveal. By ignoring many of the species that are part of this diversity, we may be failing to take into consideration important sources of food and income for rural households, particularly species, such as some vegetables that may make an important contribution to dietary diversity and nutrition. Assessing the significance and implications of the gaps in information about plant species diversity for the lives and livelihoods of rural households and for interventions to improve them is beyond the scope of this study and merit further research.

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