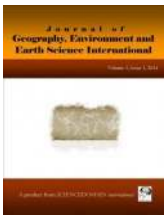

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# Contribution of Tanzania Southern Highlands Forest Diversity to Household Income and Food Supplements: The Case of Mufindi District in Tanzania

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Author DKM designed the study, performed the statistical analysis and wrote the first draft of the manuscript. Authors EJL and CC managed the analyses of the study. Author CW managed the literature searches. All authors read and approved the final manuscript.*

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## ABSTRACT

**Aims:** Understanding the role played by forest diversity to supply non-timber forest products for income and food supplements of households is important in forest management and human life. This study was conducted to investigate the role played by non-timber forest products and their implications on income and food supplements in Mufindi District in Tanzania.
**Methodology:** A cross section field survey research methodology was used in this study. Six representative villages in three wards; Rugemba, Igowole and Sadan located within 30 Km to forest

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reserves were selected. Interviews were conducted to 180 respondents from the three wards. One focus group from each village was conducted while District agricultural officers and village leaders formed a key informant's category. Quantitative data were analyzed using Statistical Package for Social Science Software and Microsoft excel while memos were produced from qualitative data and used to narrate discussion. Taxonomic plants classification was carried out at Sokoine University of Agriculture botanic laboratory.

**Results:** It was found that non-timber forest products are mostly consumed directly by the people who collect them as a useful dietary supplement, especially when food is scarce. To a lesser extent, they are also sold for cash, but the market for them is badly organized in terms of poor transport and lack of storage facilities, so they are not an important source of income except for people who live near important roads. It was discovered that deforestation and climate change are reducing the potential supply of these products.

**Conclusions:** Given the importance of the sustainable exploitation of non-timber forest products as an incentive for forest conservation, the market for non-timber forest products should be rationalized and expanded. Improvement of the use and role of wild foods should be planned and implemented within a larger scheme of sustainable forest management.

*Keywords: Non-timber forest products; southern highlands; forest biodiversity; wild food plants; food supplements.*

## 1. INTRODUCTION

Life of human beings on earth is linked to forest ecosystems, because of functions and services provided by these vital ecological settings. Documentation show that for example, in rural households' subsistence, life is partially or whole made by collecting leaves, roots, fruits and nuts from trees and other wild plants, and by hunting wild animals, fish, and insects for consumption [1,2]. These activities are associated with traditional, cultural and economic values in different local constructions mainly of the local and indigenous people [3] as a result [4] estimates that the well-being of more than half of the 1.2 billion people or more [5] globally living in poverty depend to a larger degree on the availability of non-timber forest products (NTFPs).In this study, NTFPs refer to all those goods and services of biological original obtained from forests or associated ecosystems, which contribute directly or indirectly to human welfare [6].

Forest located at the highlands of Tanzania are amongst the most important ecosystems in the world for biodiversity richness [7,8]. These highland forests have a great diversity of plant species with stocking of 200 to 400 species per hectare [9,10], hence expected to provide varieties of wild food products required to sustain life of the community surrounding them. These forests are rich in wild foods defined in this study as 'those plants with edible parts growing naturally on farms, fallow or on uncultivated land' [11]. Biodiversity within and around forests reserves is essential in order to achieve a complete and healthy diet [12]. These foods are important for dietary supplementary and adequate nutrient provisions [11] and income of households and individuals. Although NTFPs presents wild fruits, vegetables, and nuts, edible roots, bush meat, snails, edible insects and honey [5], but in this study the major focus was to investigate the role of wild foods [13], mainly the diversity of wholly edible plants or parts such as leaves, stems, roots or fruits, and edible fungi (mushrooms). These wild foods forms an important component in forest ecosystems together with timber products [5,6]. While management of forest is supposed to focus on timber and non-timber components, yet in many forest management practices, attention is paid to timber production leaving behind the integration NTFPs in implementation of forest management plans [6] and thus the value of NTFPs at household income and food supplements is neglected at large. Because of species richness of Tanzania southern highlands forest biodiversity (TSHFB) it is ascertained that this vital ecosystem is a major supplier of NTFPs in these highlands because high diversity in forest types and species results in a wide variety of NTFPs [14]. Because forest biodiversity determine to a large extent the amount of NFTPs available to supply resources for food and income, it is obvious that from the biological richness and availability of NTFPs [5], forest ecosystems and human beings are integrally linked, and this link is important in improving human welfare [12] as well as maintenance of a healthier forest ecosystem.

Wild vegetables for example, Vegetable Amaranths (*Amaranthus spp),* Black-jack *(Biden pilosa),* Chick weed *(Galinsoga parviflora),* African spider plant *(Cleome gynandra)* and Sesame bush (*Sesamothamnus busseanus)* [10,15] have been documented as important sources of proteins, micronutrient elements and vitamins, yet resource poor households (households, which have no formal income sources and food security) are highly exposed to nutritional disorders in many least developing countries. Previous studies on NTFPs by [1,2,11,13] show that wild foods are important as source of food in many African countries including Tanzania. However, there is existing gap of knowledge about the current status and the role of TSHFB in providing NTFPs and their support to Mufindi District people's livelihood. Therefore, this study focused on identifying the contribution of NTFPs to household's income and food supplement to the people in Mufindi District. It also extended the existing understanding on the role of NTFPs [2,16], by comparing data obtained from 2007/2008 and 2014/2015 households surveys, hence established the potential of TSHFB in terms of its contribution to households income, food supplements and forest management options.

## 2. MATERIALS AND METHODS

This study was conducted at Mufindi District which is one of the four Districts in Iringa Region. The District is located in southern highlands of Tanzania at latitudes 8°30'00" to 8°36'00'' south and longitudes 35°15'00 to 35°17'00''east (location of Mufindi headquarters). The District is situated about 80 km from Iringa Municipality and boarders Iringa rural in the north, Kilolo in north east, Wanging'ombe in the south, Kilombero in the south east and Mbarali in the west [17]. The District has a land area of 712 200 hectares (ha), whereby out of it 57,360 ha (8%) hectares are covered with forests. The catchment forest reserves area covers about 21,800 ha. Private forests in this District cover about 13,450 ha while local authority forest reserves cover 1,500 ha and about 20,610 are in public or individuals/or households forests. The Diversity of these forests offers a substantial economical role to the surrounding population. Apart from wood products, Mufindi forests are highly recognised as a source of wild food species such as vegetables, fruits, mushrooms, honey, edible insects, bush meat, edible roots and tubers.

Villages that were found close to forest reserves and those with their population that rely on wild food collection were included for the interviews. Sampling units for the study included the selected households and individuals involved in wild food collection, consumption and vending. In addition, key informants like District agricultural officers and village leaders (village executive officers and village chairpersons) were consulted during surveys. In regard to sample size; six representative villages were identified by the use of village inventories obtained from Mufindi District office, while purposive selection were used to obtain the intended villages for the study. These villages (in brackets) were located in three wards namely; Igowole (Maduma and Kitelewasi); Sadan (Tambalang'ombe) and Rugemba (Rungemba, Itimbo and Kinyanambo). At village level, households relying on wild food marketing or consumption were identified such that 30 respondents each representing a separate household were picked at random for the study, this led to the sample size of 180 respondents.

Both structured and non-structure interviews were used to collect data. Collected data were analyzed using Statistical Package for Social Science (SPSS) software version 18. Outputs from descriptive statistics, cross tabulation and frequencies were used in verifying the magnitude of NTFPs collection and consumption. Plants were identified in the field using local names based on local experience and forest officers, and samples were taken to Sokoine University of Agriculture botanic laboratory for further identification using Flora of Tanzania and field guide book by [10,15].

The study took place in two different seasons; whereby phase one interviews were carried out in August, September and October in 2007 for 2007/2008 season followed by other interviews, which were conducted in January, February and March 2014 to present 20014/2015 season. It was necessary to repeat the surveys in order to compare the utilization of NTFPs in these two different seasons.

## 3. RESULTS

### 3.1 Preferred Kinds of NTFPs

Respondents and botanic scientist identified thirty one wild foods in total (plant species=29 and 2 broad categories of edible fungi (mushrooms)) as part of NTFPs in southern

highlands of Mufindi District. These NTFPs resources included 1: Fruits such as Wild loquat *(Uapaca kirkiana),* Smelly-berry finger leaf *(Vitex mombassae),* Plum finger leaf *(Vitex ferruginea),* Water berry *(Syzygium spp.),* Sumac tree *(Rhus vulgaris),* Mulberry (*Myrianthus arboreus),* Rough berry *(Rubus apetalus),*Passion *(Passiflora edulis),* Fig *(Ficus sur),* Granite garcinia *(Garcinia buchananii),* Multidentia *(Multidentia crassa)*, Tangle-flowered wild medlar *(Vangueria apiculata),* Fadogia *(Fadogia ancylantha),*Large sour plum (X*imenia caffra),* Azanza (*Azanza garckeana), White beam (Alsodeiopsis schumannii)*, Kei apple *(Dovyalis abyssinica) and* Guinea palm (*Parinari excelsa);* 2. Leafy vegetables such as: Black night shade *(Solanum nigrum),* Sesame bush (*Sesamothamnus busseanus),* Black-jack *(Biden spp.)* "Mkalifya" (Local language) *(Caylusea abyssinica),* Wild jute *(Corchorus tridens),* Amaranths *(Amaranthus spp),* Woolflower *(Celosia trigyna),* Native jute *(Corchorus trilocularis),* Cucamber (*Cucumis figarei),* Abyssinian (*Ensete ventricosum)* and Sorrel *(Rumex usambarensis)* and 3. Mushrooms (*Amanita* spp. and *Lactarius* spp) as the major two categories identified during this study. However there were lack of detailed information on the local varieties consumed in this area, a situation which call for another research/survey to establish local mushroom data base in southern highlands of Tanzania.

### 3.2 Wild Fruits Collected in 2007/2008 and 2014/2015

*Uapaca kirkiana, Syzygium cordatum, Passiflora edulis, Vitex ferruginea and Rhus vulgaris* collection improved from 2007/2008 to 2014/2015 seasons. The rest of fruits declined in 2014/2015 season (Table 1). Across all seasons *Uapaca kirkiana* collection was high compared to other kinds of fruits, implying that this kind of food is important across all households in all wards.

### 3.3 Consumption of Wild Fruits

During 2007/2008 *Uapaca kirkiana* and *Vitex mombasae* as well as *Passiflora edulis* were ranked high in consumption at each household level followed by *Vangueria apiculata*, *Parinary exselsa* and *Azanza garckeana*. *Syzygium cordatum, Rhus vulgaris*, *Ximenia caffra* and *Multidentia crassa,* were consumed by households at below 5% each. In 2014/2015 the

**Table 1. Wild fruits collected in 2007/2008 and 2014/2015 (Units=Kg)**

| Kinds of fruits | 2007/2008 | | | | 2014/2015 | | | | Changes |
|---|---|---|---|---|---|---|---|---|---|
| | Number of respondents | % of respondents collected each kind of fruits | Total volume of fruits collected | Mean volume collected per each household | Number of respondents | % of respondents collected each kind of fruits | Total volume of fruits collected | Mean volume collected per each household | Volume difference 2007/2008-2014/2015 |
| *Uapaca kirkiana* | 116 | 64 | 4854 | 42 | 100 | 56 | 6400 | 64 | 1546 |
| *Vangueria apiculata* | 14 | 8 | 305 | 22 | 20 | 11 | 300 | 3 | -5 |
| *Vitex mombassae* | 44 | 24 | 975 | 23 | 20 | 11 | 900 | 9 | -75 |
| *Syzygium cordatum* | 5 | 3 | 138 | 28 | 9 | 5 | 145 | 1.45 | 7 |
| *Passiflora edulis* | 18 | 10 | 777 | 43 | 18 | 10 | 1020 | 10.2 | 243 |
| *Vitex ferruginea* | 3 | 2 | 42 | 14 | 13 | 7 | 50 | 0.5 | 8 |
| *Azanza garckeana* | 11 | 6 | 137 | 12 | 11 | 6 | 120 | 1.2 | -17 |
| *Parinary exselsa* | 13 | 7 | 168 | 13 | 13 | 7 | 140 | 1.4 | -28 |
| *Rhus vulgaris* | 4 | 2 | 5 | 1 | 4 | 2 | 10 | 0.1 | 5 |
| *Ximenia caffra* | 4 | 2 | 45 | 11 | 4 | 2 | 30 | 0.3 | -15 |
| *Multidentia crassa* | 2 | 1 | 65 | 33 | 2 | 1 | 30 | 0.3 | -35 |

consumption of *Uapaca kirkiana and Syzygium cordatum* increased while other fruits declined. The consumption by volume is shown in Table 2.

### 3.4 Collection of Mushrooms and Vegetables

Mushroom collection was the only wild food collected by 51% of respondents where by 2 100 kg were collected. *Solanum nigrum, Caylsea abyssinica, Amaranthus spp. and Sesamothamnus busseanu* were collected by less than 50% respondents. Collection of Mushrooms and *Solanum nigrum* unlike many other vegetables showed to improve in 2014/2015 season compared to 2007/2008 (Table 3).

**Table 2. Fruits consumption in 2007/2008 and 2014/2015 (Units= Kg)**

| Fruit kinds | 2007/2008 | | | | 2014/2015 | | | | Changes |
|---|---|---|---|---|---|---|---|---|---|
| | Number of respondents | % of respondents consumed each kinds of fruits | Total volume of fruits consumed | Mean volume of fruits consumed by household | Number of respondents | % of respondents consumed each kinds of fruits | Total volume of fruits consumed | Mean volume of fruits consumed by household | Difference of fruits consumed in 2007/2008 & 2014/2015 |
| *Uapaca kirkiana* | 116 | 64 | 1645 | 14 | 100 | 56 | 2050 | 21 | 405 |
| *Vangueria apiculata* | 14 | 8 | 183 | 13 | 20 | 11 | 150 | 8 | -33 |
| *Vitex mombassae* | 44 | 24 | 439 | 10 | 20 | 11 | 350 | 18 | -89 |
| *Syzygium cordatum* | 5 | 3 | 98 | 20 | 9 | 5 | 102 | 11 | 4 |
| *Passiflora edulis* | 18 | 10 | 243 | 14 | 18 | 10 | 240 | 13 | -3 |
| *Vitex ferruginea* | 3 | 2 | 42 | 14 | 13 | 7 | 42 | 3 | 0 |
| *Azanza garckeana* | 11 | 6 | 115 | 10 | 11 | 6 | 75 | 7 | -40 |
| *Parinary exselsa* | 13 | 7 | 135 | 10 | 13 | 7 | 100 | 8 | -35 |
| *Rhus vulgaris* | 4 | 2 | 5 | 1 | 4 | 2 | 5 | 1 | 0 |
| *Ximenia caffra* | 4 | 2 | 24 | 6 | 4 | 2 | 0 | 0 | -24 |

**Table 3. Mushroom and vegetables (M/V) collected in 2007/2008 and 2014/2015 (Units=Kg)**

| Kinds of M/V | 2007/2008 | | | | 2014/2015 | | | | Change |
|---|---|---|---|---|---|---|---|---|---|
| | Number of respondents | % of respondents collected each M/V | Total volume of M/V collected | Mean volume of each kind of M/V collected per household | Number of respondents | % of respondents collected each M/V | Total volume of M/V collected | Mean volume of each kind of M/V collected per household | Difference of M/V in 2007/2008 a & 2014/2015 |
| Mushrooms | 92 | 53 | 2100 | 23 | 120 | 60 | 3900 | 33 | 1800 |
| *Solanum nigrum* | 62 | 36 | 1770 | 29 | 62 | 31 | 2570 | 41 | 800 |
| *Amaranthus spp.* | 3 | 2 | 28 | 9 | 3 | 2 | 45 | 15 | 17 |
| *Sesamothamnus busseanus* | 4 | 2 | 82 | 21 | 4 | 2 | 100 | 25 | 18 |
| *Caylsea abyssinica* | 11 | 6 | 92 | 8 | 11 | 6 | 165 | 15 | 73 |
| Total | 172 | 100 | 4072 | | 200 | 100 | 6780 | | 2708 |

**Table 4. Consumption of mushrooms and leafy vegetables (Units=Kg)**

| M/V kinds | 2007/2008 | | | | 2014/2015 | | | | Changes |
|---|---|---|---|---|---|---|---|---|---|
| | Number of respondents | % of respondents consumed each kind of M/V | Total volume of M/V consumed | Mean volume of M/V consumed per household | Number of respondents | % of respondents consumed each kind of M/V | Total volume of M/V consumed | Mean volume of M/V consumed per household | Difference of M/ V consumed in 2007/2008 & 2014/2015 |
| Mushrooms | 92 | 54 | 7 | 0.1 | 120 | 60 | 215 | 2 | 209 |
| *Solanum nigrum* | 62 | 36 | 612 | 10 | 62 | 31 | 1200 | 19 | 588 |
| *Amaranthus spp* | 3 | | 28 | 9 | 3 | 2 | 45 | 15 | 17 |
| *Sesamothamnus busseanus* | 4 | 2 | 52 | 13 | 4 | 2 | 100 | 25 | 48 |
| *Caylsea abyssinica* | 11 | 6 | 103 | 9 | 11 | 6 | 165 | 15 | 62 |
| Total | 172 | 100 | 802 | 42 | 200 | 100 | 1725 | 76 | 924 |

**Table 5. Income from NTFPs in 2007/2008 and 2014/20159 (Units=TZS)**

| Wards | 2007/2008 | | | | 2014/2015 | | | | Changes |
|---|---|---|---|---|---|---|---|---|---|
| | Sellers of NTFPs(=A) | % of sellers | Total income for all households in each in each ward (=B) | Average income per household (=B/A) | Sellers of NTFPs (=A) | % of sellers | Total income for all households in each ward (=B) | Average income per household (B/A) | Difference in income between 2007/2008 & 2014/2015 |
| Rungemba | 40 | 57 | 757 800 | 18 945 | 60 | 40 | 3 356 700 | 55 945 | 37 000 |
| Igowole | 16 | 23 | 141 250 | 8 828 | 42 | 28 | 1 208 000 | 28 762 | 19 934 |
| Sadani | 14 | 20 | 82 200 | 5 871 | 47 | 32 | 1 189 000 | 25 298 | 19 427 |
| Total | 70 | 100 | 981 250 | 14 699 | 149 | 100 | 5 753 700 | 11 000 | 76 361 |

### 3.5 Consumption of Mushrooms and Wild Vegetables

The consumption of mushrooms and vegetables improved from 2007/2008 to 2014/2015 seasons (Table 4).

### 3.6 Sales and Income from NTFPs

In year 2007/2008, total ward income (Tanzania shillings (TZS) [1] ) was in the decreasing order from Rungemba, Igowole to Sadani. In 2014/2015, total income (TZS[2]) increased across all the wards i.e. for Rungemba, Igowole and Sadan orderly. Household's average income in 2007/2008 also was in that direction of Rungemba, Igowole and Sadan. Although Sadan had low income across all years, but Sadan ward income improved at large compared to Rungemba and Igowole in 2014/2015 (Table 5) because of increased collectors in this year, which affected the mean income in Rungemba and Igowole compared to 2007/2008 findings.

### 3.7 Non-timber Food Products as Food Insecurity Copping Strategy

In 2007/2018 and 2014/2015, findings showed that wild foods contributed below 50% of the total

[1] *During 2007/2008 average exchange was: 1 USD=1220.67 TZS.*

[2] *During 2014/2015 average exchange was: 1 USD=1822.70 TZS.*

*Source: FAOSTAT accessed 13/03/2017.*

household food sources across all wards while other sources were above 50% (Fig. 1).

### 3.8 Sustainability of Wild Foods at Mufindi District

Each ward reported that the status of the wild food species has declined largely across all forests. These responses were equally in 2007/2008 and 2014/2015 surveys (Fig. 2).

## 4. DISCUSSION

### 4.1 Preferred NTFPs

TSHFB harbor many kinds of NTFPs identified as cereals, oil seeds, beverages, fruits, leafy vegetables, roots and tubers, spices and edible fungi as classifies by [11,15]. Respondents categorized wild foods similarly to [15,16]. TSHFB is reflected on these types of food stuff and parts collected and consumed. It is evident that local people in Mufindi are aware on the economic value of different forest foods and parts suitable for consumption. There were consistence on listing edible plants and fungi in 2007/2008 and 2014/2005 surveys. If plans are in place this existing knowledge is an incentive to appreciate the diversity of southern highlands for planned consumption and management.

Species diversity of southern highlands serves great purpose on NTFPs supply for several months in a year for example, most of fruits mature and get used in the summer season, yet they are supplemented by other stuff such as leaf vegetables and mushrooms in rainy seasons. Although leaf vegetables persist shortly especially during and soon after rainy seasons [11], their

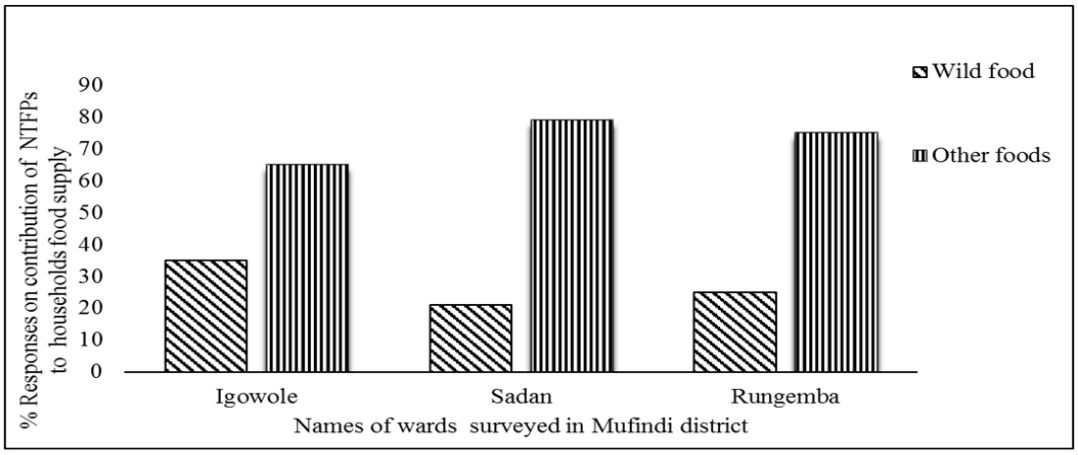


**Fig. 1. Contribution of NTFPs to households food supply**

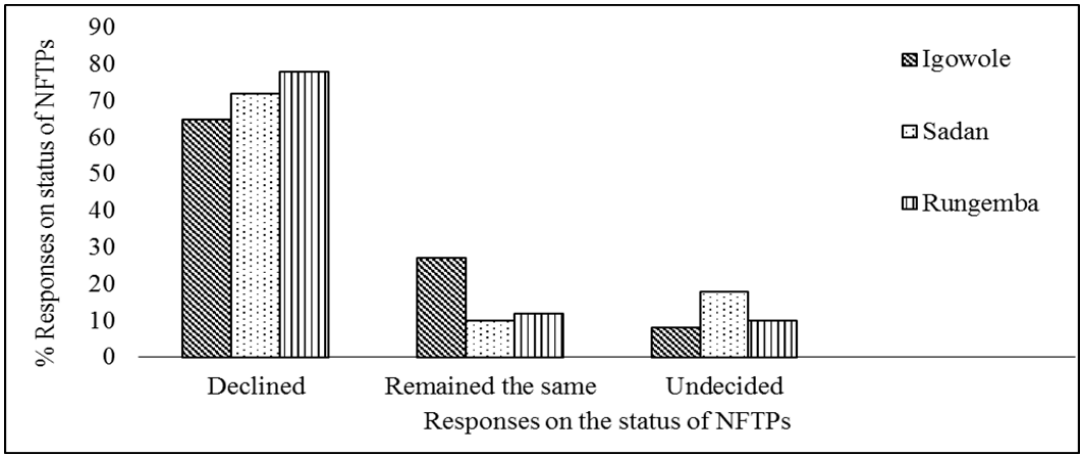


**Fig. 2. Responses on NTFPs availability**

short term availability are compensated by a wide range availability of NTFPs, which in turn function as a staggered wild foods consumption in Mufindi. Wide range of NTFPs is associated with TSHFB richness as supported by majority stakeholders. This observation challenges the seasonality availability of wild foods [15] as respondents appreciate forest biodiversity as an important parameter for different wild foods availability annually.

### 4.2 Fruits Collected in 2007/2018 and 2014/2015

Wild fruits are highly recognized as an important source of food and hence taken as household activity [13]. Collection of wild fruits fluctuates from one species to another and seasons to season. Some fruits such as *Uapaca kirkiana* and *Passiflora edulis* were collected in huge amount in 2014/2015 than before (Table 1). Responses showed that the amount collected are determined by priority options (palatability, marketability and availability). It is because of the availability horizon for example, *Uapaca kirkiana* fruit is available from October to January in each year while other fruits (*Azanza garckeana, Parinary exselsa and Rhus vulgaris)* lasts for only one or two months put chances of *Uapaca kirkiana* the most collected fruit. *Uapaca kirkiana* is collected at large followed by *Passiflora edulis* (good for juice) compared to other kinds. *Rhus vulgaris* is poorly preferred by consumers, regarded as less nutritious and rarely consumed by adults hence lowly consumed compared to other kinds consumed at large and across different age and sex categories.

### 4.3 Consumption of Wild Fruits

Home consumption volumes (Table 2) are determined mainly by palatability criteria. A wild fruit could be whole consumed or partially depending on its nature [15]. For example, *Uapaka kirkiana* is preferred because its pulp is fleshy, sweet and thus eaten by people across different ages and sex. Low priority of consuming *Rhus vulgaris* is because it is tiny, contain less edible pulp and it is acidic when eaten unripe [15]. Differences in wild fruits preferences is the main factor in determining the amount consumed across wards [13]. Palatable and available fruits serve as food supplements at large, that makes *Uapaka kirkiana* a major food supplement through January and early February in each year. *Uapaka kirkiana* is highly valued in the southern highlands because in January and February different households face food shortage. The support of wild foods to majority of families is between January and February as also reported by [13].

### 4.4 Collection of Mushrooms and Wild Vegetables

Mushroom collection was high all the time followed by *Solanum nigrum*. Although collection of different vegetables is of short season, mainly during wet seasons [12], still respondents appreciate the amount they get from wild settings. Collection trend is promising in terms of mushrooms and vegetables available in TSHFB and hence supporting vegetable supplements in Mufindi (Table 3). While there was promising environment for collection of vegetables, yet the general collection pattern indicates that there are some vegetables neglected regardless of their nutritive value, for example *Amaranthus* spp. in all seasons.

### 4.5 Consumption of Mushrooms and Wild Vegetables

The improvement in mushroom consumption in 2007/2008 to 2014/2015 (Table 4) is associated with the realization that mushroom are recently promoted and highly preferred as vegetable crop in the study area like in many African countries [18]. Mushrooms are valued higher than any kind of wild vegetables and considered the best [18,19] and as a delicacy work and important household activity [13]. Also large consumption of mushroom in southern highlands is contributed to the availability as supported by [20] that "African forests and woodlands are rich in mushrooms''. Although wild vegetables are widely eaten by many people in Africa [16], the consumption varies from season to season and from one kind to another. For example, while there was large consumption of mushroom in 2014/2015 and other vegetables compared to 2007/2008, consumption of Amaranthus *spp.* had the lowest amount in all years. One among many other reasons is that *Amaranthus* spp. life span is too short also lowly valued culturally. Low consumption is also complicated when there are different options of vegetables as different consumers develop divergent preferences of some kinds. Selection in consumption of certain types of vegetables agrees to [1] and this behavior affects exploitation of a wide range of nutritional sources from forest biodiversity.

### 4.6 Sales and Income from NTFPs

The business of NTFPs in Mufindi is undeveloped, as a result monthly earnings are far below those documented by [13]. Each household is still far from the national standards of 322 554 TZS monthly income [21]. Marketing strategies for NTFPs in southern highlands is not promising. The business is dominated by un-equal distribution of marketing opportunities. The best option is to sell products along the main road of Dar es Slaam to Zambia. This gives opportunity to villagers near the road (Rungemba) compared to those located about 27 km away. Passengers through this road present some demand though not in defined and formal systems, they buy some wild foods sold by the roadsides. Villagers located far from the main road for example Igowole and Sadan have poor sells because they only have one day per week open market locally known as *Gulio.* Although this market attracts many people from different places in a week at once, it is obvious that it is not sufficient to offer good opportunity for selling a lot of products.

Lack of formal markets for NTFPs is the persisting challenge [22]. That is why vendors primarily rely on locally available informal markets as the only options in Mufindi as also reported by [23] in Kenya, hence village informal markets remain the main disposal for NTFPs. Poor wild food marketing is also contributed by some households to consider the business a temporary activity whilst they seek or hope for permanent formal employment [23]. The findings proved that wild food selling is dominated by poor resource people (in this study defined as people without any formal means/ source of income) thus just struggle to make little earning [24]. Yet promotion of wild foods business is poor in the District and the country in general. There is lack of full components of food value chain. Products are collected and transported from forest reserves without clear mechanism for storage, processing and marketing. This puts NTFPs business in jeopardy. There is a need to improve the components of wild food value chain to realize significant benefits from this industry. Improving marketing strategies will help to contribute to poverty alleviation [24] in the District. There must be substantial capital investment, clear market and value chain information. Processing of short life span vegetables must be done to improve life shelf. Processed NTFPs must contributes to improve the availability of NTFPs throughout a year [23]. However, processing should not contribute to unsustainable harvesting and biodiversity destruction [24].

### 4.7 Non-timber Forest Products as Food Insecurity Copping Strategy

Many households consume food cultivated from their crop agriculture. In addition, they purchase cereal, pulses and grains from some formal or informal markets. During severe food shortage households get some food aids from other sources (Fig. 1). Regardless of these sources, wild food collection and consumption is partly explained to give some form of food supplements [13]. Even though contribution of NTFPs figures is less than 50% of food taken per year at each of the household, still it is valid to state that wild foods contributes to food supplementary at households. These findings somewhat substantiate the studies conducted by [1,13,25], that wild foods are important to meet subsistence needs. Contrary, focus groups and key informants view forest products reliance as ineffective strategy to support adequate food volumes. Therefore an in-depth study to understand the complexity of NTFPs as a coping substitute in food security need to be investigated further.

### 4.8 Sustainability of Wild Foods at Mufindi District

The scarcity of wild foods complicates the business especially the time spent for collection and transportation to consumers from forests. Gatherers and sellers reported that, in recent years it takes one or two weeks for someone to collect adequate amount to use at home and sell while it would take one to two days to collect the same amount in the past ten years. Increased rate of deforestation caused by shifting cultivation and uncontrolled fire are the major cause for decline of NTFPs. In addition, unreliable rainfall characterized by prolonged severe drought spells is cited as a challenge to availability of wild foods. Draught persistence because of climate change is documented to affect forests species biodiversity and hence forests ecosystems in many parts of the world [26,27]. It is obvious that forests in Mufindi District have lost the capacity to supply wild foods nowadays than before. These observations are supported by [15] that, ‘’increased deforestation, exploitation and changes in land use have affected the diversity of natural

vegetation in Tanzania''. If serious measures are not instituted, there is a danger of rendering some of wild food varieties rarer; this predicts the extinction of some species in the near future. Therefore, for sustainable wild food industry, there must be a balance of trade between collection, marketing strategies and management of NTFPs. There is no way to have sustainable NFFPs if forest ecosystems are not managed properly. Management of TSHFB must be done to embrace the recommendation by [28] that we have to manage forests of East Africa for sustainable diversity benefits.

## 5. CONCLUSIONS

This study revealed the potential of TSHFB particularly in Mufindi District. Contrary to some earlier findings, NTFPs in this District contributes to food supplements especially during months of household's food shortage mainly January and February. Local communities are in intimate connection with forest reserves or resources through collection and use of NTFPs. Depending on the locations and preferences, households get benefits differently while lack of vigorous value chain components (production, transportation, processing, storage and sales mechanisms) hinders the industry. It is imperative to put more emphasis on sustainable management of forest resources by encompassing production and rational harvesting plans. Because of its role, foresters, policy makers and ecologists / environmentalist must put efforts to improve wild foods industry in general. Collective efforts must contribute to recognize and address the potential of TSHFB in terms of NTFPs contribution to food security and households' income. Management and harvesting activities must operate within the limits of forests capacity to supply NTFPs while ensuring that they are not disturbed and degraded further. Therefore, improvement of the use and role of NTFPs should be planned and implemented within a larger scheme of sustainable forest management.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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