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**FACTORS INFLUENCING THE NUMBER OF NON-TIMBER FOREST PRODUCT
SPECIES USED AT THE INDIVIDUAL, HOUSEHOLD AND VILLAGE LEVELS IN
VHEMBE, LIMPOPO PROVINCE, SOUTH AFRICA**

A thesis submitted in partial fulfilment of the
requirements for the degree of

MASTER OF SCIENCE IN THE
DEPARTMENT OF ENVIRONMENTAL SCIENCES
AT
RHODES UNIVERSITY

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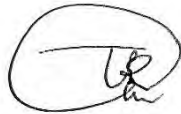
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February 2023

DECLARATION

I, Takalani Rachel Mulaudzi hereby declare that this thesis is my own original work, that it has not been submitted for any other university's degree or examination, and that all sources utilized have been completely recognized with thorough references. This thesis is presented in partial fulfilment of an MSc in Environmental Science at Rhodes University's Faculty of Science in South Africa.



Signature: _____

Date: 24/02/2023

DEDICATION

I would like to dedicate this thesis to my late mother Thivhulawi Mulaudzi, who passed away a year ago. And I would like to dedicate this thesis to my one and only son Gundo Nkazimulo.

ACKNOWLEDGEMENT

This work was funded by the South African Research Chairs Initiative of the Department of Science and Technology and the National Research Foundation of South Africa (grant no. 84379). Any opinion, finding, conclusion or recommendation expressed in this material is that of the authors and the NRF does not accept any liability in this regard.

This research study would not have been possible without the help, assistance, and involvement of many people. I'd want to offer my heartfelt gratitude and appreciation to the following people:

- Prof Charlie Shackleton, my supervisor, for providing his enormous expertise, advice, encouragement, and inspiration, as well as for being patient with me during this project.
- Every household that took part in this survey.
- Thank you to Dr Gisele Sinasson, her support and assistance in data analysis, I really appreciate a lot.
- Thank you to my friends and colleagues, especially Mr. Thabani Madonsela, Ms. Zwivhuya Tshovhote, Ms. Lerato Ndlovu, and Mr. Gundo Malema, for your encouragement and inspiration.
- Thank you for your consistent prayers, support, and unwavering faith in me, and my family, especially Alugumi Mulaudzi, Dakalo, Ndivhuwo, and Rotenda, for your constant encouragement, priceless emotional support, and wise words.

ABSTRACT

Non-Timber Forest Products (NTFPs) are wild biological resources obtained from natural landscapes, agricultural systems, and rural and urban regions for a variety of uses. NTFPs contribute significantly to livelihoods and living standards by offering a variety of socioeconomic benefits such as food, health, income generation, and safety nets. These multiple benefits are provided by a wide diversity of plant, animal and fungal species in different settings. However, the precise number of NTFP species used depends on the scale of assessment, namely use by individuals, by households and by villages. Consequently, it is difficult to compare numbers of species used between studies because of the differing scales. As a result, the objective of this study was to determine the number of NTFP species used at three different scales and how each is correlated with appropriate scale-dependent contextual variables.

This objective was met by sampling individuals and whole households in five villages in the Vhembe District in Limpopo Province, South Africa. Twenty households were randomly selected in each village, providing a total sample of 100 households and 179 individuals in those households. In each household, every adult member was interviewed individually about the NTFPs that they used or knew. The major questions covered the NTFP species used, the respondents' socioeconomic level, the NTFP species used previously, and if the number of NTFP species are changing in the landscape. Data were reported per individual as well as per household and per village. The household level was derived by adding the responses of all the adults in each household but excluding duplicates. The same approach was used at the village scale, namely, the data across the 20 households were pooled, and duplicates were omitted. Patterns of NTFP use were examined by type of NTFP, and analysis using standard statistical tests, along with a Principal Components Analysis and a multivariate Detrended Correspondence Analysis of the NTFP species composition across villages.

A total of 275 species of NTFPs were mentioned across the entire sample, including 81 species of firewood, 48 species of edible insects, 43 species of wild vegetables, 40 species of edible fruits, 38 species of wood utensils, 28 species of medicinal plants, 23 species of thatch grass, 19 species of poles, 19 species of wood for carvings, nine species of reeds, eight species of mushroom, and eight species of fodder. Of these species, some species had more than one use. Approximately 90% of the species used by the respondents were native species. Wild vegetables (e.g., *Corchorus olitorius*, *Amaranthus capensis*, *Bidens pilosa*), firewood (e.g.,

Colophospermum mopane, *Parinari curatellifolia*, *Combretum hereroense*), wild fruit (e.g., *Landolphia kirkii*, *Vangueria infausta*), and edible insects (e.g., *Imbrasia belina*, *Macrotermes michaelseni*, *Encosternum delegorguei*) were the most often used NTFPs by communities in the Vhembe area. Most of the households relied on NTFPs for subsistence.

At the scale of an individual, the mean number of NTFP species used was 26.8 ± 12.6 across the five villages. When considering a household, the mean number was 36.1 ± 10.7 species. When aggregated across the 20 households per village, the mean number per village was 105.2 ± 34.1 species. The species accumulation curve showed that 20 households per village were reasonably representative for four of the five villages.

The results from the principal component analysis (PCA) and correlation analysis revealed that age, education, and employment status were significantly associated with the number of species used by individuals, whereas gender showed no clear correlation. At the household scale, household size was positively related with the number of species used, but income level and income source were not. At the village scale, attributes such as proximity to a town, settlement type, vegetation type, and distance to a nearby savanna all had some influence on the number of NTFP species listed. Most of the respondents felt that the number of species used had increased over the last 10–15 years, although some stated the opposite. Increases were attributed by traditional councils bans, the establishment of protected areas, and restoration. Activities eroding the number of NTFP species were identified as clear felling for farming, climate change, and over-harvesting. This study suggests that communities must be made more aware of the overharvesting of NTFP species in the savanna to avoid biodiversity loss.

Keywords: species, number, NTFPs, households

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LIST OF ACRONYMS AND SCIENTIFIC UNITS

CBA- Critical Biodiversity Area

CIFOR- Centre for International Forest Research

ESA-Ecological Support Area

FAO- Food and Agriculture Organization

KNP-Kruger National Park

NP-National Park

NTFPs- Non -Timber Forest Products

RNT- Random Number Table

HH- Households

VDM-Vhembe District Municipality

Spp- species

km² - Square kilometres

°C- Degree Celsius

% - Percentage

mm- Millimeters

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1. INTRODUCTION

1.1. Introduction

Non-timber forest products (NTFPs) are generally defined as biological resources that are largely wild species derived from natural landscapes, agricultural systems, and rural and urban environments for various purposes, including firewood, fruits, fibre, medicinal and edible plants, small-diameter wood used for crafts and utensils, latex, essential oils, resins, fungi, fauna, and fodder (Leßmeister et al. 2018; Shanley et al. 2008). Wahlén (2017) states that the use of NTFPs is firmly entrenched in rural and urban communities, and sociocultural and economical systems around the world (Shackleton et al. 2017; Hurley and Emery 2018).

Globally, more than five billion people use NTFPs (Shackleton and de Vos 2022), of which at least two billion depend on NTFPs for livelihood security, income, and subsistence (Ahenkan and Boon 2011). Such dependence is typically greatest amongst the poorest communities and households (Suleiman et al. 2017) and during times of shock (Wunder et al. 2014).

According to Pandey et al. (2016), people's reliance on NTFP commercialization is increasing, and in certain circumstances, NTFP revenue can be their only source of cash income. At a broader scale, trade in NTFPs generates development opportunities. Amusa et al. (2017), for example, stated that NTFP marketing provides more than reasonable returns and is an important component of most rural households' diverse livelihood strategies. NTFP value chains and markets provide employment and income for many, and across a range of skills (Yobo et al. 2020; Peerzada et al. 2021). In particular contexts, and for higher-value NTFPs, this income is sufficient to lift trading households out of poverty as illustrated by numerous case studies presented by Pullanikkatil and Shackleton (2018). The cash savings made from subsistence or consumptive uses of NTFPs can also assist households in alleviating poverty when they make large contributions to total cash and non-cash income (Leßmeister et al. 2016, Gosling et al. 2017). More than 85% of rural South African households use wild spinaches, edible fruit, grasses, and firewood, while 50% or more use edible insects, raw honey, wood for construction, and reeds for weaving (Shackleton and Shackleton, 2004).

The multiple roles and values of NTFPs in the livelihoods of rural and urban people require investigation so that policymakers and development planners are adequately informed about the importance of local resources and take them into account when advocating particular land use policies and developments, as well as poverty alleviation strategies. The main roles of NTFPs in livelihoods are described below.

1.1.1. NTFPs for household consumption

The most widespread use of NTFPs is the routine gathering of locally available resources to support a household's direct needs for food (fruits, nuts, seeds, leafy vegetables, insects, fungi, bushmeat, honey), energy (charcoal, firewood, kindling), medicines (bark, roots, tubers /bulbs leaves), shelter (thatch grass, wooden poles for housing and fences, reeds or palms for roofing), fibers (grasses, bark, lianas), and agricultural implements made from local woods. This direct consumptive use usually includes many different species at the household level, which the residents need to be able to identify, know where to collect and how to prepare and use them.

Edible NTFPs such as leaves and nuts, enrich rural diets as components of the sauces that go with the essential carbohydrate foods. Many people commonly consume some fruits as snacks (Adebisi, 2005). Wild foods, according to De Merode et al. (2004), play an important role in the livelihoods of rural communities in the eastern DRC, and consumption habits shift seasonally, with bushmeat intake increasing by 75% during the dry season.

The majority of people in Africa also rely on NTFPs for medicinal purposes. Adebisi (2005), for example, reported that over 80% of Africa's rural inhabitants relied largely on herbal treatments for basic health care. In South Africa, a now dated estimate reports that over 27 million households use traditional medicines, nearly all of which are collected from the wild (Mander 1998).

One of the most widespread uses of NTFPs is for energy in the form of firewood or charcoal. The International Energy Agency (2004) estimated that almost a billion people in Sub-Saharan Africa will still use firewood or charcoal in 2030. The quantities used at the household level vary widely in relation to household size, the relative availability or scarcity of wood stocks, the proximity of markets, and cultural norms. Estimates in South Africa range from 1.2–7 tons (of firewood) per household per year, with a mean of about 3.2 tons (Shackleton et al. 2022).

1.1.2. NTFPs as safety nets

NTFPs provide safety nets for households, helping them to cope during times of crisis. These times are distinguished by shocks or unanticipated changes in the economic, social, or environmental conditions in which households live and operate (Wunder et al. 2014, Tibesigwa et al. 2016). For instance, Wunder et al. (2014) describe disasters such as the death or retrenchment of the breadwinner, droughts, floods, frosts, or disease causing crop damage or animal loss, substantial economic structural transformations, and sudden and large rises in the prices of staple foods and items (Paumgarten and Shackleton 2011).

According to Paumgarten (2005), the types and amounts of NTFPs deployed to cope during shocks depend on the nature, likelihood, and duration of the shock, as well as the household's capacity to deal with such shocks in terms of alternative revenue sources. Paumgarten (2005) states that 41% of people who used NTFPs as a safety net used wild food, 40% used medicinal plants, 26% substituted paraffin with firewood, 10% purchased firewood, and 9% marketed other products. While some NTFPs were more emergency nets, others were used in a range of situations. As a safety net, it covers both human and cattle illnesses and injuries. Wunder et al. (2014), for example, observed that building materials were only employed to restore damaged dwellings. The most popular NTFP employed as a safety net were medicinal plants, which covered both human and cattle diseases or injuries.

Working in two rural villages, Paumgarten (2005) reported that over the preceding two years, 99% of households encountered crises like illness, retrenchment, failure, and death (e.g., the payment of college fees and seasonal crop shortfalls). This is similar to Wunder (2014) who found that 44% of rural households across 58 sites in 24 countries reported at least one shock in the preceding year. According to Paumgarten and Shackleton (2011), all households are susceptible to shocks, irrespective of their relative wealth or the gender of the household head. Wunder et al. (2014), on the other hand, discovered that wealthier families possess more assets that provide alternative strategies during shocks (e.g., by constructing assets that are quickly liquidated) and therefore can choose amongst suites of response choices. However, a greater diversity of assets makes such households susceptible to a greater range of shocks, such as livestock owners having to cope with risks associated with disease, death or theft of their animals, which is not something that non-owners need to worry about.

The mobilization of NTFPs as safety nets can be via one or more of three means (Shackleton and Shackleton 2004). The first is for a household to extend the utilization of NTFPs that are already a part of their regular provisioning patterns (e.g., to increase the consumption of wild foods and decrease the use of purchased foods). The second is to begin the use of NTFPs that they generally don't use very frequently (e.g., use of fuelwood rather than electricity). The third is to engage in the temporary sale of NTFPs to earn cash, which can then be used to buy whatever is needed to cope with the shock.

1.1.3. NTFPs for cash income generation

Many people get revenue via selling NTFPs, which opens up opportunities for asset accumulation. In the mountainous parts of Nepal, for example, van de Boog et al. (2017)

estimated that 10-100% of families are active in the collection of commercialized NTFPs, and in certain rural hilly areas, it generates up to 50% of total annual household cash income (Yadav et al. 2016; Fajobi and Fingesi 2018).

Local, regional, national, and international trading in NTFPs can make a substantial contribution to the community and household economies (Ojomah et al. 2020). The extraction of NTFPs has multiple impacts on the economy by producing employment and money in processing and trade activities (Ojomah et al. 2020). According to Mukul et al. (2011), local communities collect a significant quantity of NTFPs, with 27% of families in the Bangladesh region receiving at least some economic gain from the collecting, processing, and selling of NTFPs. Values for South Africa are a lot lower on a wide scale but can be high within specific villages. For example, the wide-scale survey by Mugido and Shackleton (2017) found that just over 6% of rural households traded in at least one NTFP, although at an individual village scale it can be a lot higher (Shackleton et al. 2000; van de Boog et al. 2017).

According to Ojomah et al. (2020), in Awka-North Local Government Area, Nigeria, 42% of families earned at least USD212 monthly profit from the selling of NTFPs, with the majority earning more than USD159, which is significantly over the international poverty line. This demonstrates that in some circumstances, NTFP sales can generate higher income than other sources of revenue (e.g., government handouts), so helping to eliminate poverty and improve living standards. Akinta et al. (2013) and Ojomah et al. (2020) indicated that NTFPs might act as a source of wealth creation and assist in poverty reduction for many households. This is especially true given that NTFP sales are one method by which they might generate funds. Mulenga et al. (2012) found that NTFPs provide around 33% of family income for participating families. According to Cunningham et al. (2011), local and larger-scale commercialization of NTFPs is prevalent and growing in many locations, giving monetary income to many families.

The collection and sale of NTFPs can provide jobs, thereby contributing to livelihood diversification. For example, in southern Mozambique, households that included the sale of palm products had a greater diversity of livelihood strategies and also had higher household cash incomes (Martins and Shackleton 2022). Both rich and poor individuals can profit from the selling of commercially viable NTFP species (Maharjan and Dangal, 2020). According to Melaku et al. (2014), NTFPs supplied 47% of yearly family income in Southwestern Ethiopia. This is also differentiated by household attributes such as wealth. For example, in the Kat River area of the Eastern Cape, a higher number of disadvantaged households (>30%) than wealthier

households (<10%) sell NTFPs for cash (Shackleton and Shackleton 2002). Poor households also sold a broader range of NTFPs, and the revenue received contributed more to overall family income than the few rich households that sold.

Local and broader commerce in NTFPs benefits cash income more. According to Shackleton et al. (2008), persons who work full-time in the NTFPs trade can earn well over the national poverty line, however, this is largely depending on the type of the product; products with high demand or with high value addition tend to attract better prices and therefore incomes to producers. Additionally, those who trade in more than one NTFP also enjoy higher incomes (Mahonya et al. 2019). Balama et al. (2016) argue that the current collection of NTFPs is aimed not just at subsistence usage but also at cash revenue creation, which is used for a variety of family requirements (Msalilwa et al. 2013; Gauoe et al. 2016).

Seasonality, inadequate and poor transportation services, poor road systems, a lack of storage facilities, a shortage of knowledge or skills for a product change, and a lack of market expertise are among the market obstacles affecting trade in NTFPs according to Amusa et al. (2017). However, Amusa et al. (2017) observed that seasonality was the major limiting factor for sale in most NTFP products, apart from chew sticks and fever bark, which were considered important restrictions due to product dispersion across the area and poor transportation infrastructure.

1.1.4. Cash saving

Household use of NTFPs can provide significant monetary savings (Shackleton et al. 2007b). NTFPs enable households, particularly the poorest, to allocate scarce cash for livelihood needs that cannot be met through the use of NTFPs (Shackleton and Pandey 2014), such as agricultural inputs (e.g., seeds or fertilizers), school fees or books, stock purchases for trading, or some accumulation of savings against future misfortune, such as medical or transportation expenses (Shackleton and Shackleton 2004). Apart from the labor and time involved in collecting NTFPs, the majority are harvested at no cost. Many NTFPs are regarded as "free" natural resources requiring little or no capital expenditure (Delang, 2006). This enables disadvantaged households to spend their already scarce economic resources on other necessities such as school fees, medical expenses, local transportation, or the purchase of agricultural supplies.

The government can also save money (Shackleton et al. 2007) and use its current resources to support and execute other key tasks not covered by NTFP usage (e.g., water and sanitation).

Thus, the usage of NTFPs for food, energy, or any other purpose eliminates the need for households to purchase that same requirement. The direct use of NTFPs provides a double advantage: (i) via the consumption of commodities required by the family, and (ii) a monetary saving benefit because many NTFPs are gained for free from local settings (Shackleton and Pullanikkatil, 2018). The value of this cash saving has been shown to be substantial across a variety of settings. The largest international study is that of Angelsen et al. (2014) which spanned more than 8,000 households in 24 countries in Southeast Asia, South America, and Sub-Saharan Africa. They found that NTFP use contributed a mean of 28 % of household income, which is a large saving to scarce cash resources. But many studies have shown contributions from NTFPs to be more than 40 % of total household income, such as 69% reported by L’Roe and Naughton-Treves (2014) in northern Peru, 59%, in Cameroon (Angelsen et al. 2014), 52 % in Mexico (Lopez-Feldman 2014) or 44 % in Zambia (Kalaba et al. 2013) as a few examples. This shows that the cash savings from the use of NTFPs can be really important, and without them, many households would be poorer and maybe struggle to make a living. Cash savings are also a strong driver of urban collection and use of NTFPs in developing world countries (Garekae and Shackleton 2020).

1.1.5. Maintenance of culture, traditions, and knowledge

Many NTFPs are central to the culture and traditions of local communities, with many being cultural keystone species (Shackleton et al. 2018). Societies across the globe use a diverse range of plants and animals to meet culturally shaped spiritual demands and values (e.g., using a certain species to remove evil or bad luck). According to Cocks and Dold (2004), grass brooms have three significant cultural functions in South Africa's Eastern Cape province. Firstly, they are offered as traditional wedding gifts. Second, traditional grass brooms are thought to keep lightning away from houses. In the Xhosa culture, brooms are associated with magic. It is believed that keeping a broom in the house will protect the people who stay there. Finally, grass brooms can be used to administer protective medicine. The floor, walls, and ceiling are sprayed with a decoction of medicinal plants (Dold and Cocks, 2002). This approach is claimed to provide prosperity and good health to the family members (Cocks and Moller, 2002).

Cultural uses of NTFPs are not just amongst remote rural communities. More than half (59%) of urban broom purchasers did so for cultural reasons (Cocks and Dold, 2004). This revealed the importance of cultural habits in urban contexts (Cocks and Wiersum, 2003). Cultural uses of NTFPs are also observed in developed countries. For example, traditional baskets in the

USA (Grabbattin et al. 2011), or herbal remedies in Europe (Lovrić, et al. 2020). According to Shackleton et al. (2015), the cultural features of some NTFPs may have a role in cultural tourism opportunities.

Shackleton and Campbell (2007) revealed that in the Limpopo Province's Bushbuckridge municipality, brooms manufactured from grass or palms were used for a variety of household and cultural purposes. However, Shackleton (2015) argues that factors such as shifting socioeconomic circumstances, globalization, and migration have had a significant impact on the erosion of information about traditionally utilized species. These aspects have also been emphasized by Benz et al. (2000) and Cullen et al. (2007).

1.2. Number of NTFP species used or known

The flow of benefits described above from the utilization of NTFPs depends upon two things. The first is that there is a variety of NTFPs in terms of both species and functional types (such as edible species, craft species, medicinal species, etc.), which is the focus of this thesis. The second is that the desired NTFPs are accessible and available in sufficient quantities, which then depends on local conditions, population sizes, management and governance, and shocks such as wildfires and pest outbreaks. Both the number of species and the number of functional types are also linked to local knowledge (Weyer 2011) and also habitat diversity because Herd-Hoare and Shackleton (2022) show that a greater number of habitats results in a greater number of functional types and household income contributions from NTFPs.

Although many studies have reported on the value of NTFPs to rural households, relatively few report the number of species or types of NTFPs used. It is also complicated because of the different scales at which numbers can be counted and reported; including per person, per household, per group of experts or elders, per sample, or village or region. The counts cannot be transferred across scales, and so studies with larger sample sizes and spatial areas are likely to report greater numbers of species. Therefore, the relationship between the number of species or types used and the value obtained has not been analyzed.

South Africa is an extremely biodiverse country, and studies suggest that thousands of plant species are utilized as NTFPs across the country, with hundreds exploited by individual communities (Shackleton and Shackleton 2004; Njwaxu and Shackleton 2019; Dalu et al. 2021). Various studies have shown the number of NTFP species used per village (Table 1) and the type of NTFP species (Table 2) in South Africa and elsewhere across the world. For

example, more biodiverse areas are likely to have a greater variety of species used as NTFPs than less biodiverse habitats (Salick et al. 1999; Dovie, 2007). An additional example is that more productive habitats such as wetlands (Mmopelwa et al. 2009; Gosling et al. 2017) will supply more NTFPs for human consumption than less productive habitats (Mugido and Shackleton 2019). Because of the imposed unavailability of particular NTFP species in such environments, degraded habitats may give fewer species. These illustrations contrast one location with another, resulting in geographical differences. Furthermore, NTFP abundance, variety, and utilization may differ throughout the duration of a single season, resulting in a time difference.

According to Uprety et al. (2016), the native inhabitants of the Kangchenjunga area (a transboundary environment shared by Bhutan, India, and Nepal) employed 739 species of NTFPs for varied reasons, with medicinal and food plants having the most species. Tribal groups in Arunachal Pradesh, India's eastern Himalayan area, employed 163 of the 343 NTFP species documented for medicinal reasons, (Saha and Sundrupal 2012). Njwaxu and Shackleton (2019) discovered that the number of NTFP species increased with the successional age of the former old fields.

Pradhan and Singh (2019) reported that in Ribdi village, India, 24 plant species are used for medicinal purposes, 22 species of wild edibles (fruits, vegetables) are used for household consumption, fuelwood species (*Alnus nepalensis*) are primarily used, and 11 plant species are used for construction and handicrafts (poles, thatch grass). In contrast, Shackleton et al. (2002) reported the number of species used by a sample of 30-65 households in three different South African villages and found it to range between 118 to 208 species. In Mametja in the Limpopo Province, Twine et al. (2003) report the villagers used 125 different plant species, 19 insect species, and seven mammal species. The quantities involved can be substantial even at a household level. For example, Shackleton and Shackleton (2004) reported that on average each household used 58 kg of wild leafy vegetables, 5.2 tons of firewood, 104 kg of wild fruits, and 180 poles for building per year involving a variety of NTFPs across several South African sites.

Table 1: The number of NTFP species used in different local level studies in different countries

| No. of NTFP species used | Country | References |
|---------------------------------|------------------------|------------------------------|
| 92 | India (Meghalaya) | Sharma et al. (2016) |
| 480 | China | Ghorbani et al. (2012) |
| 109 | Malaysia | Kodoh et al. (2009) |
| 128 | Kenya | Maua et al. (2018) |
| 59 | South Africa | Thinyane and Maroyi (2019) |
| 151 | South Africa | Twine et al. (2003) |
| 177 | South Africa | Njwaxu and Shackleton (2019) |
| 118- 208 | South Africa (3 sites) | Shackleton et al. (2002) |

Table 2: NTFP Type and number of species used per village in different studies

| NTFPs type and number of species used per village | Sites (country) | References |
|--|----------------------------|-----------------------|
| Fuelwood (67), fodder (37), fruit (10), vegetable (7), oilseed (5), toothbrush (4), ethnomedicine (3), cottage industry (2), and mahua flower (1). | Jharkhand (India) | Islam and Quli (2017) |
| Wild edible plants (35), medicinal plants (32), orchids (8), bamboos (4), rattans (6), fish (8), and wild fruits (8). | Malaysia | Kodoh et al. (2009) |
| Medicine (66), firewood (52), food (20), fodder (15), fruits (11), and construction (27) | Kenya (South Nandi Forest) | Maua et al. (2018) |
| Trees (111), shrubs (29), herbs (21), climbers (19), and lianas (3) | India | Omkar et al. (2012) |
| Fuelwood (25), wild vegetables (13), wild fruits (11), medicinal plants (11), fodder (6), broom (2), and thatch (1) | India | Sangma et al. (2019) |

1.3. Local ecological knowledge about NTFP species

The number of species used and their precise uses depend on the local ecological knowledge (LEK) about NTFPs amongst the inhabitants of an area. Indigenous knowledge and management practices have been implicated in the long-term use of NTFPs (Yadav et al. 2016). Mutenje et al. (2011) argued that "high levels of local ecological knowledge (LEK) are required to underpin sound resource governance and sustainable harvesting of NTFPs," but Steele et al. (2015) found "no relationship between the index of LEK and the state of the woody plant communities around each village." They proposed that was because not all members of a community or a household had equal levels of LEK (Chalmers and Fabricius 2007; Steele et al. 2015), which meant that some might harvest in less sustainable ways than others.

Multiple household and contextual factors have been shown to affect the levels of LEK, and therefore possibly the number of NTFP species known and used. In general, elders are expected to have better knowledge and understanding of NTFPs than younger generations (Arajo and Lopes 2012; Paniagua-Zambrana et al. 2014). The same is regarded as true for those who work closely with NTFPs or are more intimate with local habitats and land-based livelihoods, than those who are more divorced from such (Arajo and Lopes 2012). Some studies have shown that household size and monthly household income have a positive and direct influence on knowledge (Paniagua- Zambrana et al. 2014; Campos et al. 2015). However, formal education and interaction with other non-indigenous cultures can result in a decline in LEK (Reyes-Garca et al. 2010). For example, Aguilar-Santelises and del Castillo (2015) revealed that communities that had undergone a greater degree of cultural mixing had less LEK, owing to these peoples' lack of touch with their native culture and natural resources.

Some traditional ethnobotanical knowledge is lost as a result of industry or government restrictions on gathering NTFPs on customary territory (Blaser et al. 2011). Other losses, according to McCarter and Gavin (2015), are the consequence of changes in indigenous peoples' livelihoods and lifestyles, in which particular NTFPs are replaced by mass-produced contemporary items that are less time-consuming to make, more effective, and more up-to-date (Quave and Saitta 2016).

1.4. NTFP species

Several plant species are utilized for each NTFP use type, such as fuelwood or weaving materials (Shackleton and Shackleton 2004). Indeed, people in South Africa's northern savannas utilize up to 200-300 plant species on a regular basis. Fewer appear to be utilized in

the Eastern Cape province, which may be due to decreased species variety, particularly in woody plants for lumber, fuelwood, and wild fruits. Hundreds of plant and animal species may be used by individual households (Dovie et al. 2002; Shackleton et al. 2002). According to Steur et al. (2021), a greater knowledge of the associations between NTFP abundance and plant diversity is critical for tropical NTFP conservation because it can be used to find potential efficiencies between NTFP supply and prevailing biodiversity conservation efforts, as well as aid in the development of additional resource conservation.

Several studies have confirmed that rural households in South Africa use woodland products, particularly NTFPs (Stack et al. 2003; Paumgarten and Shackleton 2009; Makhado et al. 2012). South Africa is equipped with wide-ranging and beneficial indigenous forests and woodlands that provide diverse and important resources to rural communities, which are used to support the livelihoods of individuals who live near such habitats and to promote sustainable development (Lawes et al. 2004; Ticktin 2005).

Numerous NTFP species are used in South Africa in the form of food, energy, medicinal plants, fodder, construction materials, and other goods (Tewari, 2012). The wood of *Colophospermum mopane*, *Diospyros mespiliformis*, *Combretum apiculatum*, *Senegalia nigrescens*, *Sclerocarya birrea*, *Terminalia sericea*, and *Combretum imberbe* are used for making household utensils such as mortars, pestles, spoons, plates, walking sticks decorations and hand hoes for ploughing in Limpopo (Makhado et al. 2009). Home crafts such as baskets and mats are the most economically important items in the Vhembe region. These crafts require the use of specific NTFP species sourced from the savanna. Each basket, for example, is made from a variety of NTFP species, including *Onicinotis inandensis* for the basic framework, and *Flagellaria quineensis* for weaving (Cawe 1999).

Several NTFP species are collected/bought for food by people these include edible fruits, wild spinaches, honey, honeybees, edible mushrooms, termites, stink bugs, mopane worms, and edible locusts (Makhado et al. 2009; Tewari 2012). Makhado et al. (2009) noted that in Northeast Limpopo about 71% of villagers collected mopane worms (*Gonimbrasia belina*) for subsistence and 29% sold them for income generation. Stink bugs are also used for supplementing food (Teffo, 2006). Termites are eaten in most parts of Southern Africa (Bower, 2001; Makhado et al. 2009). Edible locusts are also consumed in most rural areas of northeastern South Africa (Makhado et al. 2009). Additionally, numerous tree and shrub species supply various forages (fodder) for livestock consumption.

1.5. Factors affecting the supply of NTFPs in households

The temporal variations in NTFP supply have focused on the impacts of a current reduction in NTFP species availability, often caused by forest or land degradation, misuse, human population increase, or the harmful impacts of wildfires (Njwaxu and Shackleton 2019). For instance, Jimoh et al. (2013) investigated the relative population stability of five NTFP species in Nigerian forested areas, demonstrating the effects of habitat degradation on species population distribution and diversity. Whereas, in southwest India's Western Ghats, Krishnamurthy et al. (2013) discovered that extractors' activities harmed cycad species.

According to Augustino et al. (2013), distance to the natural areas, changes in management practices, seasonality, and changes in rainfall patterns all had an impact on the supply of NTFPs. Distance from the village to where natural resources are collected, available resources, ease of access, structural constraints, the human density of the population, employment rates, economic status, alternate solution availability, LEK, and personal and cultural preferences are all factors that influence NTFP usage (Shackleton et al. 2001; Saha and Sundriyal 2012). As a result, it is critical to identify, evaluate, and control the factors that influence the supply and availability of NTFPs (Njwaxu and Shackleton 2019) and hence their contribution to human well-being.

1.5.1. Restricted areas/ prohibited area

According to Msalilwa et al. (2013), there may be a tacit agreement allowing households to access off-limits areas to gather some NTFPs that are non-destructive, including dry firewood, mushrooms, fruits, and wild vegetables. To avoid a consequent rise in poverty and a trade-off between conservation and the extraction of NTFPs, restrictions on areas to promote conservation necessitates additional policies (Msalilwa et al. 2013; Balama et al. 2016).

1.5.2. Changes in rainfall patterns

The availability of some NTFPs, such as mushrooms, has been impacted by changes in the pattern and intensity of rainfall. According to Balama et al. (2016), in Kilonzo, Tanzania, for instance, *Amanita zambiana* and *Termitomyces le-testui* are typically collected varieties of mushrooms in December, but due to recent changes in the onset and cessation of rainfall, they are less accessible. Similarly, Chidumayo (2011) highlighted the influence of climate change on the abundance of NTFPs through wildfires linked with drought, leading to biodiversity loss.

1.5.3. Seasonality

According to Islam and Quli (2017), some NTFPs are available for about six months, excluding fuel wood, fodder, sal leaf, lac, and toothbrush, and peak trade is limited to 3-4 months. Summer, spring, and autumn seasons see a large influx of NTFPs, whereas the rainy season has the least availability of NTFPs.

Research has identified two significant factors that affect NTFP collection. First, the collection could be perceived as a household response to seasonal or unforeseen natural or social shocks such as flooding, plant disease, market imperfections, higher sickness rates among household members, political uncertainty, and food or cash insecurity (Heubach et al. 2011), and secondly, the approach could be viewed as a normal practice that consistently contributes to the household net income (Heubach et al. 2011; Saha and Sundriyal, 2012).

According to Saha and Sundriyal (2012), these tactics may result in an unsustainable collection of NTFPs, which might increase environmental degradation and biodiversity loss. Furthermore, this might result in a future lack of NTFP supply and reduced well-being for specific rural households (Islam and Quli, 2017).

1.5.4. Distance to NTFP populations

According to Balama et al. (2016), the extent of NTFP species gathering declined as distance increased. This suggests that the potential cost of labor time spent collecting grows with distance, meaning that persons living closer to the woodland are more reliant on NTFPs (Balama et al. 2016). Similarly, Kilonzo (2009) showed that in Tanzanian households around the Nyanganje Forest Reserve, firewood collection decreased dramatically with increasing distance.

1.6. Household characteristics underpinning NTFPs use

Multiple authors reported correlations between various household attributes and the extent of use or reliance on NTFPs. According to Shackleton and Shackleton (2006), socioeconomic variables impact resource usage; consequently, resource consumption may vary within any given community based on characteristics such as family affluence and gender of the household head, and gender composition of household members. For example, increasing household wealth enables the purchase of NTFPs, whereas poorer households primarily obtain NTFPs through self-collection (Shackleton and Shackleton, 2006; Balama et al. 2016; Phan et al. 2017).

1.6.1. Gender

Gender is a consideration of social differentiation in many rural areas, with women (and female-headed households) generally having lower status. Some researchers observed that men gather wood for cattle enclosure construction and sale in carvings and poles, whilst women collect NTFPs for household consumption and sale in items such as reed mats and hand brushes (Shackleton and Shackleton 2004b, Timko et al. 2010). In the Bushbuckridge region of South Africa, women collected NTFPs in 73% of the instances, while males collected in 27% of the cases (Shackleton et al. 2015), however in India, 98% of women and 91% of men gather NTFPs. Furthermore, Opaluwa et al. (2011) discovered that in Nigeria, women were more likely than men to collect NTFPs. Therefore, it is difficult to generalize across cultures and societies in terms of gender patterns of NTFP collection and use (Sunderland et al. 2014).

1.6.2. Household size

Household size has a significant impact on the use and frequency of collection of many different types of NTFPs. The larger the household, the more NTFPs, such as fuelwood for cooking or edible plants, are required. Adikhari (2014), for example, proposed that larger households have a higher demand for NTFPs and are thus more likely to collect NTFPs. Similarly, Rodrigez (2007) discovered in an Indian study on the determinants of NTFP collection that the presence of an additional individual in the household increases the household probability of collecting NTFPs.

1.6.3. Age

The type and amount of NTFPs used are affected by age. Shackleton and Shackleton (2004b) discovered that "NTFPs and related activities have few entry barriers and, together with their nutritional benefits, can significantly contribute to the livelihoods of the elderly, households with an elderly head, or children who opportunistically collect wild edible fruits, insects, and small mammals while traveling to school, herding livestock, and so on."

The age of the head of the household may have an impact on the decision to collect NTFPs. Several studies have argued that collecting NTFPs is labour-intensive, so young people may be more reliant on NTFPs than elderly people (Mamo et al. 2008; McElwee 2008). In India, for example, Rodrigez (2009) discovered that adult household heads were more likely to collect NTFPs. Other researchers (Shone and Caviglia-Harris 2006; Phan et al. 2017) discovered a link between age and the decision to collect NTFPs.

1.6.4. Level of education

Adhikari et al. (2004), for example, studied the relationship between household characteristics and NTFP collection in Nepal and discovered that a higher level of education provides opportunities for better jobs and reduces the household reliance on NTFPs, so they are less interested in collecting NTFPs. The same has been argued for studies from Sub-Saharan Africa (Timko et al. 2010).

1.7. Objective & key questions

The above introduction has provided an overview of the current state of knowledge and understanding about patterns of the usage of NTFPs globally and their incorporation into rural livelihoods. As part of that, it has identified a lack of clear understanding of the number of species used at different scales and the factors that may influence that. Therefore, the objective of the study was to determine the number of NTFP species used at three different scales (individual, household, village) and how they vary in relation to the local context. To address this objective the following key questions were addressed in each of the sampled villages:

- ❖ How many NTFP species and types are used at the individual, household, and village scale?
- ❖ Has this number of NTFP species used changed over the last 10-15 years?
- ❖ What contextual factors influence the number of NTFP species used at each scale?

1.8. Conceptual framework for the number of NTFP species used

The framework of the study was shown in figure 1, the framework demonstrate the patterns that are related to the number of species used in the households. The patterns of the NTFP species were the roles that NTFPs plays on the household livelihoods, the attributes or factors such as socio-economic and environmental, the theory of changes in terms of number of species that are used as to the reasons behind the changes and the utilization of NTFP species in the households.

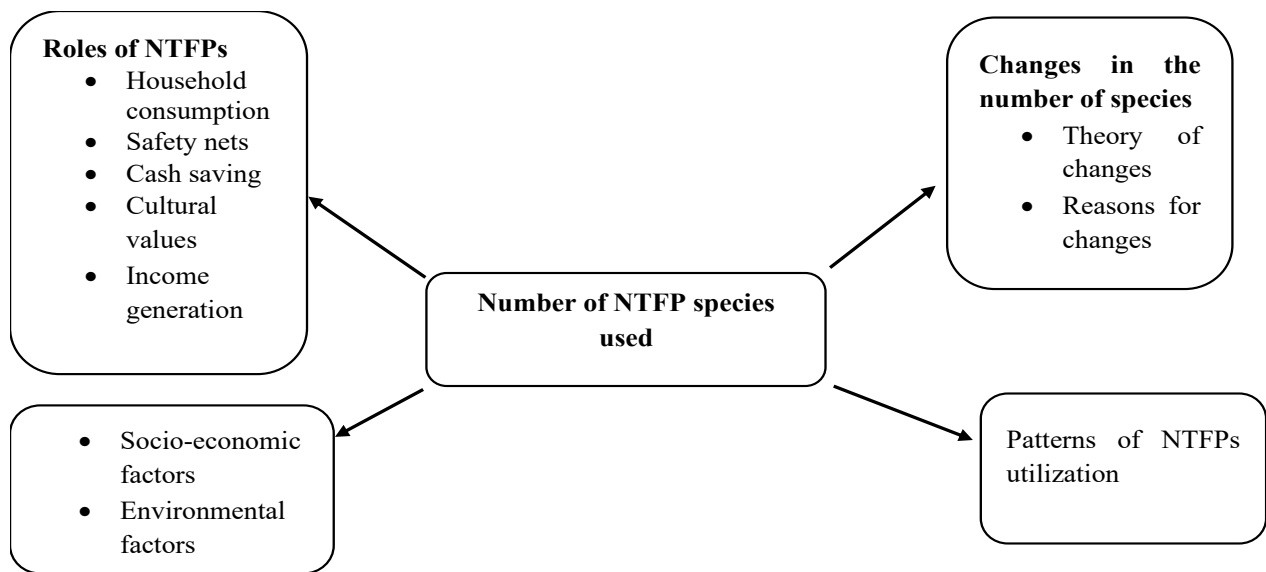


Figure 1: Conceptual framework links between utilization of NTFP species and number of species used in the households

1.9. Thesis outline

This thesis is divided into four chapters, which are as follows:

Chapter 1 General introduction: As an introduction, this chapter presents the background of the study and explains the purposes and objectives of the thesis. This chapter also examines the research on the definition, roles, benefits, and number of species of non-timber forest products (NTFPs).

Chapter 2 Study sites and methodology: This chapter describes the study area and methodology used in the study, as well as the data analysis.

Chapter 3 The results chapter: Describes the NTFP species used by the community as well as those discovered in the field. The findings also include the amount of NTFP species found in various places, respondents' socioeconomic position, previous NTFP species used, and if NTFP species are changing in the ecosystem. The results on household characteristics about the number of NTFP species used at the household scale are detailed in this chapter.

Chapter 4 Discussion, conclusion, and recommendations chapter: This chapter explores the many factors influencing the number of NTFP species used in households. It ends with a conclusion and recommendations.

2. STUDY SITES AND METHODOLOGY

2.1. Study area

The study was conducted in five villages (Table 3) in the Vhembe District (Figure 2), which is situated between 28°54'20.66" E and 31°04'31.19" E and 22°7'26.59" S and 23°26'6.49" S in Limpopo Province, South Africa. The Vhembe District is the northernmost district in the country, bordering Zimbabwe to the north, Botswana to the northwest, and Mozambique to the east. It is a largely rural region, with a mix of commercial agriculture and subsistence agriculture restricted to the communal land tenure areas. But there is also widespread mining and tourism as major economic sectors. The sampled villages fall under three different local municipalities, Ha Lambani, Miluwani, and Mukumbani are in Thulamela municipality, whereas Tshakhuma forms part of Makhado municipality, finally Tshipise forms part of Mutale municipality (Table 3).

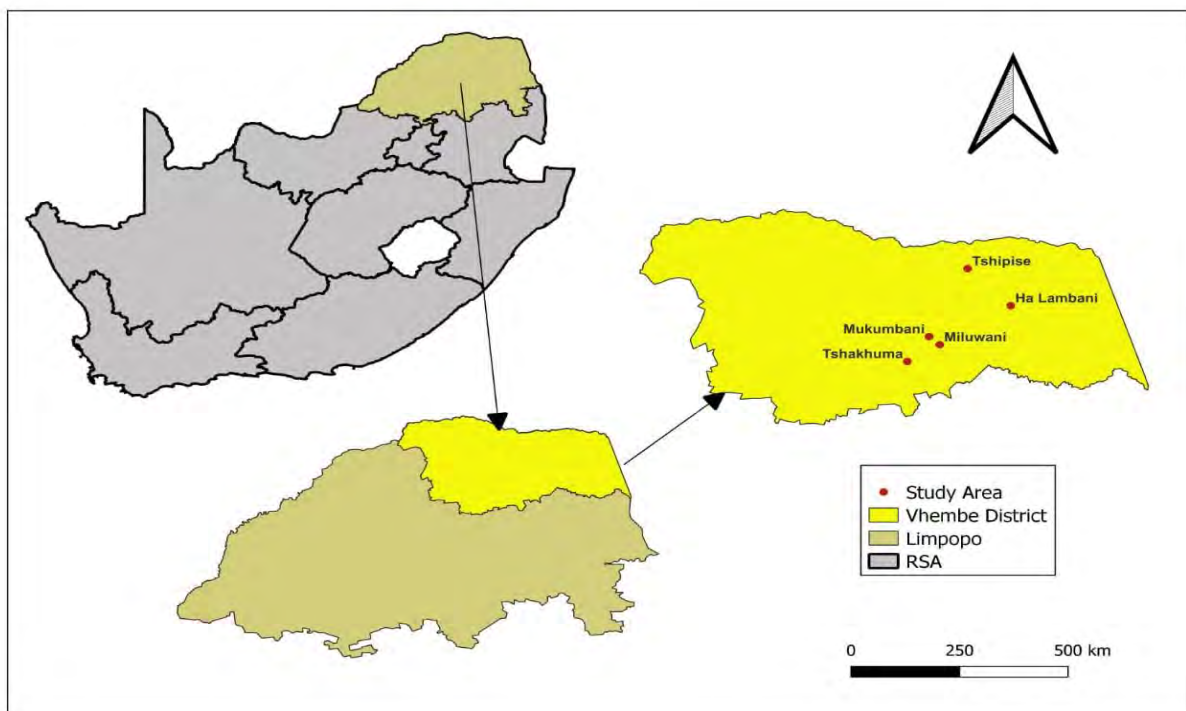


Figure 2: Location of the study area, source: Google Map

2.1.1. Bio-physical factors

Climatically, the region has a hot, wet season with high temperatures (up to 40°C and over) between Oct and March, and a warm (12–22°C) dry winter season between April and September. The rainfall varies across the district, being highest in the mountains, and lowest in the flat savannas, where it averages 400 – 500 mm per year. The wettest months are January

and February (Edokpayi et al. 2015). In Tshakhuma the wettest month (with the highest rainfall) is December (123 mm), and the driest month (with the least rainfall) is August (5 mm). The Ha Lambani area received an average annual rainfall of 522 – 598 mm and a mean average annual temperature of 23°C (Petja et al. 2010). Ha Lambani is classified as semi-arid in South Africa, with annual rainfall ranging between 500 mm and 1 000 mm (Botha, 2014). According to Joseph and Botha (2012), the majority of the rain falls in Ha-Lambani village between October and March. December, January, and February have the hottest average temperatures of 27°C, while July has the coldest average temperature of 19°C. Botha (2014) stated that Ha Lambani receives an average rainfall of 588 mm. The terrain of the Vhembe District ranges from high mountain zones with the Soutpansberg mountain range to low regions with steep and gentle slopes across the area (Mpandeli 2014). The Soutpansberg also has a significant influence on the district's weather and climate. Because of the mountain range, the Vhembe area is susceptible to heavy rainfall (VDM 2020).

The Vhembe District includes various biomes and numerous vegetation types, including savannas, grasslands, forests, mountain escarpments (Soutpansberg), and diverse wetlands (DEA, 2011). The Vhembe District encompasses the majority of the Soutpansberg mountain range, which has been designated as a local centre of floristic endemism, having an estimated 3 000 species, 45 of which are unique to the region (Van Wyk and Smith, 2001). The Vhembe District falls mostly in the savanna biome, with three primary vegetation types: Soutpansberg Sandy Bushveld, Makuleke Sandy Bushveld, and Musina Mopane Bushveld (Mucina and Rutherford 2006; Magwede et al. 2019). The provisioning ecosystem services commonly used are wild fruits and food, medicines, firewood, building and livestock fodder (Constant and Tshisikhawe 2018; Araia and Chirwa 2019). Dominating tree species within the Vhembe district include *Syzygium gerrardii*, *Xymalos monospora*, *Englerophytum maglismontanum*, *Aphloia theiformis*, *Podocarpus falcatus*, *Syzygium cordatum*, *Bridelia micrantha* and *Cassine eucleiformis* (Araia et al. 2019). *Combretum molle*, *Ekebergia capensis*, *Pterocarpus angolensis* and *Sclerocarya birrea* (Constant and Tshisikhawe 2018).

Senegalia and Vachelia species such as *V. sieberiana*, *V. tortilis*, and *S. caffra*, along with *Colophospermum mopane* are the most prominent among the trees (VDM, 2020). Exotic plants such as *Lantana camara*, *Acacia saligna*, *Acacia cyclops*, *Sesbania punicea*, *Azolla filiculoids*, *Eichhormonia crassipes*, and *Nicotiana glauca* have colonized significant areas of agricultural land and eliminated native species in wetlands in the Vhembe district (Mulugisi, 2015). The vegetation of Ha-Lambani, Miluwani and Tshakhuma villages is Soutpansberg Mountain

Bushveld (*Adansonia digitata*, *Diplorhynchus condylocarpon*, *Burkea africana*) (Mucina and Rutherford 2006). Vegetation types of Mukumbani and Tshipise are granite lowveld (*Scelrocarya birrea*, *Terminalia sericea*, *Dichrostyachys cinerea*) and mopane bushveld (*Colophospermum mopane*), respectively (see Table 3). This veld type is made up of a dense vegetation layer with a canopy cover of 60- 70% and a grassland layer that is poorly established. Open savanna sandveld on deep and shallow quartzitic sands characterizes the hilly sections. Mountain regions are grazed communally by the inhabitants of Ha-Lambani and neighboring settlements.

Table 3: Village profiles

| | Ha Lambani | Miluwani | Mukumbani | Tshakhuma | Tshipise |
|---------------------------|------------------------------|-----------------------------|------------------------------|--------------------------|------------------------------|
| Municipality | Thulamela municipality | Thulamela municipality | Thulamela municipality | Makhado municipality | Mutale municipality |
| Coordinates | 22°7'1.08" S 30°8'4.42" E | 22°9'5.6" S 30°4'6.12" E | 22°8'9.86" S 30°4'1.69" E | 23°2'40" S 30°3'28" E | 22°5'4.18" S 30°6'7.03" E |
| Size (km ²) | 18.68 | 2.78 | 3.04 | 11.62 | 1.50 |
| Mean annual rainfall (mm) | 588 | 435 | 450 | 565 | 300 |
| Vegetation type | Mountain bushveld | Mountain bushveld | Granite lowveld | Mountain bushveld | Mopane bushveld |

2.1.2. Socio-economic factors

The Vhembe District covers 21 407 km² and has a population of 1.4 million persons living in 274 480 households (Stats Storm Troops, 2016). According to the 2011 census, over 800 000 Vhembe inhabitants speak Tshivenda as their first language, whereas 400 000 speak Xitsonga. The current unemployment rate is 50.6% (Census, 2011). Rural regions continue to face socioeconomic challenges due to high unemployment and associated poverty, which corresponds with the Vhembe region having the lowest average annual household income nationally (Stats, 2015).

Ha Lambani had a population of around 3 450 people and an average household size of 3.7 people (Stats South Africa, 2014). Males made up 49% of the population of Ha Lambani, while females made up 51%. (Mashego et al. 2010). The age breakdown of the population was as follows: 37% are less than 15 years old, 39% are of working age (15-64), and 7.8% are older than 64 years. Tshakhuma is the most populous village, with 17 371 people living in 4 273 homes, followed by Miluwani with 6 207 people living in 1 578 households, Ha Lambani with 935 households, Mukumbani with 2 431 in 668 households, and Tshipise with 1 052 people living in 306 households as shown in Table 4 (Statistics South Africa, 2011). Furthermore, the female-to-male ratio favours females in all but one of the villages.

The most common source of energy for cooking and heating is fuelwood, whereas lighting is usually powered by electricity. Most households rely on governmental social benefits, agriculture production, and natural resources obtained from the wild.

Table 4: Socio-economic profiles of sampled villages

| Category | Ha Lambani | Miluwani | Mukumbani | Tshakhuma | Tshipise |
|-----------------------------------|-------------------|-----------------|------------------|------------------|-----------------|
| Population (2011) | 3 450 | 6 207 | 2 431 | 17 371 | 1 052 |
| Households | 935 | 1 578 | 668 | 4 273 | 306 |
| Cultural group | Tshivenda | Tshivenda | Tshivenda | Tshivenda | Tshivenda |
| Average HH size (people) | 3.7 | 3.9 | 3.6 | 4.0 | 3.4 |
| % Female-headed | 50.1 | 48.0 | 54.5 | 51.0 | 54.6 |
| Level of education | Secondary | Secondary | Secondary | Secondary | Secondary |
| Average annual HH income (R/year) | 9 601-19 600 | 19 601-38 200 | 9 601- 19 600 | 9 601- 19 600 | 9 601- 19 600 |
| The main source of energy | Fuelwood | Electricity | Fuelwood | Fuelwood | Fuelwood |

2.2. Approach

The NTFP species used in household livelihood were investigated using quantitative approaches. The household survey questionnaire (see Appendix 2 for the survey questionnaire) was divided into two sections: the first section inquired about the species utilized in different

kinds of NTFP and if the species had changed in the previous 10-15 years. The second section considered the socioeconomic characteristics of the respondent and household.

2.3. Data collection method

We purposefully sampled five villages in the Vhembe region (Ha Lambani, Miluwani, Mukumbani, Tshakhuma, and Tshipise) (see Figure 3) The villages were purposefully chosen to maximize the differences in geographical distribution, vegetation type, and proximity to urban areas. Within each village 20 households were randomly selected, giving a total of 100 households. In this study, a household is defined as all the people who live in a single homestead or under the same roof. The households were chosen using a simple random selection method, after the numbering of all the households visible on the latest Google Earth image of the village (Shively, 2011). I had a list of the number of households in each village, so I chose numbers from a random number table (RNT) with numbers assigned to each household. In simple random sampling, each unit has the same chance of being chosen. I conducted all interviews in the local language, *Tshivenda*, with the support of one field assistant. Within each household, every adult member was interviewed separately to record the number, uses, and names of the NTFPs that they knew (*refer to Appendix 1*). The respondents were asked to list species that they use in their home language. We matched Tshivenda names with common species names, made sure that there is no repetition of local names. Each interview lasted between 30 and 60 minutes. Data obtained included information on NTFP species used, as well as demographic information (age, gender, employment, income level, household size, income source, and education level).

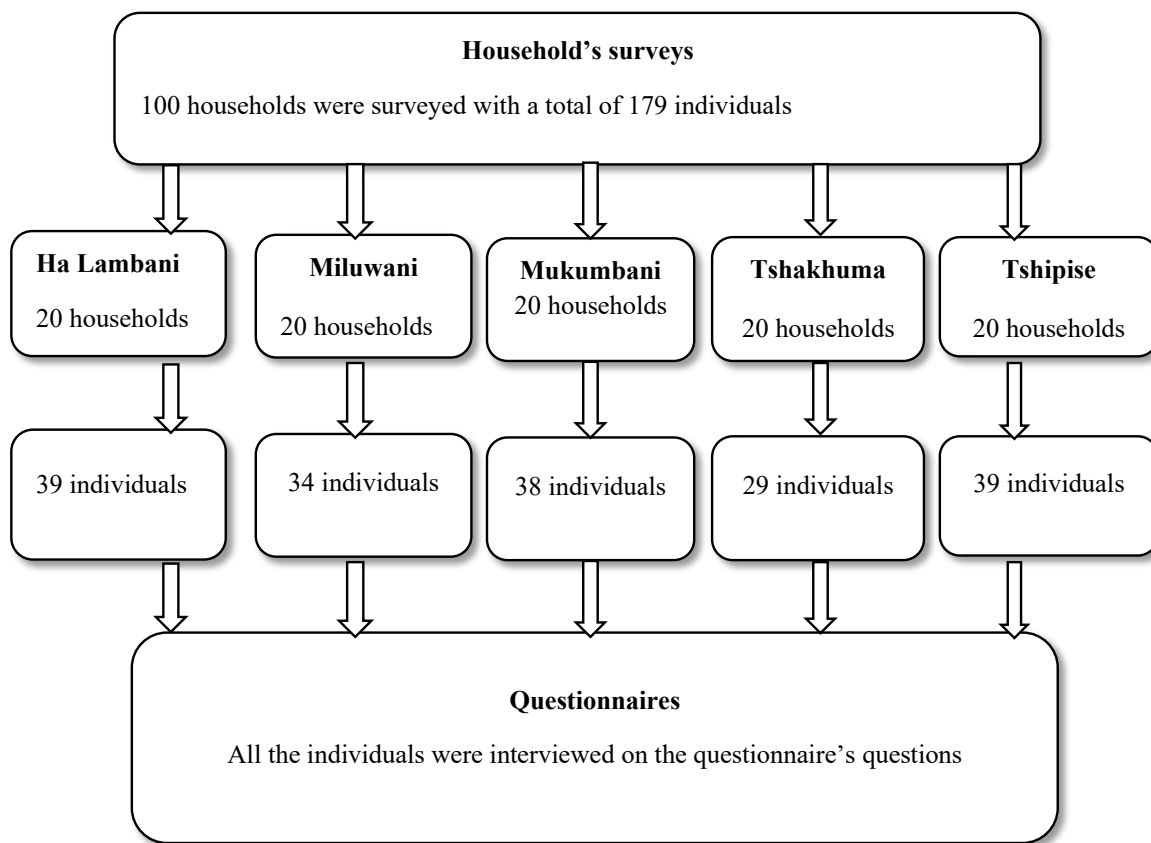


Figure 3: The data collection process

2.4. Data analysis

Microsoft Excel was used to compile the data per individual. The statistical software used was R programme. The number of NTFPs used per household was calculated as the sum of the number per adult member minus any duplicate species. Level of confidence at 1%. Therefore, if there was only one adult in a sample household the number of NTFPs used would be the same at individual and household scale for that household. The same approach was used to determine the number of NTFP species used per village, namely it was a list of all the species mentioned at least once in the 20 sample households, with careful checking to ensure that no species was counted more than once. A Kolmogorov-Smirnov test was used to test for normality, and the data were not normally distributed. The mean number of species used across five villages was compared using a Kruskal-Wallis test and Dunn's test, in case it was significant. A Chi-square test was used to see whether there was a relationship between the NTFP types and the proportion of households that used NTFPs, means of procurement, collection sites, and frequency of collection. For all of the data, a normality test (Kolmogorov-Smirnov and Shapiro-Wilks) was performed. To summarize the socio-demographic data,

descriptive statistics in the form of frequencies and proportions were employed. A t-test was used to determine which village-level factors influence the number of NTFP species used. Using ordination approaches, variations in species composition across the five villages were examined (Detrended Correspondence Analysis, DCA). Lastly, I used PCA and correlation analysis to examine the influence of respondent and household attributes (gender, age, level of income, household size, source of income, education, and employment status) with the number of NTFP species used at each scale.

The variables were chosen based on many assumptions:

Age- it is assumed that older people have more information about the NTFP species utilized in the home. As a result, we hypothesized that the number of species used increased as the age of the household members increased.

Gender- because more women in villages utilize NTFP species, we assumed/ speculated that women used more than males.

Level of income- We assume that low income leads to an increase in the number of species used.

Household size- as the number of household members increases, so does the number of species. As a result, we assumed that increasing household size increases the number of species utilized.

Source of income- we hypothesized that households with the source of income see no need to use the NTFPs, hence households that are had fewer income sources do need NTFPs. Source of income was specified categorically.

Education – we hypothesize that with a higher education level of individuals the number of species used decreases due to having an income.

Employment status- presumed that households with members that have greater employment status see no need to utilize NTFPs, hence they can afford them.

2.5. Ethical considerations

It is accepted that some ethical considerations were explored and accounted for because this study involved human subjects. The ethical principles outlined in the Rhodes University Ethics Policy (Rhodes University, 2014) were rigorously followed throughout the study process. The university ethics committee accepted the research proposal, data collection approach and survey questionnaires (Ethics approval no. 2021-1531-5985). The main objective and nature of the proposed research were clearly explained in the interviews, the privacy and anonymity of

research respondents were guaranteed, the anticipated benefits of participating in this study were highlighted, the guidelines that respondents would be asked to participate in were explained, and the willingness of respondents to withdraw their participation at any moment was assured.

Privacy was also protected by emphasizing that respondents had the option to suppress or share whatever information they choose, as well as obtaining permission before entering private property. The abovementioned principles were stated at the start of household surveys throughout formal fieldwork. Following this, each of the respondents verbally agreed to take part in the study.

3. RESULTS

3.1. Socioeconomic characteristics of the respondents

The majority of the respondents were female (67.6%), while only 32.4% were males (Table 5). The average age range was between 37-54 years (43%). Almost 42.5% of the respondents had matric, 33.3% had primary education, while 13.6%, 9.9%, and 0.7% had degrees, diplomas, or no formal education, respectively. More than one-third of respondents were unemployed (37.4%), 35.2% were employed, and 18.4% were self-employed. The remaining 6.7% and 2.2% were scholars or retired, respectively. A common source of income was government grants (43%), followed by salaries and wages (41%). Most households had 1-4 members (82%), with the rest having 5-8 (18%). The gross monthly income of 40% of the households ranged from R1,000-R3,000 per month, whereas 12% of the respondents had a monthly household income of <R1,000 per month.

3.2. Use of NTFPs

All households were involved in NTFP collection activities. The most used NTFPs were wild vegetables (81%), firewood (77%), edible fruits (76%), and edible insects (73%) (Table 6), all used by 70 % or more of households. The NTFP that was least used was fodder (6%). The only village that used fodder to any extent was Tshipise, since they had a lot of livestock in that area, they used fodder to feed their livestock.

Sixty percent (60%) of the households obtained NTFPs by collecting their own (Table 7). Other households obtained NTFPs by buying (31%) or both collection and buying (9%). Almost 97% of households using medicinal plants collected them, followed by 89% collecting wood for carvings, and 85% collecting wild vegetables and thatch grass. Wooden utensils (80%) and mushrooms (53%) were mostly bought. One percent (1%) of households were buying medicinal plants. The Chi-square test shows that means of obtaining NTFPs significantly depends on NTFP type. There was a significant difference between firewood ($\chi^2 = 28.86$, $p < 0.001$), vegetables ($\chi^2 = 16.80$, $p < 0.05$), insects ($\chi^2 = 43.21$, $p < 0.001$), fruits ($\chi^2 = 20.18$, $p < 0.05$) and means of NTFP procurement. However, medicinal plants, fodder, and reeds showed no significant difference ($p > 0.05$) between the various ways of obtaining NTFPs.

Table 5: Socioeconomic characteristics of respondents

| Characteristics | | Percentage (%) | Mean± STD |
|--------------------------|----------------------|----------------|------------|
| Gender | Female | 67.6 | |
| | Male | 32.4 | |
| Age (years) | 18-36 | 32.3 | 45.7±16.95 |
| | 37-54 | 43.0 | |
| | 55-72 | 12.6 | |
| | 73-90 | 12.1 | |
| | | | |
| Education | Primary level & none | 34.0 | |
| | Matric | 42.5 | |
| | Diploma | 9.9 | |
| | Degree | 13.6 | |
| Employment status | Unemployed | 37.4 | |
| | Employed | 35.2 | |
| | Self-employed | 18.6 | |
| | Scholar | 6.7 | |
| | Retired | 2.2 | |
| Source of income | Salaries and wages | 41 | |
| | Government grant | 43 | |
| | Farming | 16 | |
| Income (R/month) | <1,000 | 12 | |
| | 1,000-3,000 | 40 | |
| | 3,001-5,000 | 26 | |
| | 5,000> | 22 | |
| Household size (members) | 1-4 | 82 | 3.6±1.71 |
| | 5-8 | 18 | |

Table 6: Proportion of households (%) using different NTFPs in five villages

| NTFPs | Ha lambani | Miluwani | Mukumbani | Tshakhuma | Tshipise | Average |
|-------------------|------------|----------|-----------|-----------|----------|---------|
| Firewood | 75 | 60 | 85 | 80 | 85 | 77±10.4 |
| Medicinal plants | 55 | 45 | 55 | 80 | 50 | 58±13.5 |
| Vegetables | 75 | 90 | 70 | 95 | 75 | 81±10.8 |
| Insects | 75 | 80 | 45 | 80 | 85 | 73±16.1 |
| Fruits | 90 | 55 | 70 | 80 | 85 | 76±13.9 |
| Wood for utensils | 50 | 40 | 25 | 65 | 35 | 43±15.3 |
| Thatch grass | 70 | 5 | 25 | 50 | 30 | 36±24.9 |
| Poles | 70 | 40 | 45 | 45 | 35 | 47±13.5 |
| Mushrooms | 35 | 40 | 5 | 60 | 5 | 29±23.8 |
| Fodder | 5 | 0 | 0 | 0 | 25 | 6±10.8 |
| Wood for carving | 40 | 55 | 5 | 50 | 5 | 31±24.3 |
| Reeds | 75 | 45 | 40 | 65 | 35 | 52±17.2 |

Table 7: Means of procurement of NTFP (% of households)

| NTFPs | Collect | Buy | Both | N | Chi-square test |
|-------------------|---------------|---------------|--------------|-----|--|
| Firewood | 67 | 26 | 7 | 147 | $\chi^2=28.86$, p<0.0001 |
| Medicinal plants | 97 | 1 | 2 | 105 | $\chi^2=3.66$, p>0.05 |
| Vegetables | 85 | 8 | 7 | 149 | $\chi^2=16.80$, p<0.05 |
| Edible insects | 46 | 33 | 21 | 129 | $\chi^2=43.21$, p<0.0001 |
| Edible fruits | 82 | 9 | 9 | 139 | $\chi^2=20.18$, p<0.01 |
| Wood for utensils | 0 | 80 | 20 | 84 | $\chi^2=23.23$, p<0.0001 |
| Poles | 55 | 43 | 2 | 84 | $\chi^2=31.23$, p<0.0001 |
| Thatch grass | 85 | 9 | 6 | 69 | $\chi^2=25.86$, p<0.001 |
| Mushroom | 26 | 53 | 21 | 57 | $\chi^2=22.37$, p<0.01 |
| Fodder | 53 | 47 | 0 | 15 | $\chi^2=1.20$, p>0.05 |
| Wood for carvings | 89 | 7 | 4 | 55 | $\chi^2=26.13$, p<0.01 |
| Reeds | 36 | 51 | 13 | 100 | $\chi^2=8.58$, p>0.05 |
| Mean±STD | 60±7.8 | 31±6.6 | 9±2.0 | | |

A majority of the households (95%) were using NTFPs for domestic purposes, and only a few were doing so for commercial use (2%) (Table 8). Households were using medicinal plants, edible fruits, mushrooms, and fodder for only domestic use. Wood for carvings (7%), reeds

(6%), and poles (6%) were the three NTFPs most used for commercial purposes. The Chi-square test shows that there was a significant difference between vegetables ($\chi^2 = 54.96$, $p < 0.0001$), edible insects ($\chi^2 = 75.52$, $p < 0.0001$), and wood for carvings ($\chi^2 = 18.96$, $p < 0.05$) and household use of NTFPs. However, firewood, wood utensils, thatch grass, poles, and reeds showed no significant difference ($p > 0.05$) between household use of NTFPs.

Table 8: Household use of NTFPs (% of respondents)

| NTFPs | Domestic | Commercial | Both | N | Chi-square test |
|-------------------|---------------|--------------|--------------|-----|---|
| Firewood | 92 | 1 | 7 | 147 | $\chi^2=7.44$, $p>0.05$ |
| Medicinal plants | 100 | 0 | 0 | 105 | |
| Vegetables | 96 | 0 | 4 | 149 | $\chi^2=54.96$, $p<0.0001$ |
| Edible insects | 95 | 2 | 3 | 129 | $\chi^2=75.52$, $p<0.0001$ |
| Edible fruits | 100 | 0 | 0 | 139 | |
| Wood for utensils | 96 | 1 | 3 | 84 | $\chi^2=4.49$, $p>0.05$ |
| Poles | 89 | 6 | 5 | 84 | $\chi^2=13.6$, $p>0.05$ |
| Thatch grass | 90 | 0 | 10 | 69 | $\chi^2=9.52$, $p>0.05$ |
| Mushrooms | 100 | 0 | 0 | 57 | |
| Fodder | 100 | 0 | 0 | 15 | |
| Wood for carvings | 89 | 7 | 4 | 55 | $\chi^2=18.96$, $p<0.05$ |
| Reeds | 94 | 6 | 0 | 100 | $\chi^2=5.13$, $p>0.05$ |
| Mean±STD | 95±1.2 | 2±0.7 | 3±0.9 | | |

Over half of the households (53%) were extracting NTFPs from nearby communal lands, dominated by savanna (Table 9). Other households were extracting NTFPs from the mountains (28%), home gardens (8%), wetlands (7%), and farms (4%). The Chi-square test shows that there was a significant difference between firewood and various collection sites ($\chi^2 = 31.61$, $p < 0.0001$). However, there was no significant difference between edible insects and various collection sites ($\chi^2 = 6.02$, $p > 0.05$).

Table 9: The main collection sites for NTFPs (% of households)

| NTFPs | Savannas | Mountains | Home gardens | Wetlands | Farms | N | Chi-square test |
|-------------------|---------------|---------------|--------------|--------------|--------------|-----|--|
| Firewood | 58 | 41 | 0 | 0 | 1 | 109 | $\chi^2=31.61$, p<0.0001 |
| Medicinal plants | 75 | 13 | 0 | 12 | 0 | 104 | $\chi^2=39.15$, p<0.0001 |
| Vegetables | 0 | 0 | 86 | 0 | 14 | 137 | $\chi^2=24.87$, p<0.0001 |
| Edible insects | 92 | 2 | 0 | 0 | 6 | 86 | $\chi^2=6.02$, p>0.05 |
| Edible fruits | 68 | 32 | 0 | 0 | 0 | 126 | $\chi^2=40.14$, p<0.0001 |
| Wood for utensils | 47 | 53 | 0 | 0 | 0 | 17 | |
| Poles | 75 | 23 | 0 | 0 | 2 | 48 | $\chi^2=30.57$, p<0.0001 |
| Thatch grass | 33 | 67 | 0 | 0 | 0 | 63 | $\chi^2=15.54$, p<0.01 |
| Mushrooms | 93 | 0 | 7 | 0 | 0 | 27 | |
| Fodder | 75 | 0 | 0 | 0 | 25 | 8 | |
| Wood for carvings | 0 | 100 | 0 | 0 | 0 | 6 | |
| Reeds | 20 | 0 | 0 | 80 | 0 | 49 | $\chi^2=24.0$, p<0.0001 |
| Mean±STD | 53±8.8 | 28±8.6 | 8±6.6 | 7±6.1 | 4±2.1 | | |

3.3. Number of NTFP species used

3.3.1. Total number of species used

A total of 275 NTFP species that the respondents commonly used were recorded (Appendix 1), across the 12 NTFP types of firewood, medicinal plants, wild vegetables, edible insects, edible fruits, wood for utensils, thatch grass, poles, mushrooms, fodder, wood for carvings, and reeds. Firewood had 81 species, edible insects 48 species, wild vegetables 41 species, wood for utensils 38 species, edible fruits 40 species, medicinal plants 28 species, thatch grass 23 species, wood carvings 19 species, poles 19 species, reeds nine species, fodder eight species, and mushrooms eight species. Of these species, 33 species had two uses, 11 species had three uses, eight species had four uses, four species (*Scelerocarya birrea*, *Senegalia ataxacantha*, *Landolphia kirkii*, and *Grewia monticola*) had five uses and one species (*Persea americana*) had six uses.

More than 90% of the species used by the respondents were native species (Figure 4). Fodder, edible insects (e.g., *Macrotermes michaelseni*, *Imbrasia belina*), and mushrooms were native species. However, wild vegetables had 78% of native (e.g., *Corchorus olitorius*, *Vigna unguiculata*, *Amaranthus capensis*, *Cleome gynandra*) and 22% of non-native species (e.g., *Bidens pilosa*). The edible fruits had 90% of native species (e.g., *Grewia bicolor*, *Ficus zansibarica*, *Rhoicissus tomentosa*, *Strychnos madagascariensis*) and 10% of non-native species (e.g., *Persea americana*). Firewood had 85% of native (e.g., *Sclerocarya birrea*, *Spirostachys africana*) and 15% of non-native species (e.g., *Eucalyptus grandis*, *Achyranthes aspera*, *Mimosa pigra*). Reeds had 11% non-native species (e.g., *Arundo donax*) and 89% of native species (e.g., *Cyperus esculentus*).

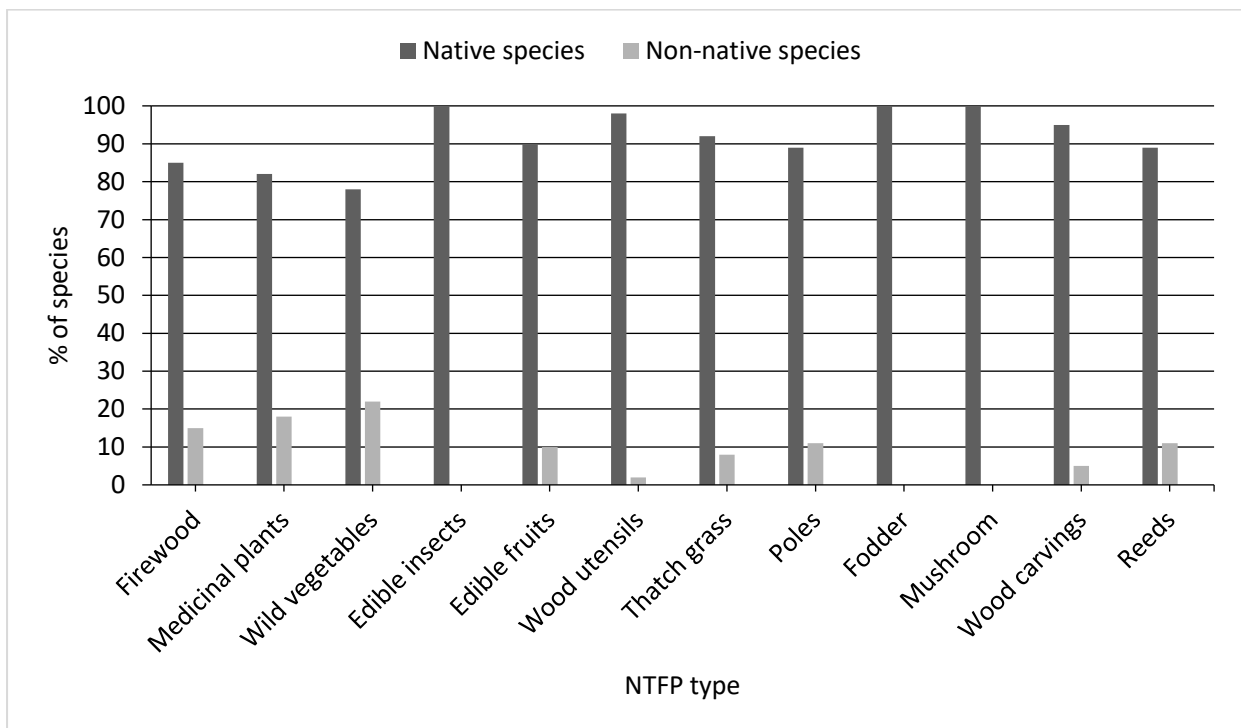


Figure 4: Proportion of native and non-native species used per NTFP type

3.3.2. Number of species per NTFP use category

NTFPs were classified according to their use purpose (Figure 5). Food (wild vegetables, edible insects, edible fruit, and mushrooms), energy (firewood), health (medicinal plants), construction materials (thatch grass and poles), craft (wooden utensils, wood for sculptures, and reeds), and fodder were among the usage categories. With 137 species, food was the used category with the most species (e.g., *Adenia gummifera*, *Macrotermes natalensis*, *Strychnos spinosa*), followed by energy (81 species). There were eight species of fodder and 28 species for health (e.g., *Moringa ovalifolia*). More NTFP species were used for energy in Ha lambani

than in Miluwani. Tshipise had eight species in the fodder category (e.g., *Cynodon nlemfuensis*, *Eragrostis curvula*) and Ha Lambani had one species (e.g., *Phragmites mauritianus*). Some of the species were classified into two or more use categories and were recorded in both, species such as *Grewia monticola*, *Breonadia salicana*, and *Dalbergia melanoxylon*.

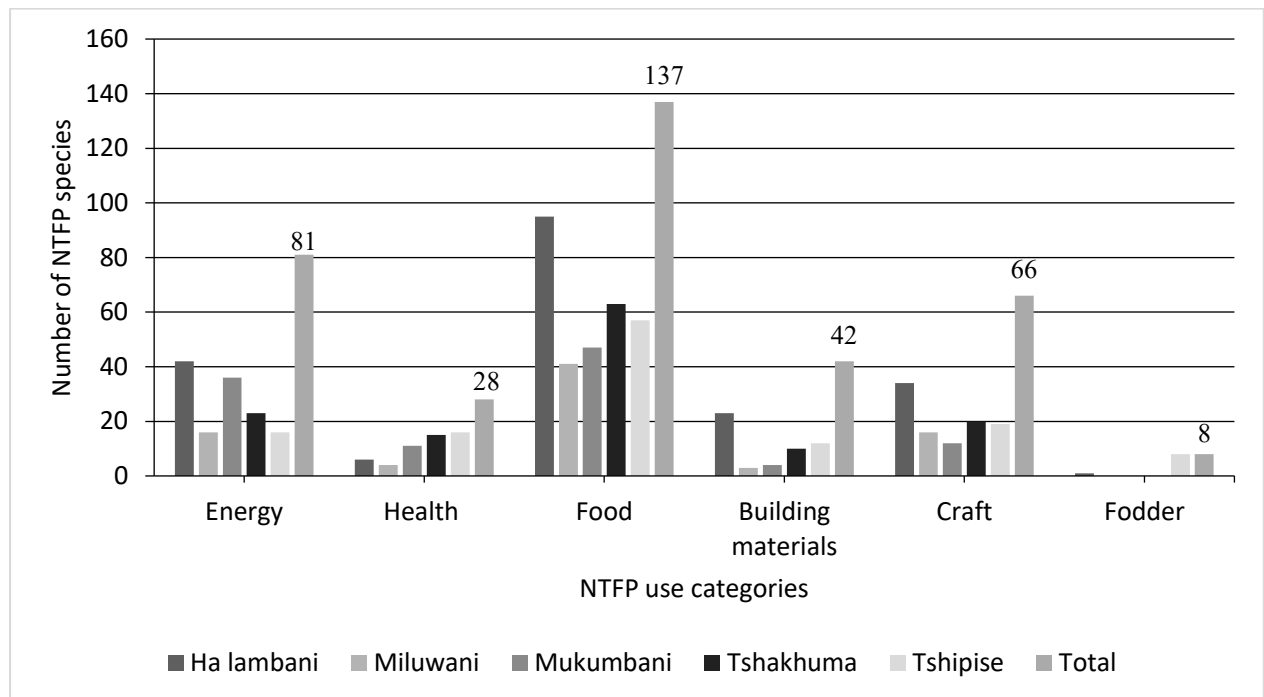


Figure 5: Number of NTFP species per use category

There were 137 species used as food, including wild vegetables, edible fruits, edible insects, and mushrooms (Table 10). Vegetables and fruits were the main edible products that were collected on farms or savannas. Edible insects and mushrooms used by individuals were mostly bought in the market. Four food species were commonly used by households in all villages specifically: *Amaranthus capensis*, *Momordica foetida*, *Imbrasia belina*, and *Scelerocarya birrea*.

There were 81 species used for energy (Table 10). Firewood was used mainly to save electricity since electricity is too expensive for many households. For example, in Ha lambani village almost all the households use firewood although they do have electricity; they say that using firewood saves them cash for electricity. *Colophospermum mopane* was the species that all households in five villages commonly used for firewood.

Twenty-eight species were used for medicinal purposes, whereas eight species were used for fodder (Table 10). Fodder (*Cynodon nlemfuensis*) is commonly used to feed livestock in Tshipise and Ha Lambani villages. *Clematis brachiata*, *Aloe chabaudii*, *Eucalyptus grandis*,

and *Solanum giganteum* were commonly used to treat common illnesses like flu by households in all villages. *Zanthoxylum capense* was the medicinal plant species that was commonly used in Tshipise.

Sixty-six species were used for crafts, including wooden utensils, wooden carvings, and reeds (Table 10). The species used were mainly woody species with a few non-woody species of reeds. Woody species used were, *Pterocarpus angolensis*, *Rauvolfia caffra*, *Scelerocarya birrea*, and *Senegalia ataxacantha* for craft decoration in all villages. Species such as *Isolepis antarctica* were mainly used to produce mats and baskets in all villages.

There were 42 species used for building purposes, namely poles and thatch grass (Table 10). Woody species (*Androstachys johnsonii*) were used for fencing yards in Tshipise and Ha Lambani, whereas poles were used for roofing (*Eucalyptus grandis*). Thatching grass was *Cymbopogon marginatus* used for roofing in Tshakhuma village.

The species accumulative curve of all five villages is shown in Figure 6. Estimated the number of species used in the particular village. In Tshakhuma the species curve starts to flatten at 10 households, indicating that the sample size was sufficiently representative of the total number of species used. This implies that with 10 households you can get a fair share of the species present in Tshakhuma. In villages such as Ha Lambani, Miluwani, Mukumbani, and Tshipise the rate of increases flattens off, but continues to increase at a much reduced rate. This implies that the sample size was probably insufficient to be well representative of the total number of species in the area.

Table 10: Commonly used NTFP species per category

| NTFP type | Scientific name | Local name | Common name |
|-----------|--------------------------------|--------------|-------------------|
| Food | <i>Amaranthus capensis</i> | Vowa | Smooth pigweed |
| | <i>Momordica foetida</i> | Lugu | Giffapel |
| | <i>Imbrasia belina</i> | Mashonzha | Mopane worms |
| | <i>Scelerocarya birrea</i> | Mafula | Marula |
| Energy | <i>Combretum hereroense</i> | Musingidzi | Russet bushwillow |
| | <i>Parinari curatellifolia</i> | Muvhula | Mobola plum |
| | <i>Colophospermum mopane</i> | Mopani | Mopane tree |
| Fodder | <i>Phragmites mauritianus</i> | Lutanga | Lowveld reed |
| Health | <i>Clematis brachiata</i> | Tshiumbeumbe | Traveller's joy |
| | <i>Solanum giganteum</i> | Mututulwa | Thorn bug tree |
| | <i>Eucalyptus grandis</i> | Mubomo | Gum tree |
| | <i>Aloe chabaudii</i> | Tshikhopha | Aloe |
| Craft | <i>Pterocarpus angolensis</i> | Mutondo | Transvaal teak |
| | <i>Rauvolfia caffra</i> | Munadzi | Quinine tree |
| | <i>Scelerocarya birrea</i> | Mufula | Marula tree |
| | <i>Senegalia ataxacantha</i> | Muluwa | Flamethorn |
| | <i>Isolepis antarctica</i> | Dzhesi | Tiger nut |
| Building | <i>Androstachys johnsonii</i> | Mutasiri | Ironwood |
| | <i>Eucalyptus grandis</i> | Mubomo | Gum tree |
| | <i>Cymbopogon marginatus</i> | Fundwi/Khode | Wood flower |

Species composition/ordination

The decorana (DCA) results in Figure 7 show all of the NTFP species present in the various villages, how often they represent the communities, and how similar the NTFP species composition is within the villages. The Figure 7 shows two graphs, the first graph it shows the species names highlighted in blue with households number in orange, then the second graph is vice versa. The groups were made up of different households in different villages. The results show *Colophospermum mopane* as the species that contributed the most within the Tshipise village. However, in Tshakhuma and Miluwani, the common species were *Eucalyptus grandis* and *Ficus sycomorus*, respectively, along with *Bidens pilosa* at miluwani. In Tshipise the top three species were *Colophospermum mopane*, *Cucurbita moschata*, and *Scelerocarya birrea*, whilst in Lambani they were *Vangueria infausta*, *Landolphia kirkii*, and *Dichrostachys cinerea*. Mukumbani was most defined by *Albizia adianthifolia*, *Arundo donax*, and *Isolepis antarctica*, and Tshakhuma by *Acmella caulirhiza*, *Solanum americanum*, and *Combretum imberbe*.

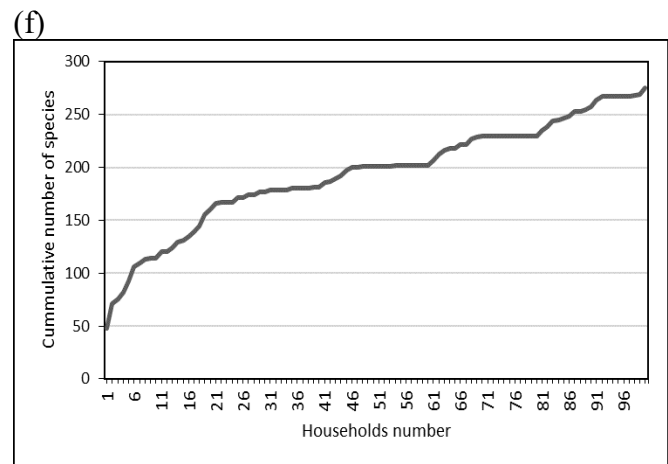
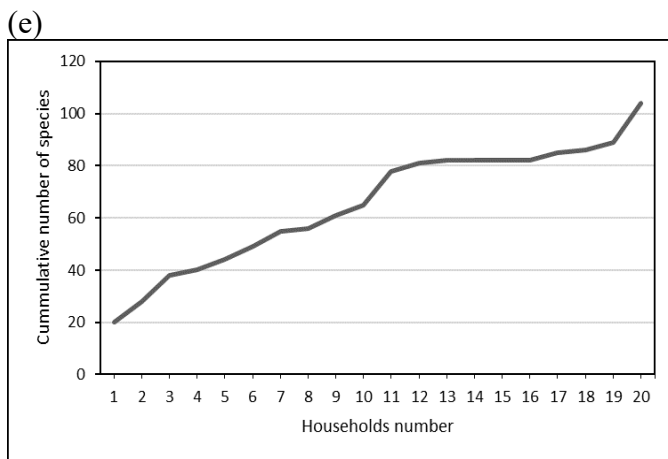
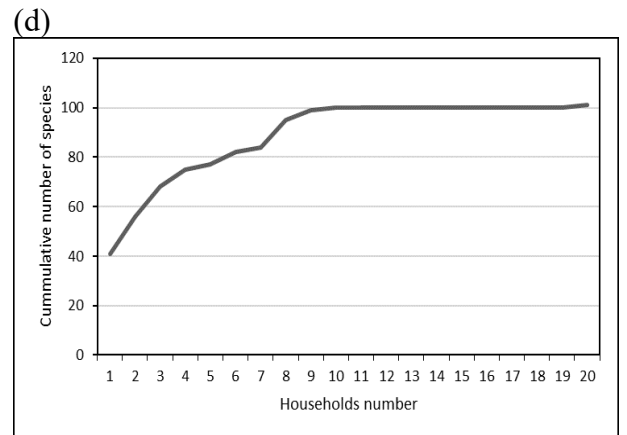
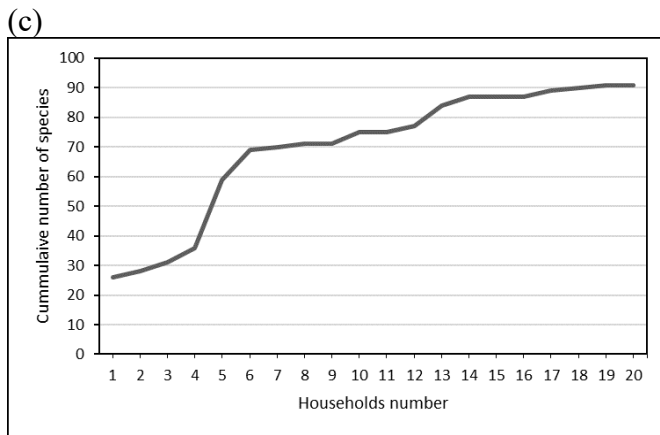
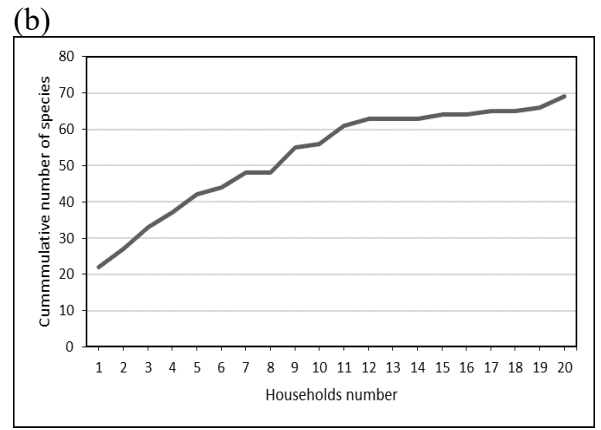
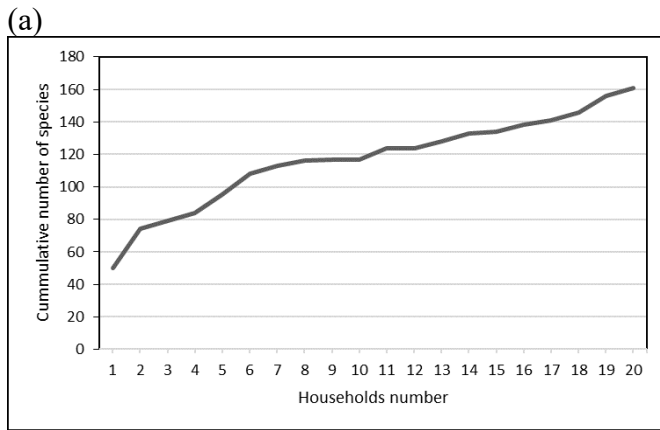


Figure 6: The species accumulative curve per household of the different villages, (a) Ha Lambani, (b) Miluwani, (c) Mukumbani, (d) Tshakhuma, (e) Tshipise, (f) all villages combined

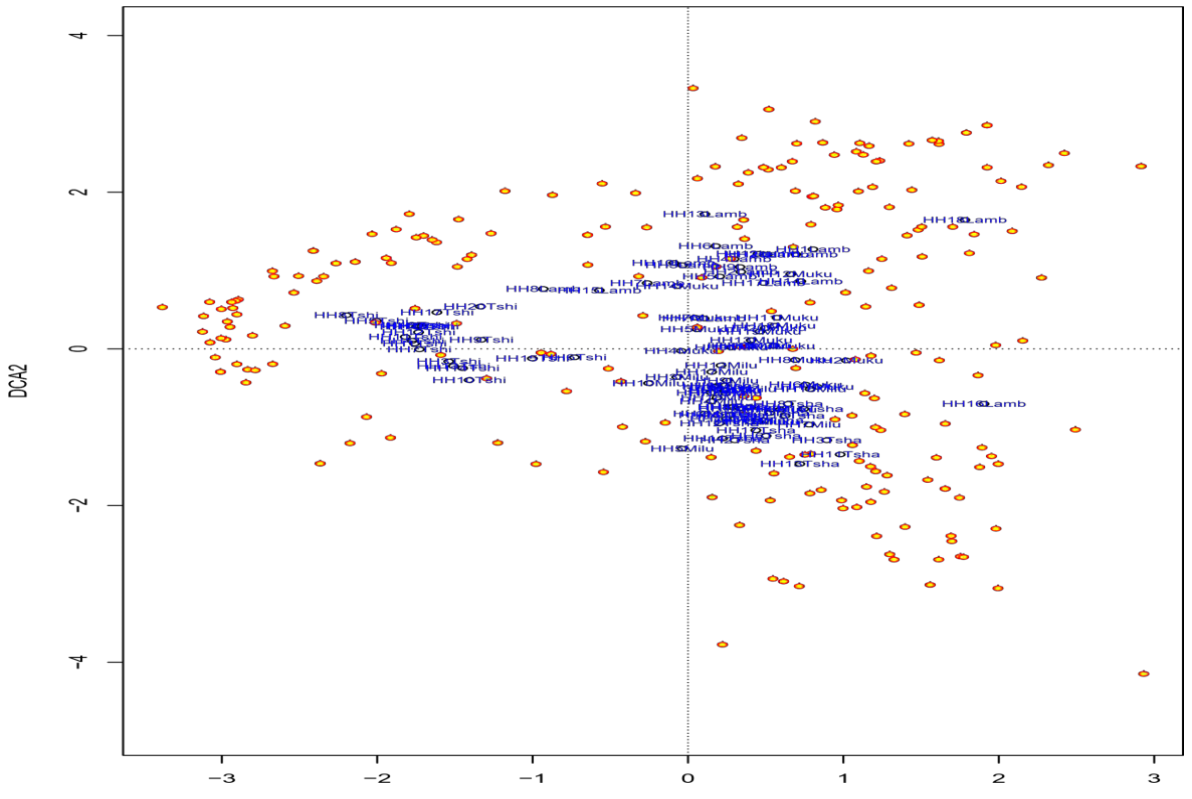
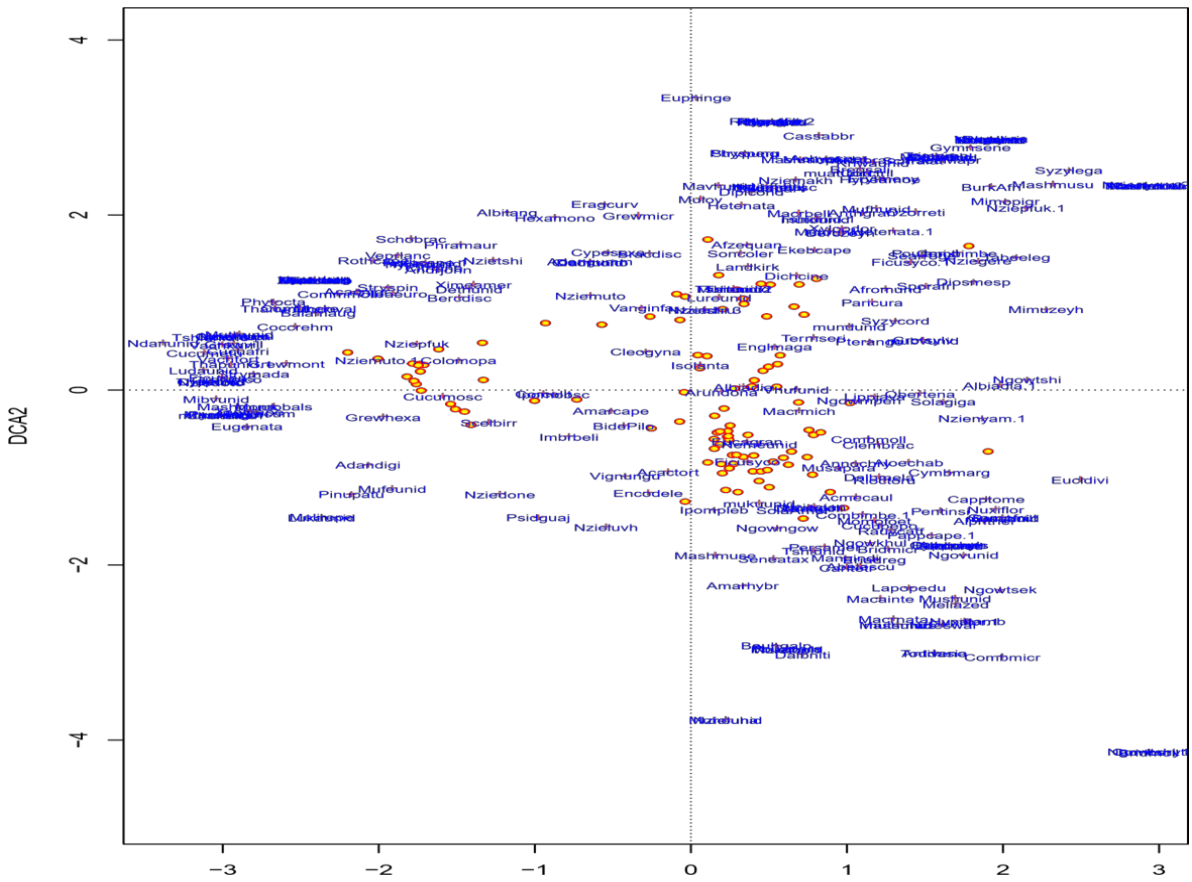


Figure 7: The Decorana results on species ordination

3.4. Mean number of NTFP species used

3.4.1. Mean number of NTFP species listed per individual

The mean (\pm STD) number of species listed per person was 26.8 ± 12.56 in Ha lambani, Miluwani 15.5 ± 5.43 , Mukumbani 15.7 ± 8.97 , Tshakhuma 23.0 ± 8.97 and Tshipise was 16.3 ± 8.14 (Table 11). Wild vegetables had the highest mean number of species (3.9 ± 0.83), followed by edible insects (3.7 ± 1.45) and then edible fruits (3.3 ± 1.36). With the exception of wooden utensils, several of the comparisons were statistically significant. The results of the Kruskal-Wallis test were significant ($H = 14.286$, $3 \text{ df}=4$, $p < 0.01$), and the number of firewood species used per respondent was significantly different among the villages. Pairwise comparisons using Dunn's test indicated that Ha Lambani ($p < 0.001$) was significantly different from Miluwani ($p < 0.05$) and Tshakhuma ($p < 0.05$). Miluwani and Mukumbani were statistically significantly ($p < 0.01$) different from each other. Moreover, the firewood species comparisons Tshipise showed a neutral effect with an equal average of 2.8 ± 1.71 . Wooden utensils showed no statistically significant ($p > 0.05$) with all these comparisons. Edible insects showed a statistically significant difference between Mukumbani and Tshakhuma ($p < 0.001$), however, Mukumbani and Tshipise showed no significant difference in edible insects ($p > 0.05$).

3.4.2. Mean number of NTFP species used per household

The mean (\pm STD) number of species used per household in Ha lambani (46.1 ± 39.09), Miluwani (26.4 ± 25.17), Mukumbani (30.6 ± 33.94), Tshakhuma (44.3 ± 40.41), and Tshipise (33.3 ± 30.32) villages are shown in Table 12. Ha lambani had a high mean number of species used per household compared to Miluwani which had the lowest. The mean number of species used was highest for vegetables (4.5 ± 0.85), followed by edible insects (4.2 ± 1.38) then edible fruits (3.7 ± 1.43). The lowest mean number of species used per household was for wood carvings and fodder at 0.2 ± 0.89 and 0.1 ± 0.26 , respectively. Tshakhuma (6.0 ± 2.27) households used more vegetable species than other villages, whereas Ha lambani households used more edible fruits (5.6 ± 2.95) than other villages. There was a statistically significant difference between the number of species used per household across all five villages and across NTFP types ($p < 0.0001$). Wild vegetables and wood utensils showed no statistically significant differences ($p > 0.05$) with all these comparisons. Pairwise comparisons using Dunn's test show that medicinal plant species were statistically significantly different between Tshakhuma and Ha Lambani ($p < 0.01$), whereas edible fruits were statistically significantly different between Tshipise and Miluwani ($p < 0.001$). However, Mukumbani and Tshakhuma were not statistically

significantly different in edible fruits ($p>0.05$). Reeds species were statistically significantly different between Ha Lambani and Mukumbani ($p<0.01$).

Table 11: Mean (\pm STD) number of NTFP species used per respondent in five villages. Different superscripts imply statistically significant differences ($p<0.05$).

| NTFP type | Village | | | | | Mean | Kruskal Wallis | |
|--------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|----------------|----------------|--------------------|
| | Ha lambani | Miluwani | Mukumbani | Tshakhu ma | Tshipise | | H | p-values |
| Firewood | 4.1 \pm 2.76 ^a | 1.9 \pm 1.67 ^b | 3.7 \pm 2.17 ^a | 2.5 \pm 1.74 ^b | 2.8 \pm 1.71 ^{ab} | 3.0 \pm 0.89 | 14.29 | p<0.01 |
| Medicinal | 0.9 \pm 1.01 ^{ab} | 0.7 \pm 0.98 ^{ab} | 1.3 \pm 1.64 ^a | 2.1 \pm 1.51 ^a | 1.1 \pm 1.41 ^{ab} | 1.2 \pm 0.54 | 11.98 | p<0.05 |
| Vegetables | 3.9 \pm 3.01 ^b | 4.0 \pm 1.58 ^b | 3.7 \pm 2.77 ^c | 5.3 \pm 1.86 ^a | 3.0 \pm 2.22 ^c | 3.9 \pm 0.83 | 10.28 | p<0.05 |
| Insects | 5.4 \pm 4.76 ^a | 3.5 \pm 2.30 ^{bc} | 1.9 \pm 2.49 ^c | 5.0 \pm 2.87 ^b | 2.9 \pm 1.66 ^c | 3.7 \pm 1.45 | 15.33 | p<0.01 |
| Fruits | 5.4 \pm 2.83 ^a | 1.6 \pm 1.64 ^b | 3.1 \pm 2.46 ^{ab} | 3.1 \pm 2.26 ^{ab} | 3.2 \pm 2.03 ^a | 3.3 \pm 1.36 | 21.93 | p<0.001 |
| Utensils | 1.3 \pm 1.56 | 0.7 \pm 1.08 | 0.4 \pm 0.79 | 1.2 \pm 1.06 | 0.7 \pm 1.01 | 0.9 \pm 0.38 | 8.37 | $p>0.05$ |
| Thatch | 1.5 \pm 1.32 ^a | 0.05 \pm 0.22 ^c | 0.3 \pm 0.63 ^b | 0.8 \pm 0.90 ^b | 0.6 \pm 1.00 ^{ab} | 0.7 \pm 0.55 | 23.54 | p<0.0001 |
| Poles | 1.5 \pm 1.27 ^a | 0.5 \pm 0.60 ^b | 0.5 \pm 0.51 ^b | 0.5 \pm 0.64 ^b | 0.6 \pm 0.99 ^b | 0.7 \pm 0.44 | 10.65 | p<0.05 |
| Mushrooms | 0.7 \pm 0.89 ^c | 0.8 \pm 1.05 ^b | 0.2 \pm 0.67 ^{bc} | 1.1 \pm 1.06 ^a | 0.1 \pm 0.44 ^{bc} | 0.6 \pm 0.41 | 20.06 | p<0.001 |
| Fodder | 0.1 \pm 0.22 | 0 \pm 0 | 0 \pm 0 | 0 \pm 0 | 0.5 \pm 0.99 | 0.1 \pm 0.22 | | |
| Wood carving | 0.7 \pm 1.08 ^a | 0.7 \pm 0.86 ^b | 0.1 \pm 0.22 ^{bc} | 0.6 \pm 0.70 ^c | 0.2 \pm 0.67 ^{bc} | 0.5 \pm 0.31 | 18.71 | p<0.001 |
| Reeds | 1.4 \pm 1.07 ^a | 0.5 \pm 0.61 ^{ab} | 0.6 \pm 0.88 ^{ab} | 0.8 \pm 0.68 ^b | 0.6 \pm 0.99 ^{ab} | 0.8 \pm 0.36 | 10.91 | p<0.05 |
| Mean | 26.8 \pm 12.56 | 15.5 \pm 5.43 | 15.7 \pm 8.98 | 23.0 \pm 8.98 | 16.3 \pm 8.14 | | | |

3.4.3. Total number of species used per village

Figure 8 reveals the overall number of NTFP species used per village. Ha Lambani (161 species) has a high number of NTFP species, species such as *Artabotrys brachypetalus* were used only in Ha Lambani, followed by Tshipise (*Adonsia digitata*, *Ficus zansibarica*, *Mormodica baisamina*, and *Zanthoxylum capense*) with 104 species, then Tshakhuma (*Cymbopogon marginatus*, *Erianthemum dregei*, *Combretum mole* and *Macademia tegrifolia*) with 101 species. Mukumbani with 91 species and Miluwani with 69 species used had a lower number of species utilized per village.

Table 12: Mean (\pm STD) number of NTFP species used per household. Different superscripts imply statistically significant differences ($p < 0.05$)

| NTFP type | Village | | | | | Mean | Kruskal Wallis | |
|---------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|----------------|----------------|-------------------|
| | Ha lambani | Miluwani | Mukumbani | Tshakhuma | Tshipise | | H | p-values |
| Firewood | 4.2 \pm 2.70 ^a | 2.0 \pm 1.76 ^{ab} | 4.7 \pm 3.23 ^a | 3.1 \pm 2.25 ^b | 3.6 \pm 1.96 ^a | 3.5 \pm 1.04 | 12.66 | p<0.05 |
| Medicinal | 1.0 \pm 1.05 ^{ab} | 0.8 \pm 1.0 ^{ab} | 1.4 \pm 1.79 ^{ab} | 2.5 \pm 1.79 ^a | 1.4 \pm 2.01 ^{ab} | 1.4 \pm 0.65 | 11.95 | p<0.05 |
| Vegetables | 4.2 \pm 3.20 | 4.1 \pm 1.59 | 4.0 \pm 3.16 | 6.0 \pm 2.27 | 4.1 \pm 2.80 | 4.5 \pm 0.85 | 9.23 | p>0.05 |
| Insects | 5.5 \pm 4.78 ^b | 3.5 \pm 2.31 ^{ab} | 2.6 \pm 3.73 ^{ab} | 5.8 \pm 3.43 ^a | 3.6 \pm 2.52 ^b | 4.2 \pm 1.38 | 10.52 | p<0.05 |
| Fruits | 5.6 \pm 2.95 ^a | 1.6 \pm 1.67 ^b | 3.6 \pm 2.95 ^{ab} | 3.6 \pm 2.50 ^{ab} | 4.1 \pm 2.35 ^b | 3.7 \pm 1.43 | 21.33 | p<0.001 |
| Utensils | 1.3 \pm 1.56 | 0.7 \pm 1.08 | 0.6 \pm 1.10 | 1.4 \pm 1.50 | 0.8 \pm 1.20 | 0.9 \pm 0.36 | 7.61 | p>0.05 |
| Thatch | 1.6 \pm 1.43 ^a | 0.1 \pm 0.22 ^{ab} | 0.4 \pm 0.75 ^{ab} | 0.9 \pm 1.0 ^b | 0.7 \pm 1.09 ^{ab} | 0.7 \pm 0.57 | 22.57 | p<0.001 |
| Poles | 1.5 \pm 1.36 ^a | 0.5 \pm 0.60 ^{ab} | 0.5 \pm 0.51 ^{ab} | 0.6 \pm 0.69 ^{ab} | 0.8 \pm 1.36 ^{ab} | 0.8 \pm 0.42 | 10.09 | p<0.05 |
| Mushrooms | 0.7 \pm 0.92 ^b | 0.9 \pm 1.14 ^b | 0.2 \pm 0.67 ^{ab} | 1.2 \pm 1.24 ^a | 0.1 \pm 0.45 ^{ab} | 0.6 \pm 0.47 | 20.51 | p<0.001 |
| Fodder | 0.1 \pm 0.22 | 0 \pm 0 | 0 \pm 0 | 0 \pm 0 | 0.6 \pm 1.39 | 0.1 \pm 0.26 | | |
| Wood carvings | 0.8 \pm 1.20 ^a | 0.7 \pm 0.86 ^a | 0.1 \pm 0.22 ^{ab} | 0.7 \pm 0.80 ^a | 0.2 \pm 0.89 ^{ab} | 0.5 \pm 0.32 | 18.66 | p<0.001 |
| Reeds | 1.5 \pm 1.19 ^a | 0.5 \pm 0.61 ^{ab} | 0.6 \pm 0.88 ^{ab} | 0.9 \pm 0.75 ^c | 1.0 \pm 1.43 ^{ab} | 0.9 \pm 0.39 | 9.62 | p<0.05 |
| Mean | 46.1 \pm 39.09 | 26.4 \pm 25.17 | 30.6 \pm 33.94 | 44.3 \pm 40.41 | 33.3 \pm 30.32 | | | |

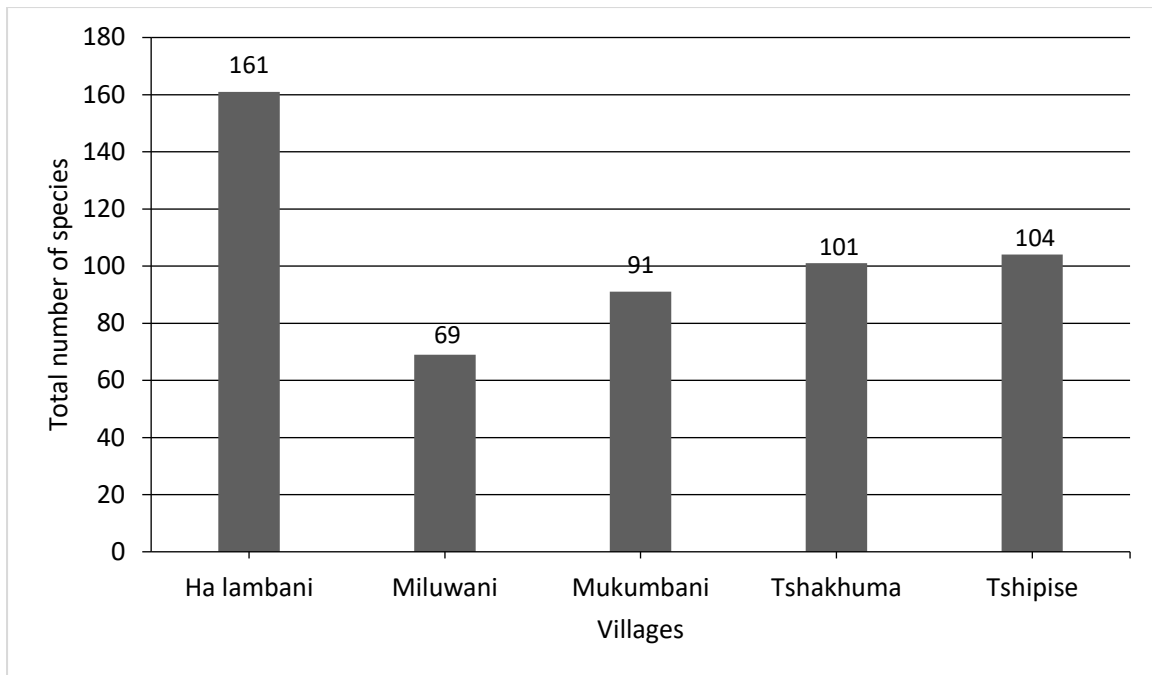


Figure 8: Total number of NTFP species used per village

3.5. Changes in the number of NTFP species used per village

The number of NTFP species used was perceived by the households to have increased compared to 10-15 years ago (Figure 9). Most households (89%) felt that the number of NTFP species had increased, but 10% felt that there had been a decrease and 1% said there had been no change.

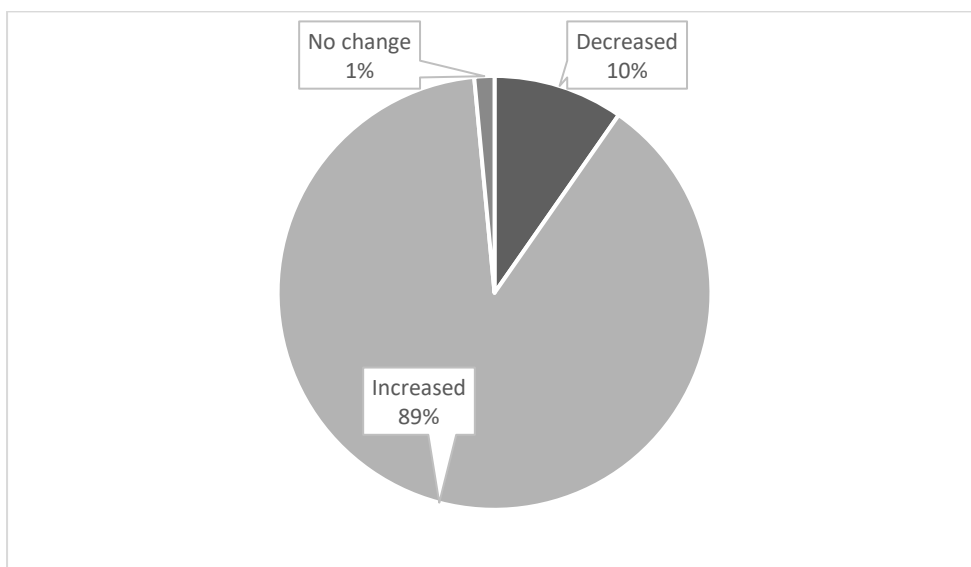


Figure 9: Perception of respondents on the number of NTFP species used now compared to 10-15 years ago.

The perceived changes in the number of species used per NTFP type are shown in Figure 10. Edible fruits (22%) were the most NTFP that households felt to have increased compared to other NTFPs. Approximately, 5.1% of households felt that wood for utensils had not changed. Two percent of households felt that the number of thatch grass and wood for carving species used had not changed. Households (15.3%) felt that the number of edible insect species used had increased.

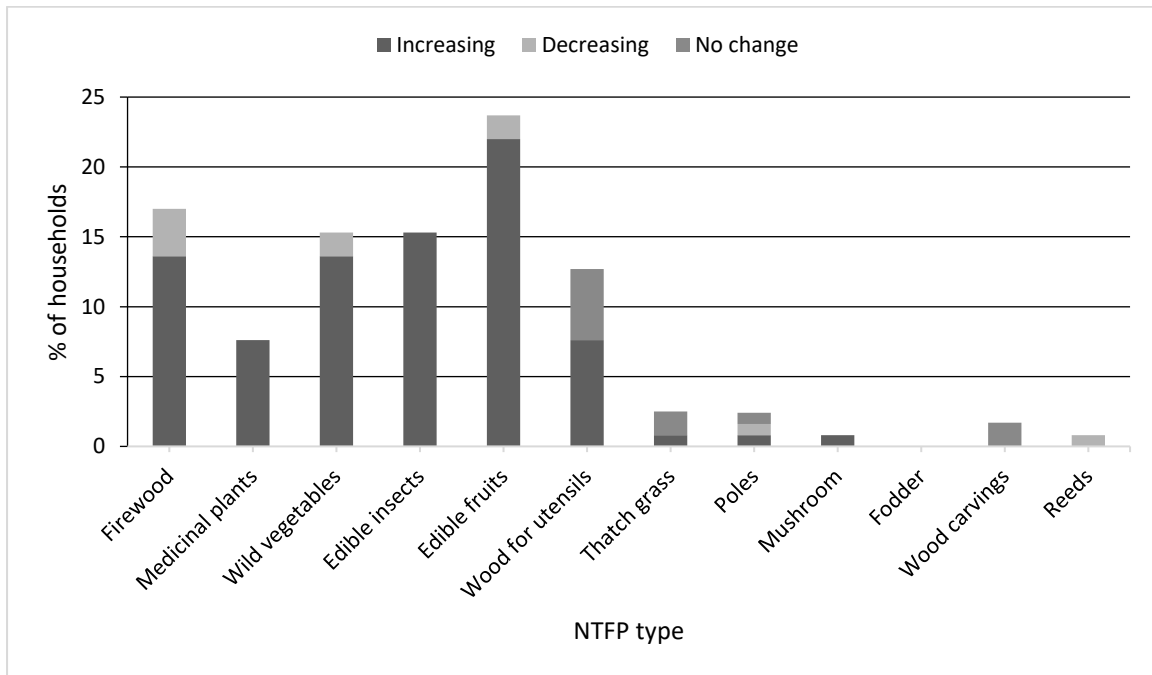
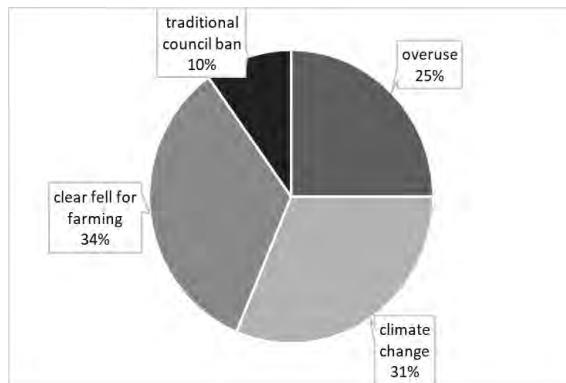


Figure 10: Perceived changes in the number of species used per NTFP type

The reasons for the number of NTFP species used to decrease were due to clear-felling for farming (34%), climate change (31%), overuse (25%), and traditional council ban (10%), as shown in Figure 11. Thirty-four percent of households mention that the number of species used had decreased due to mainly clear-felling for farming, when they needed to do farming on the land they had to cut down some of the NTFP species to clear the land. The households mention that the number of species used has increased due to protected areas (63%), sustainable agriculture methods (25%), and restoration (12%). Approximately, 63% of households felt that the number of species has increased due to protected areas, this implies that endangered species that are highly threatened or that provide a specific ecological or environmental purpose dwell in conservation areas.

(a)



(b)

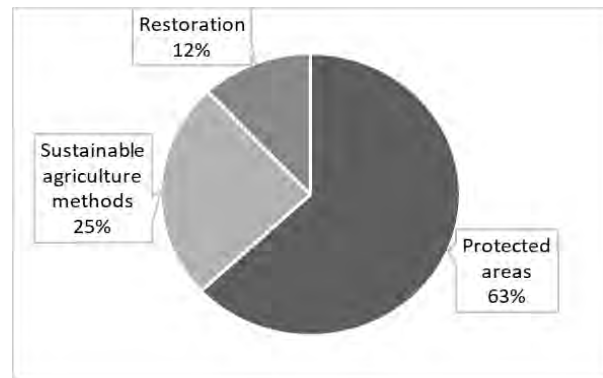


Figure 11: Reasons for the number of NTFP species used to (a) decrease and (b) increase now as compared to last 10-15 years ago

3.6. Times taken to collect NTFPs

Households procured NTFP at various frequencies, from the week, month to a year (Table 13). Households most commonly collected or bought NTFPs on average once a month (49.3 ± 21.90), with just a few households procuring NTFPs four times a year (0.4 ± 0.96). Fodder (83.3%), mushrooms (73.3%), edible insects (69.4%), medicinal plants (66.1%), wood for utensils (51.2%), and thatch grass (45.5%) were the most often collected/bought NTFPs. Reeds (59.6%), poles (56.8%), and wood for carvings (53.3%) were the NTFPs collected/bought once a year. A chi-square test of independence was performed to examine the relationship between NTFP type and frequency of procurement. There was a significant difference between households procuring firewood ($p < 0.01$), medicinal plants ($p < 0.01$), edible insects ($p < 0.05$), fruits ($p < 0.01$), utensils ($p < 0.01$), thatch grass ($p < 0.01$), poles ($p < 0.01$), carvings ($p < 0.01$) and reeds ($p < 0.01$) at various frequencies.

Table 13: Frequency of procurement of NTFPs (% of households)

| NTFPs | Twice a week | Once a week | Twice a month | Once a month | Four times a year | Twice a year | Once a year | |
|-------------------|--------------|--------------|---------------|--------------|-------------------|--------------|--------------|--|
| Firewood | 14 | 18 | 30 | 35 | 3 | 0 | 0 | $\chi^2=33.47$, p<0.01 |
| Medicinal plants | 9 | 11 | 14 | 66 | 0 | 0 | 0 | $\chi^2=39.44$, p<0.01 |
| Wild vegetables | 43 | 43 | 4 | 10 | 0 | 0 | 0 | $\chi^2=10.49$, p>0.05 |
| Edible insects | 4 | 10 | 17 | 69 | 0 | 0 | 0 | $\chi^2=24.01$, p<0.05 |
| Edible fruits | 0 | 10 | 13 | 58 | 0 | 1 | 18 | $\chi^2=73.17$, p<0.0001 |
| Wood utensils | 0 | 0 | 12 | 51 | 2 | 5 | 30 | $\chi^2=56.38$, p<0.0001 |
| Thatch grass | 0 | 0 | 12 | 46 | 0 | 3 | 39 | $\chi^2=33.61$, p<0.01 |
| Poles | 0 | 0 | 0 | 21 | 0 | 23 | 57 | $\chi^2=63.16$, p<0.0001 |
| Mushrooms | 0 | 7 | 20 | 73 | 0 | 0 | 0 | $\chi^2=12.20$, p>0.05 |
| Fodder | 0 | 0 | 17 | 83 | 0 | 0 | 0 | |
| Wood for carvings | 0 | 0 | 0 | 40 | 0 | 7 | 53 | $\chi^2=20.31$, p<0.01 |
| Reeds | 0 | 0 | 0 | 39 | 0 | 2 | 60 | $\chi^2=28.59$, p<0.0001 |
| Mean | 5.8± | 8.3± | 11.6± | 49.3± | 0.4± | 3.4± | 21.5± | |
| ±STD | 12.55 | 12.50 | 9.23 | 21.88 | 0.96 | 6.58 | 25.03 | |

3.7. People responsible for collecting NTFPs in the households

Table 14 shows the members of the families that are responsible for collecting NTFPs. The person most responsible for NTFP collecting is the mother (39.4 ± 18.27), followed by a grandmother (29.2 ± 17.29), and finally children (18.4 ± 16.96). The father (11.0 ± 10.54) and grandfather (2.1 ± 2.79) have the least responsibility for the NTFP collection. There was a significant difference between household members that are responsible for collecting firewood ($p<0.05$), edible insects ($p<0.05$), edible fruit ($p<0.05$), mushrooms ($p<0.05$), thatch grass ($p<0.01$), and poles ($p<0.01$). Approximately 52.8% of mothers in families are in charge of gathering wild vegetables, whereas 4.2% of fathers in homes are in charge of gathering wild vegetables. Edible insects are collected by 36.6% of grandparents and 24.6% of children. There was no significant difference in household members that were responsible for collecting medicinal plants, vegetables, wood utensils, fodder, carvings, and reeds ($p>0.05$).

Table 14: Household members that are responsible for collecting NTFPs (% of households)

| | Mother | Grdmother | Children | Father | Grdfather | |
|-------------------|------------------------|-----------------------|-----------------------|------------------------|----------------------|--------------------------------------|
| Firewood | 37 | 31 | 16 | 10 | 6 | $\chi^2=28.11$, p<0.05 |
| Medicinal plants | 42 | 26 | 18 | 7 | 7 | $\chi^2=25.83$, p>0,05 |
| Wild vegetables | 53 | 33 | 10 | 4 | 0 | $\chi^2=15.72$, p>0.05 |
| Edible insects | 29 | 37 | 20 | 12 | 2 | $\chi^2=27.63$, p<0.05 |
| Edible fruits | 34 | 31 | 25 | 11 | 0 | $\chi^2=25.59$, p<0.05 |
| Wood utensils | 63 | 13 | 13 | 13 | 0 | $\chi^2=4.48$, p>0.05 |
| Thatch grass | 33 | 31 | 17 | 14 | 6 | $\chi^2=33.84$, p<0.01 |
| Poles | 32 | 16 | 24 | 28 | 0 | $\chi^2=31.90$, p<0.01 |
| Mushrooms | 73 | 18 | 9 | 0 | 0 | $\chi^2=10.11$, p<0.05 |
| Fodder | 33 | 67 | 0 | 0 | 0 | |
| Wood for carvings | 0 | 0 | 67 | 33 | 0 | |
| Reeds | 44 | 48 | 4 | 0 | 4 | $\chi^2=11.26$, p>0.05 |
| Mean ±STD | 39.4± 18.42 | 29.3± 17.3 | 18.6± 17.0 | 11.0± 10.52 | 2.1± 2.84 | |

3.8. The number of species used in relation to individual and household factors

3.8.1. Individual respondent level

The number of species used per individual and respondent attributes was examined using PCA (Figure 12). As seen in Figure 12, positively correlated variables are clustered together, whereas negatively correlated variables are positioned on opposing sides of the plot origin (opposed quadrants). The first principal component explains approximately 44% of the overall variance, while the second principal component explains an additional 19%. As a result, the first two major components account for almost 63% of the overall variation. Additionally, we performed a correlation analysis between the variables (Table 15). Age demonstrated a significant ($p<0.001$) positive correlation with the number of species used, indicating that as one gets older, the number of species used increases. The number of species used also exhibited a significant positive correlation with education ($p<0.001$) and employment status ($p<0.001$), implying that respondents who had primary level used more species than those with a tertiary

qualification. On employment status, those respondents who are unemployed used a high number of species than those who are employed. The gender of the respondent had no correlation ($p>0.05$) with the number of NTFP species used, as it was positioned on the opposite side of the plot origin.

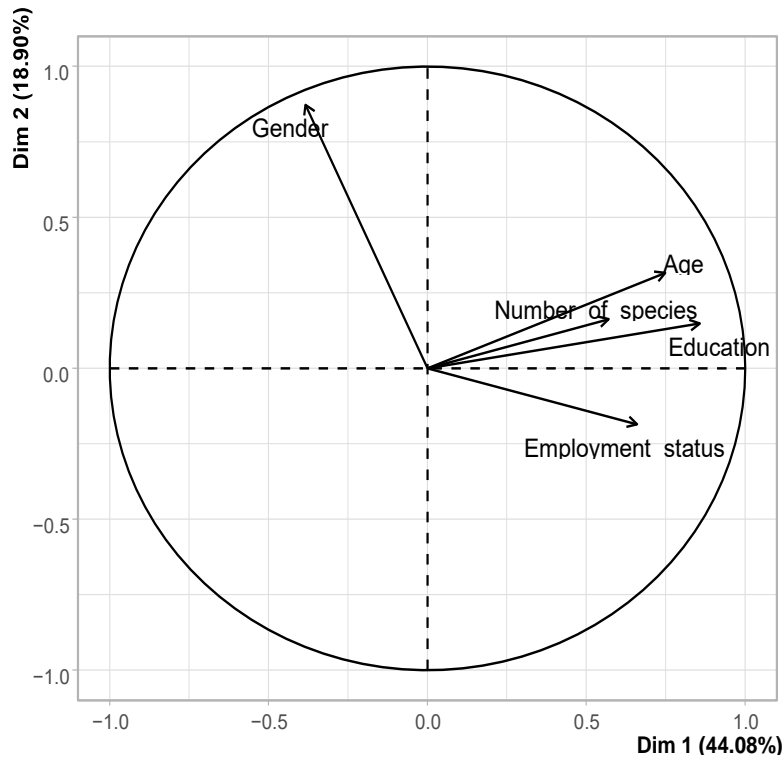


Figure 12: Principal component analysis (PCA) of the number of species across respondent (n=179) characteristics

Table 15: Correlation analysis of the number of species used in relation to individual variables (n =179)

| | Correlation values | p-values |
|-------------------|---------------------------|-----------------|
| Age | 0.25*** | 0.0005 |
| Gender | -0.10 | 0.1703 |
| Education | 0.33*** | 0.0001 |
| Employment status | 0.26*** | 0.0003 |

*. Correlation is significant at the 0.05 level

**. Correlation is significant at the 0.01 level

***. Correlation is significant at the 0.001 level

3.8.2. Household scale

A PCA was run between the number of species used and household factors such as household size, income level, and income source (Figure 13), along with a correlation analysis between the variables (Table 16). The first principal component explains 48% of the variation, and the second component was 28%. There was a positive significant ($p < 0.001$) correlation between the number of species used and household size, implying that larger household tends to use more species. The first principal component positively correlates almost perfectly with the household size. Income level ($p > 0.05$) and income source ($p > 0.05$) were not closely associated with the number of species.

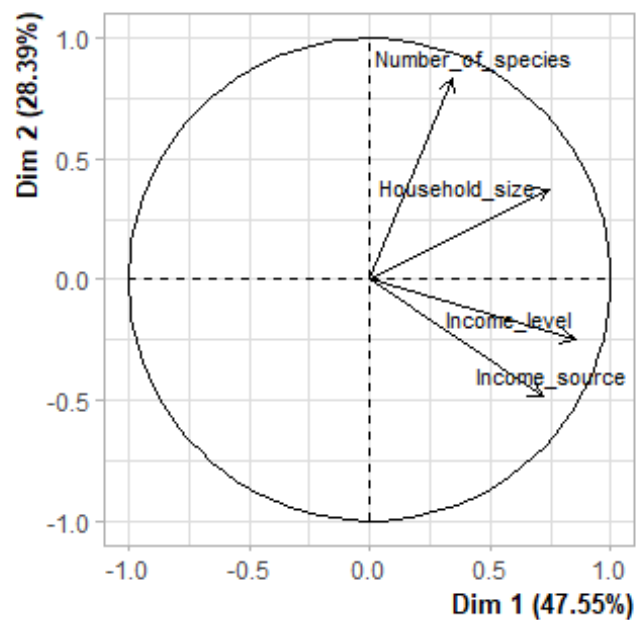


Figure 13: Variables factor map (PCA) of the number of species across household (n=100) characteristics.

Table 16: Correlation analysis of the number of species used in relation to household variables (n= 100)

| | Correlation values | p-values |
|----------------|--------------------|---------------|
| Income level | 0.082 | 0.4141 |
| Income source | -0.015 | 0.8746 |
| Household size | 0.335*** | 0.0006 |

***. Correlation is significant at the 0.001 level

3.8.3. Village scale

The number of species used per village was tested with village-level characteristics such as distance to a nearby savanna, closeness to a town, settlement (traditional, western), rainfall, and vegetation (mountain bushveld, granite lowveld, mopane bushveld) (Table 17). The sample size was not enough to perform a statistical tests, therefore I had to do write general observation. The general observation shows that the number of species used in villages which are near the savanna were high compared to villages far from the savanna. Villages which were close to town had low number of species used compared to those very far from the town. Villages such as, Ha Lambani and Tshipise those in traditional settlements used high number of species compared to villages in more western lifestyles.

Table 17: The village characteristics of sampled villages in the Vhembe region

| | Villages | | | | |
|---------------------|-------------------|-------------------|------------------|-------------------|-----------------|
| | Ha Lambani | Miluwani | Mukumbani | Tshakhuma | Tshipise |
| Number of species | 161 | 69 | 91 | 101 | 104 |
| Distance to savanna | Near | Very far | Near | Near | Near |
| Settlements | Traditional | Western | Western | Western | Traditional |
| Proximity to town | Very far | Near | Near | Very far | Very far |
| Vegetation | Mountain bushveld | Mountain bushveld | Granite lowveld | Mountain bushveld | Mopane bushveld |

4. DISCUSSION

4.1. Proportion of households using of NTFPs

In this study, all households in the five sampled villages in the Vhembe region used one or more NTFPs for food, housing, building, health, energy, and craft. The most widespread use was of wild vegetables (81%), firewood (77%), wild fruits (76%) and edible insects (73%), all used by more than 70% of households. Three of these top four NTFP types correspond to the top five summarised by Shackleton and Shackleton (2004) across several empirical studies in the country, which shows that the Vhembe region is relatively similar to other rural regions of the South Africa in terms of both the widespread use of NTFPs and the wide range of types used. The high use of NTFPs in this region is noteworthy because South Africa has a well-developed economy and social security system that provide employment and cash support, which might be expected to reduce reliance on NTFPs. But these results, and other recent studies (Dalu et al. 2021; Herd-Hoare and Shackleton 2022; Wale et al. 2022), show this is not the situation. This is likely to be because of their important contribution in easing poverty and their role in local traditions and culture.

Wild vegetables were the most utilized NTFPs, with 81% of families using them. The high percentage may be explained by the good availability of wild vegetables and appropriate knowledge of their usage and preparation. *Amaranthus capensis*, *Solanum americanum*, *Bidens pilosa*, and *Momordica foetida* were the most common wild vegetable species used in the study area. The use of wild vegetables as food should be encouraged since they may assist in the well-being of communities, add to dietary diversity and some had medicinal values. They are generally known to be high in vitamins, micronutrients and antioxidants (Sheikh et al. 2019; Anju et al. 2022). According to Shackleton (2003), several previous studies in South Africa and neighbouring countries have revealed the widespread use of wild vegetables (Maroyi 2013). Dovie (2001) and Paumgarten and Shackleton (2009) observed that the proportion of households consuming wild vegetables ranged from 92% to 100%. Studies in the Wild Coast area had also revealed a high proportion of households consuming wild vegetables (Shackleton et al. 2007c). This also applies to peri-urban and urban communities (Prinsloo et al. 2022).

In the study villages most, rural households use firewood as a primary source of energy for cooking and heating. This is because the villages are in the savanna biome where a diversity of

native and non-native trees are available, and therefore it is easy to collect firewood and also cheaper compared to other types of energy such as electricity or paraffin. However, 26% of households did not collect fuelwood but rather bought it. This might be because they lacked labour or time to collect it, or that the firewood stocks around their village were insufficient. Either way, the high use of firewood as a domestic energy is the case throughout rural South Africa (Shackleton et al. 2022) and even many urban areas too (Guild and Shackleton 2019). For example, these findings are consistent with those of Masekameni et al. (2017), who reported that 94% of respondents were active in firewood gathering, which is primarily utilized as a source of energy for cooking. This is also the case elsewhere in Sub-Saharan Africa, such as in Ethiopia where Asfwa et al. (2013) reported that 89% of households utilized firewood. And in Tanzania, in 80% of households' firewood contributed significantly to energy consumption (Kimaro and Lulandal 2013; Schaafsma et al. 2014). Thus, firewood was one of the most commonly used NTFPs (Dovie et al. 2001).

This research also showed a variety of tree species that are often utilized for firewood. *Colosphermum mopane*, *Parinari curatellifolia*, *Pterocarpus angolensis*, *Senegalia ataxacantha*, and *Bridelia micrantha* were among the species favoured. The use of *P. angolensis* is noteworthy because it is a nationally protected tree species and should not be harvested without a permit. It was claimed that these species provide a long-lasting and excellent fire, high calorific values, no unpleasant odour, and very little soot. Additionally, these species are mostly preferred by most households since they were easily accessible and affordable. Makhado et al. (2009) suggest that *Colophospermum mopane* is the most common species for fuelwood in the Vhembe region because it is abundant, burns easily, and creates less smoke. These findings were confirmed in my study. This supports the results of Grundy et al. (1993), who identified the three most abundant and often utilized firewood species in Zimbabwe, one of which being *Colophospermum mopane*.

The third most used NTFP in terms of the proportion of households using it (76%) was wild fruits. This is slightly less than some other studies in the savanna region of South Africa, but not much so. For example, more than 90% of households in three Limpopo communities used wild edible fruits (Twine et al. 2003), 80% of households in the Bushbuckridge region (Shackleton and Shackleton 2000), and more than 90% in Thorndale (Dovie (2001). Nationally,

wild fruit use is highest in the Indian Ocean Coastal Belt biome and then the Savanna biome (Sardeshpande and Shackleton 2020), which corresponds to the greater diversity of wild fruit species in these two biomes. But at a local scale the availability and then use of wild fruits (and other NTFPs) can be negatively affected by land transformation and removal of trees for firewood or wildfires (Shackleton et al. 2005). However, many wild fruits species are valued because they can be sold to earn income, such as marulas (*Sclerocarya birrea*) and prickly-pears (*Opuntia ficus-indica*) which means that some households keep or plant trees in their fields or yards (e.g., Paumgarten et al. 2005). Wild fruits are also used by many urban and peri-urban communities as revealed in the national survey by Sardeshpande and Shackleton (2020).

4.2. Use of NTFPs

The majority of households utilized NTFPs primarily for domestic use, i.e. subsistence needs, although a few households also sold NTFPs. The study found about 95% of households utilize NTFPs for domestic purposes. This may be a reflection of cultural preferences as well as some households needing to use NTFPs to save cash. For example, they can extract wild foods from fields and communal savannas and thereby buy less food in the local store. They can then use the cash they have saved for other needs that cannot be provided locally, such as transport costs, school fees, stock for a small business, or farming inputs. This is consistent with studies from other parts of Southern Africa and elsewhere in the world, where a large proportion of households rely on and use a variety of NTFP species to fulfill a variety of household demands (Shackleton et al. 2002). Similarly, Paumgarten et al. (2005) observed that NTFPs give a variety of benefits to numerous households that consume and sell a variety of species. My findings corroborate those of Suleiman et al. (2017), who reported that 68% of households use NTFPs for domestic use rather than commercial use. Other studies that have found consistent observations include Lynser and Tiwari (2016) in Meghalaya, North-East India, and Sharma et al. (2015) in Arunachal Pradesh, India.

Almost all NTFPs, including firewood, fodder, and plants, were utilized primarily for subsistence in the households closest to the South Nandi woods. This study has supported several other studies from the area and South Africa that demonstrate how rural communities have a broad knowledge of and usage for a variety of plant species for domestic and cultural purposes. Several South African studies have demonstrated that rural inhabitants identify and

use a varied range of plant species to meet a variety of household and cultural needs (Dovie 2007; Thondhlana et al. 2012; Steele et al. 2015). The findings of this study are similar to those of Suleiman et al. (2019), who revealed that local residents in remote areas prefer to use NTFPs for subsistence rather than financial gain. Despite the fact that people's commercial livelihoods are not based on savannas, their proximity and access to NTFPs show that they rely on the savanna for food, firewood, and environmental advantages, as found in prior studies (e.g., Bose et al. 2012; Timko and Kozak, 2014).

Plant species have always been used by people for food, shelter, health and culture, according to Leakey et al. (2003). This reliance is still strong throughout the African continent, particularly among rural communities (Dovie et al. 2004; Belair et al. 2010), but also urban ones (Schlesinger et al. 2015). Savannas provides vital human requirements such as firewood, food, housing, and health care (Rankoana 2016). Mulenga et al. (2011) also stated that most rural households in developing 37 regions used wild fruits, plants, and insects for direct consumption and occasionally for commercial purposes.

On average 60% of the households acquired NTFPs by harvesting them as opposed to purchasing. But there were string differences between different types of NTFPs. For example, over 80% collected NTFPs such as wild vegetables, wild fruits, edible insects, medicinal plants, thatch grass and wood for carvings from the surrounding environments (mountains, savanna) and human dominated spaces (farms, and home gardens). More NTFP types and species are obtained from the savanna than from farms. For example, firewood, thatch grass, edible insects and mushrooms are mostly from the savanna, whilst wild vegetables are usually taken from home gardens and fields. According to Tassou (2017), the NTFPs harvested from the savanna include firewood, fruits, honey, herbs, mushrooms, and construction materials. Access to NTFPs in the communal savannas in the area is unregulated and people may collect what they want whenever they wish. But some respondents had observed that some NTFP species were declining. They attributed the declines to a combination of climate change, land use transformation and overuse of specific NTFPs.

Findings from this study indicate that women are the ones responsible for collecting wild foods, whereas males tend to be responsible for the collection of building and fencing poles and wood for carvings. Women collected wild foods more because they are the ones that prepare and cook the food. Most children harvest and consume wild fruits opportunistically when they play outside, herd cattle, or perform other household chores (Maseko et al. 2017). Large and abundant fruits (e.g., *Sclerocraya birrea*, *Strychnos* spp.) might be collected in a container and brought home for everyone to share. Other wild foods like wild vegetables and mushrooms are harvested and cooked by children and women in most households. Women regularly gather wild foods on their way to get water, collect firewood, or stroll home from their fields. These findings are consistent with those of Shackleton et al. (2001), who indicated that while women are historically responsible for household food security, males utilize NTFPs connected to the construction of structures and livestock fencing. This is contrary to the popular thought that women and children make up the majority of NTFP foragers (Pandey and Saini, 2007, Sharma et al. 2015). The global study by Sunderland et al. (2014) showed that gender roles in the utilization of NTFPs vary between regions and cultures.

As to be expected, households procured different NTFPs at different frequencies, from weekly, to monthly, or even longer. This is for two reasons. The first is because some of the NTFPs are seasonal, such as wild fruits, mushrooms and some medicinal plants. In India (Madhya Pradesh) according to Bhattacharya and Hayat (2004), the highest season for NTFPs collecting among respondents was November-February. The second reason is because the demand or need for some NTFPs is irregular or not very frequent, particularly construction materials like, reeds, poles, thatch grass, etc. However, there are some NTFPs that are used on a regular basis all year long, such as fuelwood, fodder and medicinal plants. Gupta et al. (2017) discovered that respondents were collecting various NTFPs throughout the year to support their livelihoods.

4.3. Number of species used

Across the five villages households use a total of 275 different NTFP species. This might be because the species richness in the Vhembe region is high, which provides local people with a lot of resources and choices about which species they use. This finding confirms the findings of Dovie et al. (2002) that communities in the savannas of South Africa typically use up to 200-300 plant species, which is more than in other biomes. Comparisons to other literature is

difficult since most research regarding the number of NTFP species used in households was acquired by interviewing only the household head, however, in my research, i interviewed every adult member. Consequently, at the household scale, my results are likely to be higher than most previous studies in comparable settings.

As to be expected, the scale of measurement influenced the number of NTFPs used, although this has never been investigated in other studies. The greatest number was recorded at the village scale, where a mean of 105.2 ± 34.1 NTFP species per village was determined from the 20 sample households per village. This declined a lot when looking at the household scale, with a mean of 36.1 ± 10.7 species. The lowest number was at the scale of the individual respondents where the mean number across the 179 individuals was 26.8 ± 12.6 . These numbers can be considered at minimum estimates because the number of medicinal NTFP species is likely to have been underestimated. However, the species accumulation curve showed that 20 households per village was reasonably representative in four of the five villages.

In this study, species were classified according to their intended use, and the use for edible food (137 species), energy (81 species), and craft (66 species) were relatively high. This contradicts the findings of Pradhan and Singh (2019) in Ribdi village, India, where they reported that 24 plant species are utilized for fuelwood, while 11 plant species are used for building and handicrafts (poles, thatch grass). Similarly, in India Gujarat, Kumar (2015) reported that around 42 species of NTFPs be harvested and used for a variety of purposes including food, medicines, and raw materials. Households utilized more than 20 species. This is supported by the findings of Shackleton and Shackleton (2006) who observed that individual households may utilize over a hundred species. In the Bushbuckridge lowveld, for example, a single household may consume up to 20 edible fruit species, 21 species of edible herbs, and fuelwood. Thinyane and Maroyi (2019) reported that around 59 species of NTFPs are used in the Alfred Nzo District in the Eastern Cape. The range and the number of NTFP species utilized vary by household and community in response to a variety of local and external contexts, including the availability of substitutes, labour to gather, education, household income, and traditional ecological knowledge (Shackleton and Shackleton 2003).

The communities in the investigated villages in the Vhembe area used of 81 different species for firewood, which is higher than most other studies, it can be due to level of redundancy/overlap in most commonly used species. For example, Raseth et al. (2013) reported only 18 species of firewood used in the Limpopo villages, including *Berchemia discolor*, *Sclerocarya birrea*, and *Dichrostachys cinerea*. This might be because I interviewed every adult member in each household, rather than a single individual. It might also be a consequence of the high tree species richness in the region. Dovie (2001) showed that high species richness in the local environment generally results in a higher number of species used as NTFPs. Additionally, nowadays electricity has become expensive, so some households can save electricity by using firewood for cooking. Villages that were living close to the savannas or mountains can use more species available in that specific savanna close to them.

The number of wild vegetable species used was also high (43 species) relative to other studies in South Africa. Bvenura and Alfolayan (2014) recorded 22 wild vegetables being utilized in Alice, in the Eastern Cape. Similarly, Bhat and Rubuluza (2002) found 36 wild vegetable species utilized in the Transkei region of the Eastern Cape province, while Jaca and Kambizi (2011) discovered 30 species, and lastly, Cocks and Wiersum (2003) recorded only 12 species of wild vegetables used in the same province. Steyn et al. (2001) found 32 wild vegetable species used in Limpopo, with *Amaranthus* spp., *Momordica balsamina*, *Bidens pilosa*, and *Solanum nigrum* being the most frequently used ones. Additionally, Bvenura and Alfolayan (2015) conducted a literature review on wild vegetables used in Limpopo and discovered that *Cleome gynandra*, *Amaranthus hybridus*, and *Bidens pilosa* were the most often utilized species in the region. The same species were also most often used in my study. The use of wild vegetables by rural communities, and some urban ones, around the world is often interpreted as a strong expression of traditional cultures. Thus, continued use of wild foods in the face of global forces of cultural change can be viewed as cultural persistence (Pawera et al. 2020). But there is still worldwide concern about the loss of knowledge of wild food plants (Cruz-Garcia and Howard 2013).

In this study, respondents listed edible insect species, which is greater than previous authors recorded in the same province. However, the Vhavenda are well known as a people who relish edible insects. The edible insects are rich in nutrition and vitamins. Many Lepidopteran worms, termites, locusts, jewel beetles, and smelly insects are edible in South Africa (Teffo et al. 2007; Nonaka, 2009; Makhado et al. 2009). Hlongwane et al. (2020) reported eight edible insect species utilized by rural communities in Limpopo and KwaZulu-Natal provinces (e.g., *Encosternum delergorgue*, *Imbrasia belina*). Other studies elsewhere recorded six insect species being consumed as food in Botswana (Obopile and Seeletso 2013). In contrast, Makhado et al. (2009) observed that four insect species were consumed in Giyani Municipality, Limpopo. Species such as *Macrotermes falciger*, *Macrotermes natalensis*, and *Macrotermes michaelseni* were described as edible insect species by Netshifhefhe et al. (2018). All of the species were also reported by the respondents in my survey.

The number of wild fruits species used was high, encompassing 40 species across the five villages. Some of the tree species which were used for firewood were also used for wild fruits. Other studies recorded high number of wild fruits species used, for example, Mokganya et al. (2017), recorded 92 wild fruit species (e.g., *Sclerocarya birrea*, *Landolphia kirkii*) used by households in several communities in the Vhembe area of Limpopo. Mashile et al. (2019) reported 52 wild edible fruit species (e.g., *Vangueria infausta*, *Sclerocarya birrea*) used by households in the Enhlanzeni region of Mpumalanga province. In Venda, South Africa, rural communities continue to rely heavily on wild foods, including fruits for enjoyment, dietary diversity, and income (Paumgarten et al. 2018).

Only 28 species were listed as used for medicinal purposes. This is quite low in light of most rural households in South Africa using traditional medicines (Mander 1997). This might be because the respondents were unwilling to tell me what species they used because it would give me, the researcher, some insight into their personal ailments. Some others might not have wanted to reveal that they used traditional medicines in fear of being judged as unsophisticated or it being against modern religions. A similar reticence in relation to interviews about use of medicinal plants was reported by Shackleton et al. (2002), also in a village in Limpopo Province. Thus, it is likely that far more medicinal species were used by residents in the five villages than was reflected by the results.

The pole species were used for construction by households. The use of wood for construction is common in most rural areas of Southern Africa. However, Makhado et al. (2009), observed that rural communities in the Giyani area utilize poles gathered from the surrounding savanna to build mostly traditional structures including huts, fences, and animal kraals, rather than the main house. Furthermore, stated that plant species used in traditional building construction include *Colophospermum mopane* and *Combretum apiculatum*.

4.4. Changes in the number of species used

In terms of dynamic trends, most respondents felt that the overall number of NTFP species used in all villages has expanded over the last decade or so. Changes in the environment may have had an impact on the NTFP species utilized by households. According to the participants, the savannas and forests around their villages are changing. They contend that generally, the woody areas are increasing, which they attribute to a drop in field agricultural activities, a decrease in the quantities of NTFPs used by some households as they substitute them with commercial alternatives, and at times a ban by traditional councils on harvesting some species. The abandonment of field cultivation over the last 2-3 decades is a common phenomenon in the former homeland areas of South Africa, with multiple ramifications for ecological dynamics and livelihoods (Shackleton et al. 2019), including for NTFPs. In the Eastern Cape, Njwaxu and Shackleton (2019) showed how the number of species and types of NTFPs changed with increasing successional age of abandoned fields. The species richness of medicinal NTFPs and thatch grass were greatest in fields abandoned for only a few years, but the number of craft and firewood species were highest in the fields abandoned for the longest. Also in the Eastern Cape, Falayi et al. (2019) described how abandoned fields become dominated by woody species, which are now used for firewood purposes, with local people saying that the amount of firewood available has increased and it is easier to harvest. It has increased so much that some have started to sell it. The increase in species could be due to depletion of populations of the most preferred species, leading to many households diversifying to protected or less desirable species. The role of climate change in contributing to increasing tree and shrub density in savannas and grasslands also cannot be ignored (Skowno et al. 2017). A core finding was the pattern of change in the number of species used by the households. According to Paumgarten (2005), changing lifestyles, the availability of alternative items, changing knowledge and skills, changing tastes, reducing provision, and use constraints are all factors for a reduction in NTFP species used.

A minority of respondents felt that the number of NTFP species had declined over the last decade or so. A variety of reasons were given to explain this trend, including overharvesting of specific NTFPs, land transformation, climate change, and changing knowledge and practices. For example, the number of fruit-bearing trees (NTFPs) is thought to be declining, with fewer resources accessible than in the past. Fruit, for example, was seen to be diminished. Thinyane and Maroyi (2019) reported that 10% of the participants believed that NTFPs were declining because of excessive commercial harvesting and 7% stated that disruptive collecting procedures were responsible for the reduction of NTFPs. Also, drought is also frequently invoked in semi-arid areas as a cause for the decline in the supply of vital resources like NTFPs. Thinyane and Maroyi (2019) identified the over-collection of NTFPs, drought, deforestation, and land removal for habitation and farming as the primary reasons for NTFP reduction. Participants additionally said that while the usage of NTFPs is reducing due to the availability of modern substitutes, some crafts and firewood are still used during cultural gatherings such as weddings and other traditional events (Thinyane and Maroyi. 2019). A little studied aspect is the interaction of different drivers of change, such as overuse or wildfires during a drought, and how that affects NTFP population dynamics and distribution (Ticktin et al. 2012).

4.5. Factors influencing the number of species used

Several factors may influence the number of NTFP species used by individuals, households, and communities. The majority of the determinants are household factors, context-specific, and environmental, and hence vary from one place to another. It is evident from this study that household and environmental factors can influence the number of species used in households. The results from the principal component analysis (PCA) show a clear pattern between the number of species and household /environmental factors.

At the scale of the individual respondent, age showed a positive relationship with the number of NTFP species, i.e. older respondents knew more species. Additionally, the observed increase in the age of respondents indicates that older people have a variety of experiences with various NTFPs for family use. The results are consistent with those of Basnayake and Gunaratne (2011), who revealed that a person's age has had a general impact on his or her level of production, efficiency, and knowledge of NTFPs utilization. According to Paulo (2007), increasing age increases the usage of wild vegetables, wild mushrooms, medicinal plants, and

poles. Similarly, Nyingili (2003) observed in the Mbozi region that increasing age enhances the utilization of wild vegetables and mushrooms. The findings of this study contradict those of McElwee (2008), who examined the socioeconomic factors that influence NTFP usage and discovered that older persons are less likely to utilize NTFP species because they may lack the strength to perform NTFP activities. Furthermore, Mugido and Shackleton (2019) claim that old heads had less demand since they got pension benefits. The findings suggest that middle-aged and elderly families were more likely to utilize a broader variety of NTFP species than younger ones. According to Melaku et al. (2014), younger individuals are more likely to participate in NTFP production since their physical health allows them to gather them, however, they may lack the knowledge of the key species, where to find them, or how to process them (Weyer 2011). Such knowledge is accumulated with time and through experience, and hence age.

The findings of this study reveal that the respondent's education level negatively influences the number of species used. As a result, the more educated individuals are less likely to be located in the region, have jobs, and rarely use NTFPs in their households, this imply that more highly educated individuals were likely to have more western lifestyles and values and thus less likely to make extensive use of NTFP. Respondents with primary-level education used a higher number of species than respondents with a tertiary qualification. Increasing education resulted in a lower number of species used in households. Education level, according to Lema (2003), enhances one's awareness of NTFP consumption, availability, and conservation. More education broadens livelihood options and decreases direct dependency on natural commodities. According to Kamwenda (1999), one's level of education influences NTFP species use and conservation, and Mugido and Shackleton (2019) argued that a better education means that families participate in fewer NTFP extraction activities. Similarly, Newton et al. (2016) and Jain and Sajjad (2016) observed that a higher level of formal education decreases the use of NTFPs since education provides chances for off-farm jobs. Since education is linked to employment it showed that unemployed individuals used more NTFP species than employed people. These findings generally imply that the individuals that were unemployed they have the time to go to the savanna or mountains to gather some NTFPs for their household's needs. In another way, they are using the savanna to provide for their family's needs, which was the main reason for the unemployed individuals to use the NTFP species found in the savannas. In

contrast, there was no clear relationship between respondent gender and the number of NTFP species used. Female respondents tended to know more, but not significantly so.

At a household scale, a number of factors were identified. Household size significantly influences the number of NTFP species used by the households. This is because the larger family sizes are disposed to have more labour available to support NTFPs collection and utilization from communal lands. However, much of the literature talks about quantities of NTFPs used in relation to household size, rather than the number of species used. Suleiman et al. (2017) reported that families with large household sizes in Kenya derived more NTFPs due to labour availability that can be spread across various collection activities. Larger households use more NTFP species in comparison to smaller families since larger households have more members and people to feed (Almeida, 1992). Similarly, Adhikari et al. (2004) stated that larger households have a greater need for the utilization of NTFP species and more labour to fulfil this need. However, according to Moubarakau (2017), a unit increase in household size increases the chance of using NTFPs by 30% but does not indicate the number of species. This may be due to the availability of labour for NTFP utilization in larger families. Similarly, Rodrigez (2007) discovered in an Indian study on the factors of NTFP collection that the presence of an additional member in the home increases the household's ability to collect NTFP species. According to Nyingili (2003), an increase in family size considerably enhances the use of wild foods in the Mbozi district.

There were no discernible patterns at the household scale between the number of NTFP species used and household income levels and sources. Households with grants, salaries, or farming were likely to use more or less the same number of species, with no significant differences between them. While the general picture suggests that household income has little influence on NTFP usage, there are several variations when different NTFPs are included. NTFP species usage was low in rural populations with a high income (Saxena 2003).

Lastly, at a village scale, the findings suggest that the number of species utilized is substantially influenced by distance to the surrounding savanna, closeness to an urban region, vegetation type, and settlement type. Villages surrounded by savanna areas have more access to a variety

of NTFPs. The distance from urban areas leads to significant opportunity costs for accessing items and services, whereas communities closer to urban areas can acquire commodities and services instead of NTFPs (Paumgarten, 2005). Traditional settlement villages use more NTFP species than non-traditional settlement villages because traditional settlement villages have savanna lands nearby. The overall number of species utilized in villages adjacent to the town, non-traditional settlements, and far from the savanna was low. These results are consistent with those of Kilonzo et al. (2018), who discovered that respondents in Tanzania's Kilombero area who live close to the savanna relied substantially on a large range of NTFP species for socio-economic benefits. Individuals that live close to the savanna, according to Melese (2016), will typically rely largely on a number of different NTFP species for their daily requirements. These findings are consistent with those of previous studies that have been undertaken (Baiyegunhi et al. 2016; Dagm et al. 2016; Mukul et al. 2016). According to Mushi et al. (2020), the primary factors in using NTFP species frequently were the distance from the savanna, with people living closer to the surrounding savanna utilizing more NTFP species. Households may obtain more NTFP species due to their closeness to the savanna while spending less on labor and transportation (Ndagalasi et al. 2007). This is consistent with the findings of Davidar et al. (2010) and Fisher et al. (2010), who discovered village location to be a significant factor in household NTFP usage in India and Malawi, respectively.

The findings also revealed that the Vhembe region is extremely abundant with numerous NTFP species that contribute to the livelihoods and culture of the population. For example, more biodiverse areas are likely to have a greater variety of species used as NTFPs than less biodiverse habitats (Salick et al. 1999; Dovie 2007). An additional example is that more productive habitats such as wetlands (Mmopelwa et al. 2009; Gosling et al. 2017) will probably supply more NTFPs for human consumption than less productive habitats (Mugido & Shackleton 2019). Because of this indicated unavailability of NTFP species in such environments, degraded habitats may give fewer species. These illustrations contrast one location with another, resulting in a geographical difference. Furthermore, NTFP abundance, variety, and utilization may differ throughout the duration of a single season, resulting in a time difference in what species are used and when.

5. CONCLUSION AND RECOMMENDATIONS

5.1. Study conclusions

Based on the findings of this study, it is clear that the NTFPs support rural livelihoods through the provision of various benefits such as fuelwood, medicinal herbs, and fodder for livestock, vegetables, edible insects, fruit, etc., for domestic use and sale for income generation. These benefits are supplied by a wide range of different species within each use category. Most households were not very involved in the commercialization of NTFPs but used them for direct consumption. The availability of NTFPs and the rich diversity of species to provide them is critical and should not be undervalued. The variety of these resources has greatly assisted rural inhabitants' livelihoods. All households used at least one NTFP.

A total of 275 species were used in the five sampled villages in the Vhembe region. The NTFP types in the study were firewood (81), medicinal plants (28), wild vegetables (43), edible insects (48), edible fruits (40), wood utensils (38), thatch grass (23), poles (19), mushroom (8), fodder (8), wood carvings (19), and reeds (9). Many species had more than one use and were recorded in each use category. In this study firewood, insects, and wild vegetables counted the highest number of species, and reeds, mushrooms, and fodder had the lowest number of species. The most common NTFPs used were wild vegetables (e.g., *Corchorus olitorius*, *Amaranthus capensis*, *Bidens pilosa*), firewood (e.g., *Colophospermum mopane*, *Parinari curatellifolia*, *Combretum hereroense*), wild fruits (e.g., *Landolphia kirkii*, *Vangueria infausta*), and edible insects (e.g., *Imbrasia belina*, *Macrotermes michaelseni*, *Encosternum delegorguei*). Most of the NTFP species were used for domestic use. These results corroborate several additional studies from the region and South Africa showing that rural communities recognize and use a diverse range of plant species for a variety of domestic and cultural purposes (Dovie 2007; Thondhlana et al. 2012; Steele et al. 2015).

At the scale of an individual, the mean number of NTFP species used was 26.8 ± 12.6 across the five villages. The number increased by approximately 40% when considering the household scale where the mean number was 36.1 ± 10.7 species. This value increased by 300% when the 20 households per village were aggregated, providing a mean number of 105.2 ± 34.1 NTFP species per village. The species accumulation curve showed that 20 households per village were reasonably representative in four of the five villages.

The majority of the respondents mentioned that the number of species used now was greater than the number used 10-15 years ago, although a few felt that the number of species used has decreased. Furthermore, the reasons for the NTFP species to decrease were that they have cleared lands for farming, other places have been banned by the traditional council, climate change, and overharvesting. The number of species used by most households has increased, owing to the designation of other regions where they obtained NTFPs as protected areas. On the contrary, restoration and sustainable agricultural practices have also contributed to the growth in species number.

With respect to household and individual attributes, several significant influences were revealed. First, the gender of the respondents showed no significant influence on the number of NTFP species used, although female-headed households listed slightly more than males. Second, increasing the education of the respondent resulted in a lower number of species used. This was confirmed by the respondents with tertiary qualifications who used fewer NTFP species. Third, the relationship between the age of the respondent and the number of species used was positive. Fourth, the employment status of respondents showed a significant influence on the number of species used, with unemployed respondents acquiring a higher number of species compared to employed. Additionally, household size was significantly and positively related to the number of NTFP species, with larger households generally using more species. Lastly, income source and income level showed no relationship with the number of species used at the household scale.

This study further revealed that village attributes also influence the number of species used. Village attributes such as proximity to the urban area, vegetation type, distance to nearby savanna, and settlement type influence the number of species used. The households and villages living in close proximity to the surrounding savanna use more NTFP species. Villages that are far from urban areas use more species than those ones close to the urban areas. The villages that stay in traditional settlements tend to engage in the use of more species than those in the western settlement. More biodiverse areas are likely to have a greater variety of species used as NTFPs than less biodiverse habitats (Dovie, 2007). Because of the imposed unavailability of particular NTFP species in such environments, degraded habitats may give fewer species. These illustrations contrast one location with another, resulting in spatial differences.

In conclusion, socioeconomic factors (such as age, household size, employment, and education), and environmental factors influence the number of NTFP species used. This study has added to the expanding research literature in South Africa on the influence of socioeconomic characteristics of households on the use of NTFP generally, and the number of species used specifically.

5.2. Recommendations

Based on the findings from this study that there is a widespread use of dozens of NTFP species this study has several policy implications and hence recommendations.

- The first is that relevant authorities from national down to local appreciate the importance of NTFPs in rural livelihoods, and consequently enact and implement policies to promote sustainable land use practices, including conservation of NTFPs. If and where populations of core NTFPs are being degraded, then restoration or afforestation initiatives should be considered, along with the implementation of community-based natural resource management approaches. People should be encouraged to plant NTFPs as safety nets in their fields and around their homes to ease demands on wild populations. State and local governments should grow seedlings of NTFPs used as safety nets and offer them to rural populations.
- Secondly, the high use of NTFPs as a means to save cash and promote culture indicates that they should be integrated into poverty reduction policies and emphasize the relevance of NTFPs in income production and protection.
- Furthermore, training on value addition, processing, and market access by all stakeholders would stimulate increased rural household engagement in NTFP operations. Make local marketplaces available for the NTFPs that may be sold. Based on these conclusions, ecologists and extension officers should consider communities to be informed about the environmental effect of their harvesting practices and the necessity for sustainable harvesting methods, as well as raise public knowledge regarding NTFP conservation and management. Provide instruction to communities on how to harvest NTFPs for usage and trade in a sustainable manner. From a research perspective this study has highlighted other research needs. Key amongst them would be to undertake similar studies in other locations to determine the ratio of NTFP species numbers between individual, household and community scales. Once several more

studies are done we might be able to generalize what those ratios are, and then allow scaling between studies that report figures at only one scale. A second research area is to untangle the drivers that lead to decreases (or increases) in NTFP populations. This is necessary at local scales to allow appropriate response options at that scale. Third, is the need for longitudinal studies of NTFP use and population dynamics over time. To date there has been only one in South Africa dealing with general NTFP use at a household level (i.e., Falayi et al. 2019), although there has been some on specific NTFPs, like fuelwood. Longitudinal studies are necessary to understand the effects of cultural and dietary changes associated with increased urbanization, government social grants and integration into the market economy by even remote rural villages.

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APPENDICES

List of species used

| Local name | Scientific name | Common name | Parts used | Uses |
|--------------|---------------------------------------|---------------------|--------------------------------|---------------------|
| Muvhuyu | <i>Adansonia digitata</i> | Baobab | Stem, fruits, bark | EF, MP |
| Musuma | <i>Diospyros mespiliformis</i> | Jackalberry | Stem, branches, fruits | FW, EF, POL |
| Munanga | <i>Acacia nigrescens</i> | Knob thorn | Stem, branches | FW |
| Mulala | <i>Hyphaene coriacea</i> | Lala palm tree | Stem, branches, leaves, grass | RED, TG |
| Mufula | <i>Scelerocarya birrea</i> | Marula tree | Stem, branches, fruits, leaves | FW, EF, MP, WU, WC |
| Mopani | <i>Colophospermum mopane</i> | Mopane tree | Stem, leaves, branches | FW, EI, POL, WC |
| Munara | <i>Acanthosicyos horridus</i> | Nara plant | Stem, branches | FW |
| Muvevha | <i>Kigelia pinnata</i> | Sausage tree | Stem, branches | FW |
| Mutamboti | <i>Spirostachys africana</i> | Tamboti | Stem, branches | FW |
| Musaunga | <i>Acacia tortilis</i> | Umbrella thorn | Stem, branches | FW |
| Musese | <i>Schotia brachypetala</i> | Weeping boer bean | Stem, branches, leaves | MP |
| Mutebvu | <i>Macadamia integrifolia</i> | Macademia nut tree | Stem, branches, fruits | FW, EF, WC, WU |
| Munombelo | <i>Englerophytum magalismsontanum</i> | Stemfruit | Stem, branches, fruits | FW, EF, WU |
| Mukwalikwali | <i>Antidesma venosum</i> | Forest tassel-berry | Stem, branches, fruits | FW, EF |
| Muluwa | <i>Senegalia ataxacantha</i> | Flamethorn | Stem, branches, grass | FW, WU, TG, RED, WC |

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|---------------------|--------------------------------|------------------------|--------------------------------|------------------------|
| Muafukhada | <i>Persea americana</i> | Avocado tree | Stem, branches, leaves, fruit | FW, MP, WC, WU, EF, WC |
| Munzere | <i>Bridelia micrantha</i> | Mitzeerie | Stem, branches, fruits | FW,EF, POL |
| Muvhambangoma | <i>Albizia adianthifolia</i> | Rough-barked flatcrown | Stem, branches | FW, WU, WC |
| Muserenga | <i>Melia azedarach</i> | Persian lilac | Stem, branches | FW,WU |
| Mugwiti | <i>Combretum molle</i> | Velvet bushwillow | Stem, branches, leaves, roots | FW, MP |
| Muvhula | <i>Parinari curatellifolia</i> | Mobola-plum | Stem, branches, fruits | FW, MP, EF,WU, POL |
| Mubomo | <i>Eucalyptus grandis</i> | Blue gum tree | Stem, branches, leaves | FW, POL, MP |
| Muvuvha | <i>Combretum collinum</i> | Bicoloured bushwillow | Stem, branches | FW |
| Munngo | <i>Mangifera indica</i> | Mango tree | Stem, branches, fruits | FW, EF |
| Mutshatshakhwali | | | Stem, branches | FW |
| Muhuyu | <i>Ficus sycomorus</i> | Sycamore fig | Stem, branches, fruits | FW, EF |
| Mugwavha | <i>Psidium guajava</i> | Guava | Stem, branches, fruits, leaves | FW, EF, MP,WU |
| Muvhulavhusiku/daka | <i>Xylopi odoratissima</i> | Kalahari bitterwood | Stem, branches | FW, POL |
| Muvundambado | <i>Pappea capensis</i> | Jacket-plum | Stem, branches | FW |
| Mutu/mutwa | <i>Syzygium cordatum</i> | Water berry | Stem, branches, fruits | FW, EF, WU, POL |
| Mufhefhera | <i>Alphonia theiformis</i> | Albino-berry | Stem, branches | FW |
| Murenzhe | <i>Dichrostachys cinerea</i> | Sickle bush | Stem, branches | FW,WU |

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|---------------------------------|---|---------------------------|----------------------------------|-------------------|
| Mukurukuru | <i>Trema orientalis</i> (L.) Blume | | Stem, branches | FW |
| Mutswiriri | <i>Bauhinia galpinii</i> | Pride-of-De kaap | Stem, branches, leaves, roots | FW, MP |
| Musinde | <i>Dalbergia nitidula</i> | Purplewood flat- bean | Stem, branches | FW, WC |
| Mususu/mususa | <i>Terminalia sericea</i> | Silver custer-leaf | Stem, branches | FW |
| Mundende | | | Stem, branches | FW |
| Munukhavhaloi | <i>Heteropyxis natalensis</i> | Lavender-tree | Stem, branches | FW |
| Musimbiri | <i>Androstachys johnsonii</i> | Lebombo- ironwood | Stem, branches | FW, POL |
| Munetshenetshe | | | Stem, branches | FW |
| Tshifhatane | <i>Brachylaena huillensis</i> | | Stem, branches | FW |
| Mulanotshi | <i>Nuxia floribunda</i> | Wild elder | Stem, branches | FW |
| Muelela | <i>Albizia adianthifolia</i> | Rough-barked flatcrown | Stem, branches, fruits | FW, WU |
| Murabvuma/Mukuk uwa/Khukhuna | <i>Grewia hexamita</i> <i>Burret</i> | Giant raisin | Stem, branches | FW,WU,EF |
| Mutwari | <i>Olea europaea</i> | Wild olive | Stem, branches | FW,WU |
| Mutondo | <i>Pterocarpus angolensis</i> | Transvaal teak | Stem, branches | FW, WU, WC,EF |
| Mugubisi | <i>Croton sylvaticus</i> | Forest fever-berry | Stem, branches | FW |
| Mubvubvu | | | Stem, branches | FW |
| Mutaari | <i>Terminalia prunioides</i> | | Stem, branches | FW |
| Muheri | | | Stem, branches | FW,WC |
| Munie | <i>Berchemia discolor</i> | Brown ivory | Stem, branches, fruits, grass | FW, EF, FOD,WC |
| Mutasiri | <i>Searsia rogersii</i> | Roger's currant | Stem, branches | FW/WU |
| Munienie | <i>Berchemia zeyheri</i> | red ivory | Stem, branches | FW, POL |

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|---------------------|---------|--|------------------------|------------------------|--------------------|
| Tshiphopha | | <i>Apodytes dimidiata</i> | | Stem, branches | FW |
| Muthowa | | <i>Diplorhynchus condylocarpon</i> | Horn-pod tree | Stem, branches | FW,WU |
| Mukumbakumba | | <i>Bridelia mollis</i> | Velvet sweet berry | Stem, branches | FW |
| Muhatu | | <i>Tabernaemontana elegans</i> | Toad-tree | Stem, branches | FW,WU |
| Mutangule | | <i>Euclea divinorum</i> | Magic guarri | Stem, branches | FW |
| Mubvuvha | | <i>Combretum erythrophyllum</i> | | Stem, branches | FW |
| Musingidzi | | <i>Combretum hereroense</i> | Russet bushwillow | Stem, branches, grass | FW, FOD |
| Mitabva/ Murapfa | Mutava/ | <i>Grewia bicolor</i> | White leaved raisin | Stem, branches | FW, POL,EF |
| Mugeri | | <i>Combretum imberbe</i> | Leadwood | Stem, branches | FW |
| Murapfa | | <i>Grewia monticola</i> | Silver rasin | Stem, branches, grass | FW,WU, FOD, POL,EF |
| Musu | | <i>Vachellia tortillis</i> | Umbrella thorn | Stem, branches | FW |
| Muukhuthu | | <i>Commiphora mollis</i> | Velvet-leaved corkwood | Stem, branches | FW, WU |
| Mutondowa | | <i>Pseudolachnostylis maprouneifolia</i> | Kudu berry | Stem, branches | FW |
| Mukavhamahunguvu | | <i>Psydrax livida</i> | Green twig quar | Stem, branches | FW |
| Mutokota | | <i>Azelia quanzensis</i> | Pod-mahagony | Stem, branches | FW, WU, WC |
| Muataha | | | | Stem, branches | FW |
| Mudedede | | <i>Heteropyxis natalensis</i> | Lavender-tree | Stem, branches | FW,POL |
| Muzwilu | | <i>Vangueria infausta</i> | Velvet wild-medlar | Stem, branches, fruits | FW, EF, WU |
| Mukulu | | <i>Achyranthes aspera</i> | | Stem, branches | FW |
| Muhondwa | | <i>Vepris lanceolata</i> | | Stem, branches | FW,WU |

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|---------------|---|-------------------------------------|-------------------------------|------------------|
| Mupfuka | <i>Grewia microthysa</i> | Sand rasin | Stem, branches | FW,EF,WU,P OL |
| Mutulume | <i>Breonadia salicana</i> | Matumi | Stem, branches | FW, POL, WC |
| Murathole | <i>Rothmannia capensis</i> Thunb. | | Stem, branches | FW |
| Munavhule | <i>Afrocanthium mundianum</i> | | Stem, branches | FW |
| Tshipophamadi | <i>Anthocleista grandiflora</i> | Forest big-leaf tree | Stem, branches | FW |
| Mukavha | | | Stem, branches | FW |
| Mukuduba | <i>Rothmannia capensis</i> | Wild gardenia | Stem, branches | FW |
| Mutongowa | | | Stem, branches | FW |
| Mulingwi | <i>Schrebera alata</i> Welw. | | Stem, branches | FW |
| Museri | <i>Eugenia natalitia</i> | | Stem, branches | FW |
| Muhanga | | | Stem, branches | FW |
| Muatata | <i>Mimosa pigra</i> L. | | Stem, branches | FW |
| Muvhungo | <i>Landolphia kirkii</i> | | Stem, branches, fruits, grass | FW, EF, FOD, POL |
| mupfa | <i>Vachellia karroo</i> (Hayne) Banfi & Gallaso | | Stem, branches | FW |
| Muthethenyeka | <i>Trimeria grandifolia</i> | Wild mulberry | Stem, branches | FW |
| Tshiumbeumbe | <i>Clematis brachiata</i> | Mugwort/ sage brush Traveller's joy | Leaves | MP |
| Tshikhopha | <i>Aloe chabaudii</i> | Aloe | Leaves | MP |
| Mututulwa | <i>Solanum giganteum</i> | Healing-leaf tree | Fruits | MP |
| Mukavhavhe | <i>Pappea capensis</i> | Jacket-plum | Leaves, fruits | MP |
| Mufentsi | | | Leaves | MP |

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|-------------------|-------------------------------------|---------------------|---------------|-------|
| Muhaba | <i>Toddalia asiatica</i> | Climbing orange | Leaves | MP |
| Mukopokopo | <i>Combretum microphyllum</i> | Forest burning bush | Leaves, roots | MP |
| Tshishengelapofu | <i>Acmella caulirhiza</i> | | Leaves, roots | MP |
| Nngu | <i>Momodica foetida</i> | | Leaves, roots | MP,WV |
| Mubositie | <i>Athrixia phyllicoides</i> | | Leaves, roots | MP |
| Mubvafhisa | <i>Gomphocarpus fruticosus</i> | Milkweed | Leaves, roots | MP |
| Musudzungwane | <i>Lippia javanica</i> | Fever tea | Leaves, roots | MP |
| Munungu | <i>Ozoroa reticulata</i> | | Leaves, roots | MP |
| Mugwambazi | <i>Capparis tomentosa</i> | Cape bush | Leaves, roots | MP |
| Muringa | <i>Moringa ovalifolia</i> | Phantom tree | Leaves, roots | MP |
| Tshikhafushi | <i>Zanthoxylum capense</i> | Wild cardamon | Leaves, roots | MP |
| Mutambaname | <i>Maerua angolensis</i> | Bead-bean tree | Leaves, roots | MP |
| Murandelaphunguwe | <i>Pechuel-Loeschea leubnitziae</i> | Stinkbush | Leaves, roots | MP |
| Mushato | <i>Xanthocercis zambesiaca</i> | Nyala tree | Leaves, roots | MP |
| Mupfure | <i>Ricinus communis</i> | Castor-oil tree | Leaves, roots | MP |
| Vowa | <i>Amaranthus capensis</i> | Smooth pigweed | Leaves | WV |
| Muxe | <i>Solanum americanum</i> | | Leaves | WV |
| Mushidzhi | <i>Bidens Pilosa</i> | Blackjack | Leaves | WV |
| Mufungwi | <i>Riocreuxia torulosa</i> | | Leaves | WV |
| Delele lupfumo | <i>Corchorus olitorius</i> | Jute plant | Leaves | WV |

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|------------------|-------------------------------|-------------------------|--------|----|
| Delele mandande | <i>Abelmoschus esculentus</i> | Okra | Leaves | WV |
| Muvhazwi | <i>Obertia tenax</i> | Mountain nettle | Leaves | WV |
| Munawa | <i>Vigna unguiculata</i> | Cowpea | Leaves | WV |
| Murudi | <i>Cleome gynandra</i> | African cabbage | Leaves | WV |
| Gwigwitimba | <i>Pouzolzia parasitica</i> | Small stinging nettle | Leaves | WV |
| Thanga | <i>Cucurbita pepo</i> | | Leaves | WV |
| Thebe | <i>Amaranthus hybridus</i> | Common pigweed | Leaves | WV |
| Dzaluma | <i>Laportea peduncularis</i> | River stinging nettle | Leaves | WV |
| Muthanzwa | <i>Pouzolzia mixta</i> | Soap nettle | Leaves | WV |
| Phulule | <i>Pentarrhinum insipidum</i> | Heart vine | Leaves | WV |
| Mupinki | <i>Phytolacca octandra</i> | Inkberry | Leaves | WV |
| Phuri | <i>Cucurbita moschata</i> | Phuri | Leaves | WV |
| Mutshatsha | <i>Citrullus lanatus</i> | Bitter melon | Leaves | WV |
| Shashe | <i>Sonchus oleracus</i> | Common sowthistle | Leaves | WV |
| Tshinyagu | <i>Cucumis africanus</i> | Wild cucumber | Leaves | WV |
| Tshibavhe | <i>Momordica balsamina</i> | Balsam apple | Leaves | WV |
| Tshithangavhavhe | <i>Cucumis metuliferus</i> | African horned cucumber | Leaves | WV |
| Daledale | <i>Chenopodium album</i> | Wild spinach | Leaves | WV |
| Mibvi | | | Leaves | WV |

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|------------------------|---|---|------------------------|---------|----|
| Galange | | <i>Pyrenacantha kaurabassana</i> | | Leaves | WV |
| Mufhafhe | | <i>Coccina rehmannii</i> | Wild cucumber | Leaves | WV |
| Thapfa | | | | Leaves | WV |
| Delele mukula/mutavha | | <i>Corchorus trilocularis</i> | | Leaves | WV |
| Tshinzie | | <i>Erythrococca menyharthii</i> | | Leaves | WV |
| Thanamaswi | | <i>Secamone parvifolia</i> | | Leaves | WV |
| Tshibokoto | | <i>Hypoestes forskoolii (Vahl) R. Br.</i> | | Leaves | WV |
| Beleha | | <i>Adenia gummifera</i> | Monkey rope | Leaves | WV |
| Mutohotoho | | <i>Cleome monophylla</i> | Spider plant | Leaves | WV |
| museto | | <i>Dicerocaryum senecioides</i> | | Leaves | WV |
| Dathola | | | | Leaves | WV |
| Mulembu | | <i>Grewia occidentalis</i> | Cross-berry | Leaves | WV |
| Muvavhadembe | | | | Leaves | WV |
| Tanye | | <i>Vernonia fastigiata</i> | starstalk | Leaves | WV |
| Luvhambo | | <i>Celtis africana</i> <i>Burm.f.</i> | | Leaves | WV |
| Mashonzha mopani | a | <i>Imbrasia belina</i> | Mopane worms | Insects | EI |
| Mashonzha muserenga | a | <i>Melia azedarach</i> | Persian lilac worms | Insects | EI |
| Mashonzha mutobvuma | a | <i>Ekebergia capensi</i> | | Insects | EI |
| Mashonzha munembenembe | a | <i>Cassia abbreviata</i> | Long tail cassia worms | Insects | EI |

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|--------------------------|---|---|-----------------------|----------|---------|----|
| Mashonzha maduhwi | a | <i>Ipomoea obscura</i> | Wild worms | pertunia | Insects | EI |
| Mashonzha muthowa | a | <i>Diplorhynchus condylocarpon</i> | Horn-pod worms | tree | Insects | EI |
| Mashonzha mufhulu | a | <i>Burkea africana</i> | Wild-seringa worms | | Insects | EI |
| Mashonzha mupfuka | a | <i>Grewia microthysa</i> | Sand rasin worms | | Insects | EI |
| Mashonzha musuma | a | <i>Diospyros mespiliformis</i> | Jackalberry worms | | Insects | EI |
| Mashonzha mutaladzi | a | | | | Insects | EI |
| Mashonzha muvhungi | a | | | | Insects | EI |
| Mashonzha a nzhelengende | | | | | Insects | EI |
| Nzie tshigome | | | | | Insects | EI |
| Nzie tshibvula | | | | | Insects | EI |
| Nzie diru | | | | | Insects | EI |
| Nzie mutotombudzi | | | | | Insects | EI |
| Nzie mufhulu | | | | | Insects | EI |
| Nzie pfukaluhura | | | | | Insects | EI |
| Nzie done | | <i>Cyrtacanthacris septemfasciata</i> | | | Insects | EI |
| Nzie luvhele | | | | | Insects | EI |
| Nzie swai | | | | | Insects | EI |
| Nzie nyamurovheni | | | | | Insects | EI |
| Nzie gerere | | | | | Insects | EI |
| Nzie lukhula | | | | | Insects | EI |
| Nzie sianama | | | | | Insects | EI |
| Nzie luhatsi | | | | | Insects | EI |

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| Nzie mukundandou | | | Insects | EI |
| Nzie mupfa | | | Insects | EI |
| Nzie doto | | | Insects | EI |
| Nzie thethereda | | | Insects | EI |
| Nzie nyamboshu | | | Insects | EI |
| Nzie nyamakhadzi | | | Insects | EI |
| Nzie tshigwamathukhwi | | | Insects | EI |
| Thongolifha/mbilim edzi | <i>Encosternum delegorguei</i> | | Insects | EI |
| Magege mutshenzhe | a <i>Macrotermes bellicosus</i> | | Insects | EI |
| Magege a nthwa | <i>Macrotermes natalensis</i> | | Insects | EI |
| Magege thohokhulu | a <i>Macrotermes michaelsoni</i> | | Insects | EI |
| Nthwa makhura | <i>Ipomoea plebeia</i> | Wild pertunia | Insects | EI |
| Nemeneme | | | Insects | EI |
| Khukhurubani | | | Insects | EI |
| Thanzwa | <i>Ximenia americana</i> | blue sourplum | Fruits | EF |
| Thungulu | <i>Carissa tetramera (Sacleux) Stapf</i> | | Fruits | EF |
| Thondo | <i>Cephalanthus natalensis</i> | Quinine berry | Fruits | EF |
| Thole | <i>Ficus sycomorus L.</i> | | Fruits | EF |
| Maramba | <i>Strychnos spinosa</i> | Spiny monkey-orange | Fruits | EF |
| Tomboti | <i>Afrocanthium mundianum</i> | Rock alder | Fruits | EF |
| Miomva ya daka | <i>Musa paradisiaca</i> | Banana forest | Fruits | EF |

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|------------------|-----------------------------------|----------------------------|----------------|--------|
| Thamva | <i>Ficus sansibarica</i> | Knobbly fig. | Fruits | EF |
| Makwakwa | <i>Strychnos madagascariensis</i> | Black monkey-orange | Fruits | EF |
| Thaladzi | <i>Mimusops zeyheri</i> | Red milkwood | Fruits | EF |
| Phunzu | <i>Grewia villosa</i> | Mallow raisin fruit | Fruits | EF |
| Mahuhuma | <i>Hexalobus monopetalus</i> | Shakama-plum | Fruits | EF |
| Madzidzi | <i>Artabotrys brachypetalus</i> | Large hook-berry | Fruits | EF |
| Zwitopitopi | <i>Limeum viscosum</i> | | Fruits | EF |
| Mazwilungala | <i>Vangueria esculenta</i> | | Fruits | EF |
| Mundirivhedaka | <i>Rhoicissus tomentosa</i> | Forest grape | Fruits | EF |
| Maembe | <i>Annona chrysophylla</i> | | Fruits | EF |
| Thombe | <i>Hyperacanthus amoenus</i> | Spiny gardenia | Fruits | EF |
| Khwakhwa | <i>Strychnos pungens</i> | Spine leaved monkey-orange | Fruits | EF |
| Thawi | <i>Syzygium legatii</i> | | | EF |
| Maruda | <i>Physalis peruviana</i> L. | | Fruits | EF |
| Phimbi | <i>Garcinia livingstonei</i> | Lowveld mangosteen | Fruits | EF |
| Mulanotshi | <i>Nuxia floribunda</i> | Wild elder | Stem, branches | WU |
| Munadzi | <i>Rauvolfia caffra</i> | Quinine-tree | Stem, branches | WU, WC |
| Lukumbe | | | Stem, branches | WU |
| Murondo/mutondwa | <i>Cephalanthus natalensis</i> | Quinine berry | Stem, branches | WU |

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|---------------|-------------------------------------|--------------------------|----------------|--------|
| Mutasiri | <i>Podocarpus falcatus</i> | Yellowwood | Stem, branches | WU |
| Muuluri | <i>Dalbergia melanoxylon</i> | Zebrawood | Stem, branches | WU, WC |
| Muthobegwa | | | Stem, branches | WU |
| Mulori/vi | | | Stem, branches | WU |
| Mululu | <i>Balanites maughamii Sprague</i> | | Stem, branches | WU |
| Munombelo | <i>Englerophytum magalimontanum</i> | Stemfruit | Stem, branches | WU, EF |
| Muhato | <i>Faidherbia albida</i> | Ana-tree | Stem, branches | WU |
| Mufhata | <i>Brachylaena discolor</i> | Lowveld silver-oak | Stem, branches | WU |
| Mutari | <i>Tarchonanthus trilobus</i> | Broad-leaved camphorbush | Stem, branches | WU |
| Muhondwa | <i>Vepris lanceolata</i> | White ironwood | Stem, branches | WU |
| Mulakholomo | <i>Markhamia acuminata</i> | | Stem, branches | WU |
| Murea ntsa | | | Stem, branches | WU |
| Mutwari | <i>Terminalia prunioides</i> | Purple-pod cluster-leaf | Stem, branches | WU |
| Muratha pfene | <i>Grewia hexamita</i> | Giant raisin | Stem, branches | WU |
| Muligwi | <i>Schrebera alata Welw.</i> | | Stem, branches | WU |
| Tshipandwa | <i>Gymnosporia senegalensis</i> | Confetti spikethorn | Stem, branches | WU |
| Mukunguvhudi | | | Stem, branches | WU |
| Tshilungwa | <i>Erianthemum dregei</i> | Wood flower | Grass | TG |
| Fundwi/khode | <i>Cymbopogon marginatus</i> | Grass | Grass | TG |

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| Mushingidzhane | <i>Sporobolus africanus</i> | Rats tail dropseed | Grass | TG,RED |
| Mushenzhe | <i>Hyperthelia dissolute</i> | yellow thatching grass | Grass | TG |
| Mahundwi | <i>Hyparrhenia tamba</i> | blue thatching grass | Grass | TG |
| Madadasenga | <i>Cymbopogon caesius</i> | Thatching grass | Grass | TG, RED |
| Muhiri | <i>Hemarthria altissima</i> | Swamp couch | Grass | TG |
| Tshidzima | <i>Andropogon gayanus</i> | blue grass | Grass | TG |
| Lureakhovhe | <i>Hyparrhenia hirta</i> | common thatching grass | Grass | TG |
| Dethenya | <i>Andropogon huillensis</i> | large silver grass | Grass | TG |
| Tshinukhwa | <i>Schizachyrium sanguineum</i> | red autum grass | Grass | TG |
| Ludangombe | <i>Trachypogon spicatus</i> | giant spear grass | Grass | TG |
| Rambaza | <i>Melinis repens</i> | natal red top | Grass | TG |
| Ndangwa | <i>Heteropogon contortus</i> | Spear grass | Grass | TG |
| Lukamadi | | | Grass | TG |
| Hatsi ha tshiulu | <i>Hyparrhesia dregeana</i> | Tambuki grass | Grass | TG |
| Tshidavhula | <i>Themeda triandra</i> | Red grass | Grass | TG |
| Mufhafha | | | Grass | TG |
| Dangulamukumbi | <i>Eragrostis curvula</i> | weeping grass | Grass | TG,FOD |
| Dzhesi | <i>Isolepis antarctica</i> | | Grass | TG, RED |
| Bungushui | <i>Hyparrhesia filipendula</i> | Thatching grass | Grass | TG |

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|-------------------|-------------------------------|----------------|-----------|----------------|---------|
| Thanga | <i>Arundo donax</i> | | | Grass | TG, RED |
| Matanga a luvhule | <i>Pennisetum glautum</i> | African millet | | Grass | TG |
| Mutate | <i>Cyperus sexangularis</i> | Star edge | | Grass | RED |
| Ngoyo | <i>Cyperus rotundus</i> | | | Grass | RED |
| Tsitsi | <i>Themeda triandra</i> | | | Grass | RED |
| Muhiri | <i>Combretum imberbe</i> | Leadwood | | Grass | TG |
| Sereni | <i>Cynodon nlemfuensis</i> | | | Grass | FOD |
| Thangunga | <i>Hyparrhenia cymbaria</i> | boat grass | thatching | Grass | FOD |
| Matanga | <i>Phragmites mauritianus</i> | | | Grass | FOD |
| Ngowa ngowa | | | | Stem | MR |
| Vhufilifindi | | | | Stem | MR |
| Ngowa ndenya | | | | Stem | MR |
| Ngowa mpengo | | | | Stem | MR |
| Ngowa ngwana | | | | Stem | MR |
| Ngowa tshiulu | | | | Stem | MR |
| Ngowa tsekene | | | | Stem | MR |
| Ngowa vhukuma | | | | Stem | MR |
| Ngowa tshitanda | | | | Stem | MR |
| Mukokoroshi | | | | Stem, branches | POL |
| Vhukumbe | | | | Stem, branches | POL |
| Mushadzhavha | | | | Stem, branches | POL |
| Muumo | <i>Ficus craterostoma</i> | Bastard natal | | Stem, branches | WC |

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| Mulelu | <i>Albizia tanganyicensis</i> | Sneezewood | Stem, branches | WC |
| Munii | <i>Hexalobus monopetalus</i> | Shakam-plum | Stem, branches | WC |
| Mudulu | <i>Balanites maughamii</i> | | Stem, branches | WC,RED,WU |
| Mukudubu | <i>Rothmannia capensis</i> | Wild gardenia | Stem, branches | WC |
| Mutondwa | <i>Cephalanthus natalensis</i> | | Stem, branches | WC |
| Mutulungwa | | | Stem, branches | WC |
| Mukonde | <i>Euphorbia ingens</i> | | Stem, branches | WC |

FW-firewood, MP- medicinal plants, WV- wild vegetables, EI- Edible insects, EF- edible fruits, WU- wood utensils, WC- wood carvings, RED- reeds, MR- mushrooms, TG- thatch grass, POL-poles, FOD- fodder

Questionnaires



RHODES UNIVERSITY

Department of Environmental Science, Makhanda 6140 South Africa

Research Questionnaire

Dear respondent,

My name is Takalani Rachel Mulaudzi a Postgraduate student in Environmental Science. The following is a research questionnaire on “Factors influencing the number of Non-Timber Forest Product (NTFP) species used at a household scale” which requires your response to all items with sincerity. There are no right or wrong answers, so answer freely. Be rest assured that all information will be treated with utmost confidentiality and will be used for research purpose only. To complete this questionnaire, it will take only 30-60 minutes of your time. Participation is voluntary, and you are free to withdraw at any point or not answer certain questions. Do not write your name or any other form of identification on the questionnaire to maintain the anonymity. When the study is complete, you will be provided with the results, provided you request for the findings.

If you have any enquiries, do not hesitate to contact Prof C.M Shackleton (my supervisor) on his office telephone no: +27 (046)-603-7001

Thank you for your cooperation.

The main objective of this study is to determine the factors influencing the number of NTFP species at a household scale.

Village name..... Date...../...../.....

Household number.....

SECTION A: ABOUT NTFPs AND NUMBER OF NTFP SPECIES

Firewood:

1. Do you or your household use firewood? (a). Yes [] (b). No []
2. If yes how do you usually obtain it? (a). collect [] (b). buy [] (c). both []
3. Approximately how many times a week or month do you collect/buy it?
 >>In rainy season >>In dry season
4. If collected, who in the household is most responsible for collecting it?

5. What purpose do you use firewood for? (a). domestic use [] (b). commercial [] (c). Both []
6. Where do you harvest/extract firewood?
7. How do you get there? (a). car [] (b). feet [] (c). other(specify)
8. Can you please list the names of any firewood species that you/your household uses, it doesn't matter if it is often or rarely.

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9. Did you use to use other firewood species in the past, say 10-15 years ago, that are no longer used? Yes [] No []

10.If yes, please tell me the names of those species

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11.Is the number of firewood species that you use changing in the environment for the past 10-15 years ago? Yes [] No []

12.If yes, it is increasing or decreasing?

13.Why is it increasing or decreasing? >>overuse [] >>clear fell land for farming[] >>climate change [] >>traditional council ban [] >>other

14.Are there any other firewood species that you know about but you/your household does not use? Yes [] No []

15.If yes, please tell me the names of those species

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16. Who in your household do you think knows the highest number of different firewood species?

Medicinal plants:

1. Do you or your household use medicinal plants? (a). Yes [] (b). No []

2. If yes how do you usually obtain it? (a). collect [] (b). buy [] (c). both []

3. Approximately how many times a week or month do you collect/buy it?

>>In rainy season >>In dry season

4. If collected, who in the household is most responsible for collecting it?

.....

5. What purpose do you use medicinal plants for? (a). domestic use [] (b). commercial [] (c). Both []

6. Where do you harvest/extract medicinal plants?

7. How do you get there? (a). car [] (b). feet [] (c). other(specify)

8. Can you please list the names of any medicinal plants species that you/your household uses, it doesn't matter if it is often or rarely.

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9. Did you use to use other medicinal plants species in the past, say 10-15 years ago, that are no longer used? Yes [] No []

10.If yes, please tell me the names of those species

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11.Is the number of medicinal plants species that you use changing in the environment for the past 10-15 years ago? Yes [] No []

12.If yes, it is increasing or decreasing?

13.Why is it increasing or decreasing? >>overuse [] >>clear fell land for farming[] >>climate change [] >>traditional council ban [] >>other

14.Are there any other medicinal plants species that you know about but you/your household does not use? Yes [] No []

15.If yes, please tell me the names of those species

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16. Who in your household do you think knows the highest number of different medicinal plants species?

Wild vegetables:

1. Do you or your household use wild vegetables? (a). Yes [] (b). No []

2. If yes how do you usually obtain it? (a). collect [] (b). buy [] (c). both []

3. Approximately how many times a week or month do you collect/buy it?

>>In rainy season >>In dry season

4. If collected, who in the household is most responsible for collecting it?

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5. What purpose do you use wild vegetables for? (a). domestic use [] (b). commercial [] (c). Both []

6. Where do you harvest/extract wild vegetables?

7. How do you get there? (a). car [] (b). feet [] (c). other(specify)

8. Can you please list the names of any wild vegetables species that you/your household uses, it doesn't matter if it is often or rarely.

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9. Did you use to use other wild vegetables species in the past, say 10-15 years ago, that are no longer used? Yes [] No []

10.If yes, please tell me the names of those species

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11.Is the number of wild vegetables species that you use changing in the environment for the past 10-15 years ago? Yes [] No []

12.If yes, it is increasing or decreasing?

13.Why is it increasing or decreasing? >>overuse [] >>clear fell land for farming[] >>climate change [] >>traditional council ban [] >>other

14.Are there any other wild vegetables species that you know about but you/your household does not use? Yes [] No []

15.If yes, please tell me the names of those species

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16. Who in your household do you think knows the highest number of different wild vegetables species?

Edible insects:

1. Do you or your household use edible insect? (a). Yes [] (b). No []

2. If yes how do you usually obtain it? (a). collect [] (b). buy [] (c). both []

3. Approximately how many times a week or month do you collect/buy it?

>>In rainy season >>In dry season

4. If collected, who in the household is most responsible for collecting it?

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5. What purpose do you use edible insect for? (a). domestic use [] (b). commercial [] (c). Both []

6. Where do you harvest/extract edible insect ?

7. How do you get there? (a). car [] (b). feet [] (c). other(specify)

8. Can you please list the names of any edible insect species that you/your household uses, it doesn't matter if it is often or rarely.

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9. Did you use to use other edible insect species in the past, say 10-15 years ago, that are no longer used? Yes [] No []

10.If yes, please tell me the names of those species

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11.Is the number of edible insect species that you use changing in the environment for the past 10-15 years ago? Yes [] No[]

12.If yes, it is increasing or decreasing?

13.Why is it increasing or decreasing? >>overuse [] >>clear fell land for farming[] >>climate change [] >>traditional council ban [] >>other

14.Are there any other edible insect species that you know about but you/your household does not use? Yes [] No []

15.If yes, please tell me the names of those species

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16. Who in your household do you think knows the highest number of different edible insect species?

Edible fruits:

1. Do you or your household use edible fruits? (a). Yes [] (b). No []

2. If yes how do you usually obtain it? (a). collect [] (b). buy [] (c). both []

3. Approximately how many times a week or month do you collect/buy it?

>>In rainy season >>In dry season

4. If collected, who in the household is most responsible for collecting it?

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5. What purpose do you use edible fruits for? (a). domestic use [] (b). commercial [] (c). Both []

6. Where do you harvest/extract edible fruits?

7. How do you get there? (a). car [] (b). feet [] (c). other(specify)

8. Can you please list the names of any edible fruits species that you/your household uses, it doesn't matter if it is often or rarely.

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9. Did you use to use other edible fruits species in the past, say 10-15 years ago, that are no longer used? Yes [] No []

10.If yes, please tell me the names of those species

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11.Is the number of edible fruits species that you use changing in the environment for the past 10-15 years ago? Yes [] No[]

12.If yes, it is increasing or decreasing?

13.Why is it increasing or decreasing? >>overuse [] >>clear fell land for farming[] >>climate change [] >>traditional council ban [] >>other

14.Are there any other edible fruits species that you know about but you/your household does not use? Yes [] No []

15.If yes, please tell me the names of those species

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16. Who in your household do you think knows the highest number of different edible fruits species?

Wooden utensils:

1. Do you or your household use wood utensils? (a). Yes [] (b). No []

2. If yes how do you usually obtain it? (a). collect [] (b). buy [] (c). both []

3. Approximately how many times a week or month do you collect/buy it?

>>In rainy season >>In dry season

4. If collected, who in the household is most responsible for collecting it?

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5. What purpose do you use wood utensils for? (a). domestic use [] (b). commercial [] (c). Both []

6. Where do you harvest/extract wood utensils?

7. How do you get there? (a). car [] (b). feet [] (c). other(specify)

8. Can you please list the names of any wood utensils species that you/your household uses, it doesn't matter if it is often or rarely.

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9. Did you use to use other wood utensils species in the past, say 10-15 years ago, that are no longer used? Yes [] No []

10.If yes, please tell me the names of those species

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11.Is the number of wood utensils species that you use changing in the environment for the past 10-15 years ago? Yes [] No []

12.If yes, it is increasing or decreasing?

13.Why is it increasing or decreasing? >>overuse [] >>clear fell land for farming[] >>climate change [] >>traditional council ban [] >>other

14.Are there any other wood utensils species that you know about but you/your household does not use? Yes [] No []

15.If yes, please tell me the names of those species

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16. Who in your household do you think knows the highest number of different wood utensils species?

Thatch grass:

1. Do you or your household use thatch grass? (a). Yes [] (b). No []

2. If yes how do you usually obtain it? (a). collect [] (b). buy [] (c). both []

3. Approximately how many times a week or month do you collect/buy it?

>>In rainy season >>In dry season

4. If collected, who in the household is most responsible for collecting it?

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5. What purpose do you use thatch grass for? (a). domestic use [] (b). commercial [] (c). Both []

6. Where do you harvest/extract thatch grass ?

7. How do you get there? (a). car [] (b). feet [] (c). other(specify)

8. Can you please list the names of any thatch grass species that you/your household uses, it doesn't matter if it is often or rarely.

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9. Did you use to use other thatch grass species in the past, say 10-15 years ago, that are no longer used? Yes [] No []

10.If yes, please tell me the names of those species

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11.Is the number of thatch grass species that you use changing in the environment for the past 10-15 years ago? Yes [] No[]

12.If yes, it is increasing or decreasing?

13.Why is it increasing or decreasing? >>overuse [] >>clear fell land for farming[] >>climate change [] >>traditional council ban [] >>other

14.Are there any other thatch grass species that you know about but you/your household does not use? Yes [] No []

15.If yes, please tell me the names of those species

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16. Who in your household do you think knows the highest number of different thatch grass species?

Poles:

1. Do you or your household use poles? (a). Yes [] (b). No []

2. If yes how do you usually obtain it? (a). collect [] (b). buy [] (c). both []

3. Approximately how many times a week or month do you collect/buy it?

>>In rainy season >>In dry season

4. If collected, who in the household is most responsible for collecting it?

.....

5. What purpose do you use poles for? (a). domestic use [] (b). commercial []

(c). Both []

6. Where do you harvest/extract poles?

7. How do you get there? (a). car [] (b). feet [] (c). other(specify)

8. Can you please list the names of any pole species that you/your household uses, it doesn't matter if it is often or rarely.

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9. Did you use to use other pole species in the past, say 10-15 years ago, that are no longer used? Yes [] No []

10.If yes, please tell me the names of those species

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11.Is the number of pole species that you use changing in the environment for the past 10-15 years ago? Yes [] No []

12.If yes, it is increasing or decreasing?

13.Why is it increasing or decreasing? >>overuse [] >>clear fell land for farming[] >>climate change [] >>traditional council ban [] >>other

14.Are there any other poles species that you know about but you/your household does not use? Yes [] No []

15.If yes, please tell me the names of those species

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16. Who in your household do you think knows the highest number of different poles species?

Mushrooms:

1. Do you or your household use mushroom? (a). Yes [] (b). No []

2. If yes how do you usually obtain it? (a). collect [] (b). buy [] (c). both []

3. Approximately how many times a week or month do you collect/buy it?

>>In rainy season >>In dry season

4. If collected, who in the household is most responsible for collecting it?

.....

5. What purpose do you use mushroom for? (a). domestic use [] (b). commercial [] (c). Both []

6. Where do you harvest/extract mushroom?

7. How do you get there? (a). car [] (b). feet [] (c). other(specify)

8. Can you please list the names of any mushroom species that you/your household uses, it doesn't matter if it is often or rarely.

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9. Did you use to use other mushroom species in the past, say 10-15 years ago, that are no longer used? Yes [] No []

10.If yes, please tell me the names of those species

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11.Is the number of mushroom species that you use changing in the environment for the past 10-15 years ago? Yes [] No []

12.If yes, it is increasing or decreasing?

13.Why is it increasing or decreasing? >>overuse [] >>clear fell land for farming[] >>climate change [] >>traditional council ban [] >>other

14.Are there any other mushroom species that you know about but you/your household does not use? Yes [] No []

15.If yes, please tell me the names of those species

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16. Who in your household do you think knows the highest number of different mushroom species?

Fodder:

1. Do you or your household use fodder? (a). Yes [] (b). No []

2. If yes how do you usually obtain it? (a). collect [] (b). buy [] (c). both []

3. Approximately how many times a week or month do you collect/buy it?

>>In rainy season >>In dry season

4. If collected, who in the household is most responsible for collecting it?

.....

5. What purpose do you use fodder for? (a). domestic use [] (b). commercial []

(c). Both []

6. Where do you harvest/extract fodder?

7. How do you get there? (a). car [] (b). feet [] (c). other(specify)

8. Can you please list the names of any fodder species that you/your household uses, it doesn't matter if it is often or rarely.

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9. Did you use to use other fodder species in the past, say 10-15 years ago, that are no longer used? Yes [] No []

10.If yes, please tell me the names of those species

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11.Is the number of fodder species that you use changing in the environment for the past 10-15 years ago? Yes [] No []

12.If yes, it is increasing or decreasing?

13.Why is it increasing or decreasing? >>overuse [] >>clear fell land for farming[] >>climate change [] >>traditional council ban [] >>other

14.Are there any other fodder species that you know about but you/your household does not use? Yes [] No []

15.If yes, please tell me the names of those species

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16. Who in your household do you think knows the highest number of different fodder species?

Wood for carvings:

1. Do you or your household use wood carvings? (a). Yes [] (b). No []

2. If yes how do you usually obtain it? (a). collect [] (b). buy [] (c). both []

3. Approximately how many times a week or month do you collect/buy it?

>>In rainy season >>In dry season

4. If collected, who in the household is most responsible for collecting it?

.....

5. What purpose do you use wood carvings for? (a). domestic use [] (b). commercial [] (c). Both []

6. Where do you harvest/extract wood carvings?

7. How do you get there? (a). car [] (b). feet [] (c). other(specify)

8. Can you please list the names of any wood carvings species that you/your household uses, it doesn't matter if it is often or rarely.

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9. Did you use to use other wood carvings species in the past, say 10-15 years ago, that are no longer used? Yes [] No []

10.If yes, please tell me the names of those species

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11.Is the number of wood carvings species that you use changing in the environment for the past 10-15 years ago? Yes [] No []

12.If yes, it is increasing or decreasing?

13.Why is it increasing or decreasing? >>overuse [] >>clear fell land for farming[] >>climate change [] >>traditional council ban [] >>other

14.Are there any other wood carvings species that you know about but you/your household does not use? Yes [] No []

15.If yes, please tell me the names of those species

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16. Who in your household do you think knows the highest number of different wood carvings species?

Reeds for mats, baskets, ropes etc.:

1. Do you or your household use reeds? (a). Yes [] (b). No []

2. If yes how do you usually obtain it? (a). collect [] (b). buy [] (c). both []

3. Approximately how many times a week or month do you collect/buy it?

>>In rainy season >>In dry season

4. If collected, who in the household is most responsible for collecting it?

.....

5. What purpose do you use reeds for? (a). domestic use [] (b). commercial []

(c). Both []

6. Where do you harvest/extract reeds?

7. How do you get there? (a). car [] (b). feet [] (c). other(specify)

8. Can you please list the names of any reeds species that you/your household uses, it doesn't matter if it is often or rarely.

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9. Did you use to use other reeds species in the past, say 10-15 years ago, that are no longer used? Yes [] No []

10.If yes, please tell me the names of those species

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11.Is the number of reeds species that you use changing in the environment for the past 10-15 years ago? Yes [] No []

12.If yes, it is increasing or decreasing?

13.Why is it increasing or decreasing? >>overuse [] >>clear fell land for farming[] >>climate change [] >>traditional council ban [] >>other

14.Are there any other reeds species that you know about but you/your household does not use? Yes [] No []

15.If yes, please tell me the names of those species

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16. Who in your household do you think knows the highest number of different reeds species?

SECTION B: SOCIO ECONOMIC STATUS

- 1. Age:
- 2. Gender: Male [] Female []
- 3. Highest grade/education attained:
- 4. Household size: how many children live here who are under 17 years?
 how many adults live in this household?
- 5. Employment status: Employed [] Unemployed [] Self employed [] Retired []
 Scholar []
- 6. How does this household get income? >>Salaries and wages [] >>farming []
 >>property [] >>government grant [] >>other(specify).....
- 7. Level of income: <R1000 [] R1000-R3000 [] R3000-R5000 []
 R5000> []

Thank you for participating in the questionnaire...