Master's Thesis of Forest Environmental Science

The Contribution of Wild Edible Mushroom to local livelihoods of the Copperbelt province, of Zambia.

잠비아 코퍼벨트(Copperbelt) 주에서 야생 식용버섯이 지역 생계에 미치는 영향 분석

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Abstract

Wild edible mushrooms are distributed widely globally. In Zambia, this important non-timber forest product (NTFPs) is foraged by humans for food and income and contributes substantially to rural livelihoods. As with most NTFPs, there are limited studies on wild edible mushrooms in Zambia in general. The few studies are relatively old (over 20 years) and mostly focused on diversity, ecology, and nutritional analysis. Currently, no studies have documented the importance (collection, consumption, and trade) of wild edible mushrooms to rural livelihoods. The objectives of this study included:

1. To identify the species of wild edible mushrooms foraged and traded on the Copperbelt province of Zambia;
2. To determine the importance of wild edible mushrooms by measuring the level of collection/foraging, consumption, and trade amongst rural households in selected villages on the Copperbelt province of Zambia.
3. To determine the perceived state of wild edible mushroom populations in the wild.

The importance of wild edible mushrooms was investigated through a socio-economic survey, and 220 interviews with rural households were conducted in Mufulira district of Zambia. A total of 16 mushroom types are foraged for food in the study area. The common edible mushroom types in the study area included *Amanita Zambiana, Lactarius kabansus, Lactarius*

gymnocarpus, Cantharellus cibarius, and Termitomyces letestui. A high proportion of the interviewed households were involved in the collection (100%), consumption (100%), and trade (92%) in wild edible mushrooms. The foraging activity is done mostly by women and children, and it took them between 60-119 minutes to reach mushroom hotspots. However, 93% of the interviewed rural households perceived wild edible mushrooms in the wild as declining due to deforestation and forest fires. Household income from mushroom sales in the month of January 2021 ranged from $11.19 in Sakala village to $23.17 in 14 miles village. Research into sustainable utilization of wild edible mushrooms is needed to continue sustaining rural livelihoods and meet the demands of the locals. Forest zoning should be done to set aside production sites, and areas with high diversity and abundance should be identified and prioritized for this.

Keyword: Wild edible mushroom, Local livelihoods, Foraging activity, Interview survey, Zambia.

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List of Abbreviation

ANOVA……Analysis of Variance

CO_2……Carbon dioxide

NWFPs…….Non-Wood Forest Products

FAO……..Food and Agriculture Organisation

UNSD…….United Nations Statistical Division

WCO……....World Custom Organization

CITES……Convention on International Trade in Endangered Species

FRA…….….Forest Resource Assessment

REDD+…….Reduction Emissions from Deforestation and forest Degradation

Chapter 1 Introduction

Forestry is defined as the science and craft of creating, managing, using, conserving, and repairing forests, woodlands, and other associated natural resources to benefit human beings and the environment (SAFnet, 2013). Forestry science comprises several elements: biological, physical, social, political, and managerial sciences (FAO, 2020). Forestry encompasses a wide range of concerns in which multiple-use management is involved. These are landscape and community protection, recreation, provision of timber, wildlife habitat, natural water quality management, erosion control, employment, appealing aesthetic landscapes, biodiversity management, watershed management, and lastly, the ability to hold forests as sinks for atmospheric carbon dioxide (Derby and Stakes, 1981). Globally speaking, we derive several benefits from mitigating climate change, food, and providing a livelihood for humans as examples (Chapter 2). Yet, we cannot sustainably make it (APEC, 2011).

The economic value of the services generated from forests has been estimated to be 16.2 trillion dollars, rendering employment to people. This job opportunity comes in role-playing as many indispensable products such as wood are used to manufacture paper, furniture, energy, and construction purposes. Other products include resins, honey, fruits, the production of medicines, cosmetics, tourism, just a mention a few.

Forests can host a bigger percentage of all terrestrial biodiversity, such as animals, plants, fungi, and bacteria, which provide a vital role in nature and the survival of human beings. This proves that humans and the rest of the environment rely on forests for all medicinal and pharmaceutical ingredients. This also plays a major role in providing clean water and air to attain a good health status.

From the research and findings, it is also evident that absorbing water best occurs through the existence of trees. This improves groundwater, feed springs, and rivers because forests can extract moisture from fog and clouds. In addition, forests regulate the rate of precipitation on a global scale. This is done because forests emit biological particles such as pollen and fungal pollen, containing nuclei of rain droplets and snowflakes. Thus, coastal forests capture moisture from seas and carry it to other or drier places. Forests are, therefore, key factors in climate change issues.

Forest are also referred to as natural cooling systems because they use solar energy to evaporate moisture to cool down the temperature. On the other hand, forests contribute a lot to slowing down global warming because they are termed carbon sinks. This implies that the more we have trees in a particular area, the less carbon dioxide (CO_2) we have in the atmosphere.

Forests also protect all living and non-living organisms from disasters. This is carried out by ensuring that floods are less common during the period of heavy rainfall. More water was absorbed into the soil, unlikely flowing in the river or bare land. However, forest protects us from the risk of landslides, sand storms, and tsunamis, giving a few examples.

Forests benefit us by ensuring that fewer fertile soil particles are carried away during the process of precipitation and soil erosion. This is done because the roots of trees hold nutrients from deep soils to the soil's surface. Plant materials such as leaves also feed the soil and ground-dwelling organisms as they rot and decompose into the soil.

Moreover, forests help us purify the soil, water, and air by getting rid of pollutants such as carbon monoxide, sulfur dioxide, nitrogen dioxide, and finer particles such as dust. Last but not the list forests provide us with food. All macro and micro-organisms rely on food for growth and survival. Hence, animals derive most of their nutrients from the food that is provided or sourced from the forests.

However, to put the non-wood forest products (NFWPs) into perspective, it is very important to consider the relevant and related terms that are interchangeably used to describe the non-wood forest products and services derived from the forest other than timber products. NWFPs provide goods and services which benefit the urban and rural people to a large extent. There are several benefits which are obtained from NWFPs; these include non-timber resources and cultural heritage, miscellaneous forest products, naval stores, forest by-products, natural forest resources, good climatic benefits such as carbon sequestration economic forest products, agricultural forest products, food such as wild fruits just and mention a few.

In addition, the term NWFPs was coined to specifically project the emphasis of non-wood products towards the livelihoods of those who greatly depend on forests and to create a more friendly environmental use of forest products to encourage a more and better balance of the use of forest products to reduce on degradation and deforestation. Thus, the emphasis on promoting NWFPs was first placed on tropical forests in all developing countries and created awareness in temperate and boreal forests in developed countries.

According to the (FAO) United Nations Food and Agriculture (2009), NWFPs include all goods of biological existence apart from wood, which is derived from the forests, other wooded lands, and trees outside the forests. These products include the source of food, feathers and fur, honey, beverages, fuels, forage, animals, birds, medicine, lac, silk, and so many more. Services that forests offer include conservation and recreation aspects. However, in the past few years, there has been a consistent increase in the energy sources such as biofuels, which also fall in the category of NWFPs because they are extracted from natural resources, plantations, farms, and many more. NWFPs are well utilized for subsistence, commercial, industrial, social, cultural, or religious significance.

Mushrooms and truffles are the fleshy and edible part of several species of fungi. They grow either above ground (including on trees) or underneath and are typically found in forests.

Many types of mushrooms are traditionally considered NWFPs, but of those produced and traded, the majority are commercially cultivated species rather than fungi collected in the wild. Although mushrooms and truffles are found worldwide, species that are harvested in significant quantities tend to grow in a limited number of countries, and there is considerable regional variation in the importance of different species and types. Consequently, the availability of data and species covered in national and international statistics is likely to vary between countries and regions.

From the marketing point of view, it is evident that NWFPs have a common challenge in producing goods because of their amounts, versatility, end-use variations, dissimilarities, and resource richness. However, most of the NWFPs are seasonal, which means that one can barely and entirely be specialized on one product; a good example of seasonal NWFPs are wild edible mushrooms. The resource base also varies very much, tends to grow and occur naturally. In comparison, some resources are maybe plantation-based. Moreover, researchers have collectively characterized NWFPs as frequently small in size, consumed domestically by the collectors, often accessible to the poor or rural people, labor-intensive and seldomly require capital input, a few examples of large-scale industrial plantations which capitalize on either primary consumer goods or raw materials which are further processed using non-wood forest resources (Lund, 1998).

In the African context, it is usually required to define NWFPs by the functions and role they play in rural households and livelihood, in agroforestry productions, and community forestry systems. These roles include food production and food security, provision of house construction materials, heath security through medicines accessed from forest products, agricultural and household tools such as cooking sticks, hoes, just to mention a few. In a nutshell, NWFPs are very important in income generations, and this is shown through the

processing of harvesting, processing, and trading in products such as gums, resins, leaves, oils, fruits, as well as eco-tourism aspects, among many others

Recent studies show that NWFPs still form the basis of lives and livelihoods in many parts of the world and play a much more significant role in food and nutrition than previously thought (FAO, 2016; Rowland *et al*., 2016; Ickowitz *et al*., 2014).

For this reason, the FAO Forestry Statistics Programme has taken a renewed interest in addressing the existing data gap on NWFPs to provide a sound evidence base for decision-making regarding their use. As a point of departure, a systematic review of NWFPs in the existing international classification systems used for collecting and disseminating data on production, trade, and economic activities was initiated to improve data collection on NWFPs ultimately. A number of reports, journal articles, working papers, statistical publications, and databases were also reviewed.

Experts were invited over four months (July to October 2016) to provide suggestions to help improve the study through documentation of use of non-wood forest products (central statistical office, 2012). A selection of "major" NWFPs were identified, including edible mushrooms and truffles; forest berries; maple products; edible nuts; bamboo and rattan; cork; bark; latexes; gums and resins; hides; skins and trophies; game meat and edible insects. Although some important product categories were excluded from this initial review, the study should be seen as a first step towards improving data collection on what is an extremely vast category of products.

1.1 Study background

Non-wood forest products (NWFPs) are simply foods, substances, materials and commodities collected from the forests apart from timber. These include fur-bearers, nuts seeds, game animals, sap. oils, foliage, medicinal plant, pollarding, peat, mast, fuelwood, fish, insects, spices and forage (Ministry of forest and range, 2008). Zambia has one of the largest forest resources in the entire Southern African with about 66% of its landcover with forest (Ng'andwe *et al*.,2014). The level of dependence on these NWFPs of most Zambian's population, especially the rural households is very high and the demand is ever rising in terms of production cost and has a great potential to offer a much cheaper and more accessible alternative to livelihood. (Kalaba *et al*.,2013)

However, despite having remarkable potential, there is urgent need for understanding the contribution and value of wild edible mushroom to the rural as well as urban livelihood in Zambia. Hence, this study gives a review of the NWFPs, specifically focusing on wild edible mushrooms. All the information in this paper will be used in line with need to create awareness on the value of wild edible mushroom and sustainable forest management linking national and international efforts.

In fact, indiscriminate collection of valuable forest resources for consumption and trade of products such as charcoal, sawn-timber, fuel-wood is the greatest drivers of deforestation. This also includes issues related to customary land tenure, lack of documentation about forests as well as incompetent institutions are contributing factors which has gradually accelerated deforestations rates in Zambia (Ratnasingma *et al*.,2014). Hence, it is precisely the goal of this study to emphasise on the need to invest in NWFPs (wild edible mushroom) and establishing an equitable sharing of benefits with local communicates are core pre-requites to shift a sustainable forest management. In the context, the implementation of the REDD+ initiatives, which aims at the ability to establish the capacity and technical knowledge on the status of forest through improved monitoring reporting and verification of forest resource's information from a fixed planned command may positively help to reduce or cease the depletion of forest resources especially through sustainable management of all forest products (Ng'andwe *et al*.,2015).

1.2 Statement Of The Problem

Wild edible mushrooms contribute significantly to the socio-economic status of households globally. They have rapidly become the subject of most rising trade businesses locally and internationally. For example, Serbia, a small country found in South East of Europe, has become a great source of massive exportation of the commercial importance of wild mushrooms. In Zambia, the demand for several NWFPs, especially those for food and medicines, increases in urban centres. As members from respective communities migrate to these urban centres, they carry along with their culture and habits.

Recently, there has been a sudden increase in interest in mushroom utilization worldwide. They are considered either taste food or special biochemical compositions, with significant antioxidant compounds, proteins, carbohydrates, lipids, enzymes, minerals, vitamins, and water. These essential components attract more attention as functional health promoters and in the development of drugs and nutraceuticals.

Despite the rapid increase in interest in picking wild mushrooms in both developed and developing countries for use as food and medicinal applications, research indicates that there is scanty documentation of social, economic, and environmental implications meaning that little has been done in the documentation and research of NWFPs especially wild edible mushrooms.

Not surprisingly, according to Sorrenti (2017), the report found that data on international trade and production of NWFPs is partial and not comparable across countries and over time, this is because -forest management are still sectoral, scattered and uncoordinated (Vinya *et al.*2011). A major difficulty for statistics gathering is that NWFPs are often classified under agricultural categories without distinguishing between wild and farmed produce. Nevertheless, many NWFPs – such as maple products, cork, bamboo and rattan, gums, and resins lack

documentation. Thus, wild edible mushrooms in Zambia have not been comprehensively studied and documented Ng'andwe *et al*, 2017

1.3 Justification Of The Problem

Generally speaking, natural resources greatly contribute to the economic, social, and cultural aspects in so many ways. Wild edible mushrooms are among the NWFPs not well documented in many countries, including Tanzania, as examples in this scenario. In fact, mushroom-forming fungi are poorly collected, sparingly studied, and relatively underutilized in many countries.

For example, there is no efficient information on how much is harvested, no market orders and channels, and general awareness regarding the income generation potential and its contribution to food security, except the comprehensive work done by Härkönen; *et al*. (2009), which documented more than 100 species of mushroom in Tanzania and other countries, and Tibuhwa (2009), who documented the Folk taxonomy and use of mushrooms in communities around Ngorongoro and Serengeti National Park, Tanzania; mushroom researches in the country have been generally conducted on the mushroom biology sciences, taxonomy, diversity and the bioactive compounds from mushrooms.

However, it is evident that there is no purposeful effort by the Ministry of Agriculture in Tanzania and many other countries to update the status of mushrooms as a crop. This leads to a lack of documentation and reports on the amount of mushroom produced, harvested, exported, and imported, which would have helped establish the market value chain of mushroom dynamics in the country.

However, wild edible mushroom collection may be viewed as a professional job, requiring long traditional training and acquiring knowledge through experience regardless of

the formal education level. A recent study by Tibuhwa (2009) established that there is a tremendous decline of mycological knowledge with decreasing in age, implying that the traditional mycological knowledge, which basically is the main tool of taxonomy in rural areas, is in danger. Thus, there is a need to properly document this knowledge and promote these groups with mycological knowledge by enhancing them to transmitting it to the new generation. To indigenous people, mushrooms are a source of income and nourishment and contribute largely to their food security and improved livelihood.

Nevertheless, harvesting is the energy spent to gather the mushroom and small buckets and sacs used in carrying harvested mushrooms back home. This fact makes this economic activity of its own kind. Many disadvantaged groups in rural areas, especially older adults, women, and children, see it as a source of quick money because the collection of wild edible mushrooms is seen as a convenient ready-made product for food and selling.

Looking at how mushrooms are intensively collected implies that mushrooms are often an economical alternative for most disadvantaged groups, such as widows with young children or women who are the head of their families. This impression has also been observed in local populations of the rainforest of south Cameroon by Van Dijk *et al*. and established in an ethnomycological review study by Garibay-Orijel *et al*. (2002).

Tanzania is among the developing countries; thus, most of her people, especially those living in rural areas, cannot get an adequate intake of essential food with balanced food rich in essential compounds such as proteins, vitamins, minerals, and essential fatty acids. Wild edible mushrooms have these essential compounds and active substances for human health, including bioactive components including phenols, flavonoids, β-carotene, lycopene β-glucans, and Vitamins.

However, it is well document in FAO reports that undernourishment is a characteristic feature of poverty and a direct violation of a universally recognized human right. Undernourishment poses lots of negative effects to humans, which lead to illness in people, including underweight new born babies, thus face nutritional handicaps that affect their health structure throughout their lives. Thus, Collecting and eating a wild mushroom in rural areas will provide them with a portion of delicious food and a healthy one.

Some low-income families in villages are even more disadvantaged by having insufficient land to produce crops and raise animals. Nevertheless, the available fertile land in some places is kept under rural environment protection agency to protect forest ecosystems, which in turn denies the right of the poor farmers to assess it. This has been causing a lot of conflicts between rural dwellers and the authorities. Among the problem that faces whole seller traders who are mainly wild mushroom collectors is some restriction to get into conserved forests. Mushrooms are fruit bodies of certain groups of fungi. Thus, under normal circumstances, collecting mushroom fruit bodies pose little effect to the fungus itself since only the fruits are being harvested.

Thus, this study calls for good cooperation and general awareness to forest conservers to freely allow mushroom gatherers to collect and use these underutilized resources from the forest, which hardly affects the conserved forest. It is also clear that if communities are allowed to harvest these mushroom resources, they will, in turn, be cooperative in preserving these forests since they will have tangible direct benefits from them, thus reduces community conflicts with environmentalists and forest ecosystem conservers.

Moreover, the study promotes a purposeful awareness to rural dwellers to harvest and utilize these underutilized local resources, providing them nutritious food and an alternative employment opportunity in rural areas, especially to the disadvantaged group's women older

adults. Like any other NWFPs, wild edible fungi more valuable than other NWFP, for example, they protect water catchments and fragile sloping land; they help conserve biodiversity.

The relevance of NWFPs is closely related to the identified three groups according to Chikamai and Tchatat (2004). Firstly, NWFPs are very important to several forest-dwellers and the rural communities who rely on these resources for livelihood support, social and cultural aspects. Secondly, to the urban consumers and lastly, to the traders. A wide range of NWFPs is used directly or as supplements of food. According to (FAO 1995; and Arnold, 1995), NWFPs are used to manufacture household baskets, farm tools, tanning materials, sponges, and brooms. The economic value of NWFPs is the mater key in eradicating poverty. In addition, forest products such as water regulation, climate improvement, and last but not the list, carbon sequestration.

However, research has shown that rural households rely on NWFPs in response to agricultural crop failures and other contingencies that may arise from unsustainably managing resources. For instance, according to Loibooki *et al*. (2002), in the northwest Africa of Tanzania, local people responded to crop failure by massively hunting bush meat for consumption reasons and sales.

Other important services forests are rendering to humanity include processes of the overall regulation of life on earth, the conservation of biodiversity, and, most importantly, gene storage. It is evident that life on earth is possible due to a balanced combination of known gases in the atmosphere, including carbon dioxide (CO_2). With the rapid increase in the development of human activities, the release of CO_2 increases anxiety significantly. This is only solved by the ability of forests to absorb and release carbon dioxide and maintaining the amount of carbon dioxide in the atmosphere (FAO, 1993).

According to Sorrenti (2017), the findings suggest that there is scope to improve data collection by further clarifying terminology and classification issues and strengthening collaboration with the United Nations Statistics Division (UNSD) and the World Customs Organization (WCO), who are responsible for revising the classification of products, as well as with other agencies such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). They also point to the conclusion that no matter how well these methodologies are refined, these figures will only capture a part of the picture, leaving out many products that are traded informally, produced for subsistence, or for cultural purposes. Targeted household surveys are needed to complement these figures and are recommended to capture the full value of NWFPs.

1.4 Main objective

To assess the contribution of wild edible mushrooms on local livelihoods in terms level of consumption, types of wild edible mushrooms found locally, tribes involved in the collection of wild edible mushrooms and trade of wild edible mushrooms in Mufulira, Copperbelt province, Zambia.

1.5 Specific objective

- To identify the species of wild edible mushrooms foraged and traded to know and understand the types of wild edible mushroom, collected, consumed and traded at the local markets.
- To determine the level of collection and consumption of wild edible mushrooms among rural households in selected villages on the Copperbelt province to discover whether or not wild edible mushrooms are important.

1.6 Hypothesis

1.6.1 Null Hypothesis

Wild edible mushrooms do not contribute to the local livelihoods in the Copperbelt province, Zambia.

1.6.2 Alternative Hypothesis

Wild edible mushrooms contribute to the local livelihoods in the Copperbelt province, Zambia.

1.7 Research questions

- What species of wild edible mushrooms are foraged and traded in the Copperbelt province, Zambia?
- To what extent (level of activities and quantities exploited) are wild edible mushrooms consumed and traded among rural households in the Copperbelt of Zambia?

1.8 Significance of the study

This study can greatly contribute to the sustainable management of non-wood forest products, especially wild edible mushrooms adequate management of forest resources. However, this study was deployed mainly due to the spontaneous increase of demand of forests as an effective a way of adapting and mitigating of climate change. This has been the case as a result of increased rates of deforestation and loss of biodiversity.

According to Kasaro *et al.*, (2019) forests play a very significant role in the lives of local communities because they provide us with construction materials, charcoal for cooking, help reduce soil erosion and provide various access to food and medecines as a result of biodiversity. Globally, a gradual attention among policymakers, developing agencies and academics in labouring to understand the associations and how much forests attribute to the human well-

being and survivor (Kalaba, 2014). However, all existing and rising facts all vividly highlight the importance of forest and a sound call for sustainable management of wood and non-wood forest products to eliminate climate change and alleviate poverty at larger.

Chapter 2 Literature review

A forest is an ecosystem dominated by trees through which microclimate, hydrology, soils, nutrient cycling, storage and turnover, biomass creation, and food chain processes reflect the dominance by large, long-lived wood plants (Brockerhoff *et al*., 2008).

According to the United Nations' Global Forest Resource Assessment (FRA 2000), the world has approximately 3,500 million hectares of forest. Half of the world's forest areas, mostly in developing countries, are found in tropical and sub-tropical regions (Stephens and Wagner, 2007). Forests provide valuable resources, such as food, firewood, construction materials, fodder, medicines, and many other things (Noble and Dirzo, 1997).

To maintain a healthy climate, trees and forests often play an important role. They keep clean air and water, avoid erosion and floods, enrich the soil, make habitat for birds, animals, and plants, provide shade, and make our communities beautiful. In addition to this, trees and forests contribute to climate stabilization and climate change mitigation (Bonan, 2008). For forests to continue to provide energy and preserve a healthy environment, they must be well cared for, treated equally, and used wisely in the community (Norden *et al*., 2009).

Forests are a significant source of livelihood (Fig. 2.1). Some international organizations and governments say the greatest damage to forests is caused by poor people who cut down trees to farm or earn their livelihood. The need to survive becomes more important than the need to protect forests when people do not have enough food, jobs, or other essential needs (Sunderlin *et al*., 2005).

Fig. 2.1: Rural people making a living from forest resources. Source: Fassio (2015).

In most developing countries, forests are important for the livelihoods of the local people. Local people rely on forest resources for various products such as fuelwood, building materials, medicine, and food (Langat *et al*., 2016). Internationally, it is estimated that between 1,095 billion and 1,745 billion people depend to varying degrees on forests for their livelihoods, and about 200 million indigenous communities almost entirely depend on forests (Chao, 2012).

In addition, 350 million people living adjacent to dense forests are dependent on them for livelihood and income (Anselin *et al*., 2006). According to Vedeld *et al*. (2007), it is estimated that 20-25% of rural people's income in developing countries is obtained from environmental resources and serves as safety nets in crisis times or during seasonal food shortages (Shackleton and Shackleton, 2004). However, Warner (2000) reviewed that the total contribution of forests and trees to livelihoods is difficult to quantify.

According to Mutumba (2007) a study was conducted to compare the income contribution of forest products such as wild edible mushrooms to farm related products such as livestock

rearing and growing of crops. Results indicated a very high dependency of non-farm activities such as collection of non-wood forest products to any conventional farm activities.

Forest environmental programs may help the local poor people either directly or indirectly through agreements for transfer payments (compensation to local people for externalized benefits). For example, the direct benefits include the preservation of healthy forest habitats to preserve the quantity and efficiency of local forest ecosystems water supply to dwellers (Kassam, 2002) or to sustain or boost on-farm agricultural production through the restoration of fertility in agroforestry systems (Sanchez *et al*., 1997).

Since income alone is inadequate as a poverty criterion, higher incomes are clearly important to the household's economic sustainability (Sunderlin *et al.,* 2005). As a complement to other revenues, income from forest products is often essential. Large numbers of households generate some of their income from selling forest products, mostly on a part-time basis, when farm production is insufficient to ensure food self-sufficiency throughout the year (Ackermann, 2004). The collection of non-wood forest products are often obtained from indigenous forest and other woodlands in rural area for subsistence needs and most importantly income generation (Muimba-Kankolongo *at el.* 2015).

Most of the forest-based income-generating operation is seasonal, for example, certain good may be collected only at certain times of the year, demand or availability of labor may fluctuate seasonally, and forest-based income may contribute to the purchase between harvests of farm inputs or food. According to Byron and Arnold (1999), income from forest products is also used to acquire inputs for other livelihood-contributing operations such as purchasing crops, the recruitment of farm labour, or the production of working capital for trading activities. In the absence of other job opportunities, the rural poor people often produce, process, and sell

forest products, for example, making mats and baskets and selling fuelwood, often as a part-time activity within farming households (Ackermann, 2004).

Food security is an important element of livelihood (Ambrose-Oji, 2003). Forests are the source of various foods that supplement and complement farming, wood fuel for cooking food and boiling water, and a wide variant of traditional medicines and other hygiene products. Most rural households in developing countries, and a large proportion of urban households, are probably dependent on forest plants and animal products to meet some of their nutritional, cooking, and health needs (Byron and Arnold, 1999).

In favour of the value non-wood forest products a number of articles have been reviewed to explain their contribution significantly and all non-consumptive role of forest products has been categorised in terms of eco-tourism whilst social and economic value of non-wood forest products is reviewed under subsistence and commercial perspectives Chikamai *et al*.(2020).

Forests and forestry practices restore, protect, and sustain water quality, watershed health, water flows, and condition (USDA, 2014). The availability and especially the quality of water are highly influenced by forests (Ekhuemelo, 2016). According to Dudley and Stolton (2003), well-controlled natural forests almost always have better quality water, with less sediment and fewer contaminants, than water from other catchments.

Trees and forests play an important role in many ways of minimizing storm water and eliminating or filtering contaminants that would otherwise end up in our waterways. Forests filter and control the flow of water, mainly because of their leafy canopy that intercepts rainfall, slowing its fall to the ground and the forest floor, which acts as a massive sponge, usually absorbing precipitation of up to 45.72 cm (depending on the composition of the soil) before eventually releasing it into natural channels and recharging groundwater (Ekhuemelo, 2016).

The terminology non-wood forest products (NWFPs) and non-timber forest products (NTFPs) are internationally known and sometimes used interchangeably. However, the variety of the goods covered by each group, which should be remembered, varies considerably (Chikamai *et al*., 2009). According to FAO (1999), a working description in which NWFPs have adopted consists of products of biological origin other than wood originating from forests, other forested lands, and trees outside forests. This word excludes all wood. On the other hand, NTFPs provide wood for uses other than timber and thus cover a broader product/resource/service category.

NWFPs have been used by humans and are continuing to play a major role in supporting livelihoods. An analysis shows that three main groups are important to NWFPs (FAO, 1995); rural communities that have historically used these products for subsistence and social and cultural purposes, urban consumers, and traders/product processors whose numbers are growing as urban markets expand in the NWFP sector. In addition, NWFPs play a significant social and cultural role among different groups. For instance, an estimated 105 tonnes of bush plums *(Dacryodes edulis)* and 100 tonnes of eru *(Gnetum africanum and G. buchholzianum)* and exported to Africans living in France and Belgium (Ruiz Pérez *et al*., 1999).

NWFPs contribute greatly to national economic development and foreign exchange in economic terms. According to Shackleton *et al*. (2000), research in Southern Africa found that wild plant resources lead to a household income of U.S. $194,1114 per year. Herbal medicines that reached the international market globally were estimated at U.S. $14 billion in 1996 (SCBD, 2001).

NWFPs contribute significantly to household food security and family nutrition by supplementing family diets (Sunderlin *et al*., 2005). Several NWFPs are also used to improve health through disease prevention and treatment. For vulnerable groups, such as landless people,

women, and children, who mostly come from poor households and live in and around forest areas, forests can become the source of their livelihoods in their daily lives or in times of crisis. Fruits and seeds, nectars and saps, stems and tubers, leaves, twigs, and mushrooms are predominantly tree foods (Simons and Leakey, 2004). Bamboo shoots are typically used as fresh or preserved vegetables in many villages. In local and national markets, bamboo shoots are also on markets.

NWFPs play a very vital role in traditional livelihood and culture in most drylands in the western part of African. These are also important in agriculture and many other food systems and have remained common in rural areas as well as urban areas Carpena *et al.*(2016). According to Kazungu *et al*.(2020) forest areas in both tropical and subtropical areas massively sustain the livelihoods of their inhabitants through acts like subsistence use of wood and non-wood forest products and cash incomes returned from the selling of such products.

For example, in Botswana, Namibia, and parts of South Africa, the Kalahari plant known as devil's claw *(Harpagophytum spp.)* is typically found where livelihood options are very small. As such, its extraction by local communities is necessary for survival. Although NWFPs are essential to food security at the subsistence level, they are often sold for cash (Shackleton and Shackleton, 2004). Fruits, leaves, seeds and nuts, tubers and roots, honey, mushrooms (Fig. 2.2), gum, and sap are forest foods. According to Chupezi *et al*. (2009), these foods are necessary to provide vital vitamins, minerals, carbohydrates, and protein.

In many traditions around the world, wild or domesticated plants are the key medicinal commodities, and sometimes the use of forest medicinal products overlaps with the use of forest food. People add ingredients to foods to enhance the flavour and add healthy tonic. The uses are most often closely related to cultural traditions and often combine traditional and

western medicine (FAO, 1995). Ingredients derived directly from medicinal plants comprise about 25 percent of the medicine prescribed worldwide.

According to Bodegom (2000), the overall economic benefit of drugs derived from plants is estimated at U.S. $43 billion annually. Many of these species, however, are not harvested from natural forests but discovered in cultivated form. While medicinal products are, to a large degree, locally traded products of low monetary value, they play an important role in rural production systems by supplying a significant proportion of the community's health care needs (Langat *et al*., 2016).

In general terms, “mushroom is a macro fungus with a distinctive fruiting body that can be either epigeous or hypogenous and large enough to be seen with naked eyes and picked by hands (Chang, 1989). It is perhaps the most well-known and documented edible forest product (Belcher and Schreckenberg, 2007). Mushrooms have been commonly used as food (Falconer and Koppell, 1990) and very frequently as delicious and nutritious foods (Vinceti *et al*., 2013). Out of the 1.5 million fungi estimated globally, approximately 14,000 described species develop fruiting bodies that are large enough to be considered mushrooms (Chang, 2006). Mushrooms belong to basidiomycetes and ascomycetes with a cell cycle including sexual spore formation and have two phases of development, i.e., the vegetative phase (mycelia) and the reproductive phase (fruit bodies). The fungal spores are situated in a special structure known as the basidium (for Basidiomycetes) or the ascus (for Ascomycetes). In three main stages, the mushroom continues its life cycle, vegetative growth, reproductive growth, and spore production of the mushroom fruit bodies (Gupta *et al.*, 2019).

Fig. 2.2: Different types of mushrooms collected in the forest. Source: Health benefits of Mushrooms (2020).

2.1.1 Mushroom as a source of income

The production of mushrooms offers an opportunity to produce a highly tradable product, contributing to the generation of profits (Ferreira *et al*., 2009). However, due to a weak marketing strategy, most farmers struggle to make money from their mushroom production activities (Beetz and Kustudie, 2004). It is an easy system for manufacturers to sell directly to retailers or even users. However, the mushroom has its own limitations, such as seasonal cultivation and mushroom glut at a specific time. An example, in north India, during the winter months, forces the mushroom to be sold in distress (Gupta *et al*., 2019).

2.1.2 Nutrition in Mushrooms

For decades, edible mushrooms have been commonly used as human food and appreciated in terms of texture, taste, as well as medicinal and tonic properties (Manzi *et al*., 2001). In general, 90 percent water and 10 percent dry matter are found in mushrooms (Carmen Sánchez, 2010). However, mushrooms have a chemical composition that is attractive from a nutritional point of view (Dundar *et al*., 2008). Mushrooms are important in terms of nutrition because they are rich in protein, fibers, and minerals while poor in fats.

The mushroom protein contains all of the nine essential amino acids that human beings need. Due to their high digestibility, mushrooms are considered a possible replacement for muscle protein (Kalač, 2009). In addition, mushrooms are also rich in vitamins B1, B2, B12, C, D, and E (Heleno *et al.*, 2010). They are a relatively good source of nutrients such as phosphorus, iron, and vitamins such as thiamine, riboflavin, ascorbic acid, ergosterol, and niacin (Barros *et al*., 2008). According to Pehrsson *et al*. (2003), fungi are also an excellent source of vitamin D that is not otherwise present in other food supplements.

Mushrooms are low in calories, free of sugar, free of gluten, free of cholesterol, and very low in sodium. However, mushroom fruit bodies are rich in minerals such as potassium, iron, copper, zinc, and manganese. Mushrooms also include ash, glycosides, volatile oils, tocopherol, flavonoids, carotenoids, folates, organic acids, phenolic compounds (Sánchez, 2004). As mushrooms contain many compounds such as unsaturated fatty acids, phenolic compounds, tocopherols, ascorbic acid, and carotenoids, fungi are also essential from a nutraceutical perspective.

The nutritional properties of edible fungi and the health-beneficial effects of their bioactive compounds make mushrooms a safe food (Ferreira *et al*., 2009). Consumers are increasingly interested in bioactive foods that provide human beings with beneficial effects in

health promotion and reduction of disease risk. Mushrooms can be called functional foods that provide health benefits in addition to their nutritional value (Rathee *et al*., 2012).

(I) Proteins and amino acids

The crude protein content of edible mushrooms is generally high but varies considerably and is influenced by factors such as the species and stage of mushroom development (Longvah and Deosthale, 1998). The free amino acid level of mushrooms is typically low in dry edible mushrooms, ranging from 7.14 to 12.3 mg/g, and contributes to the key flavor properties of mushrooms (Maga, 1981). The important mushroom amino acid profiles indicate that the proteins are deficient in amino acids containing sulfur, including methionine and cysteine. However, these edible mushrooms are comparatively rich in valine and threonine (Gupta *et al*., 2019).

(II) Carbohydrates

There are high levels of oligosaccharides in edible mushrooms and just a low percentage of total soluble sugars (Bano and Rajarathnam, 1988). The carbohydrate content of edible mushrooms varies from one species to another and ranges from 35 percent to 70 percent (Mau *et al*., 2001).

(III) Vitamins

Mushroom is a good source of some vitamins, such as riboflavin, niacin, and folate. In mushrooms, the vitamin B2 content is higher than that usually found in vegetables (Mattila *et al*., 2001). Mushrooms contain relatively high folate concentrations, and their bioavailability is as good as that for folic acids (Clifford *et al*., 1991). In addition to riboflavin, niacin, and folate, mushrooms also contain small quantities of vitamin C and vitamin B1, as well as traces of vitamins B12 and D2 (Mattila *et al*., 2001).

(IV) Fatty acids

The amount of fatty acid is usually low in mushrooms at around 2-8 percent of distilled water. Compared to saturated fatty acids, the level of polyunsaturated fatty acids is quite high,

accounting for more than 75 percent of total fatty acids, the most common of which are oleic and linoleic acids. In contrast, palmitic acid is the largest saturated fatty acid (Ribeiro *et al*., 2009).

Chapter 3 Methodology

3.1 The Study Area

The study was conducted in Mufulira district in the Copperbelt province of Zambia (Fig 3.1), a total area of about 1637km^2. Its population was 1,958,623 in the 2010 census (central statistics office, 2010). Of this population it was indicated that 49.7 % were males and 50.3 % were females about 12% of the entire population for the Copperbelt province is for Mufulira district (central statistics office, 2010). Mufulira district has abundant natural and exotic forest products, the common fertile soil, wooded vegetations and a number of water bodies all contribute to the dynamic biodiversity of the district (Kawesha, 2020).

However, the geographical coordinates were along latitude 12º 33' 0.972" and longitude 28º 14' 27". The average minimum temperature is 15.1℃, and the average maximum temperature is 23℃. Meanwhile, the average annual amount of rainfall in Mufulira is about 1268mm (Mtonga, 2018). The general geography and landscape of the Copperbelt Province indicate to support a high potential for the gravity water system, availability of fertile land, and surface water (Shitima, 2005).

The estimated cost of living in Mufulira district is about 66% of the Copperbelt province population of people living below the poverty line whilst to the national an average of 61% poverty in Zambia is more pronounced in rural areas as compared to the urban areas (Central Statistics Office, 2010). Meanwhile, in the year 2010 rural to urban areas poverty rates indicated 78% and 28%, respectively and 60% of the Copperbelt province population is based in rural areas (Central Statistics Office, 2012).

The bemba ethical group largely dominate the Copperbelt province of Zambia with 21% of the country's population, this is followed by the tonga ethical group (14%). Rural households

are commonly under the rule of a village headman and his subordinates such as key farmers. Despite the existence of Mufulira Copper Mine, livelihoods in Mufulira district especially in rural areas depend upon mixed farming with goats, chickens and poultry as well as growing of crops such as maize, groundnuts, cassava, sweet potatoes, millets etc. Typically speaking, a smallholder farmer owns about 1ha to 5ha size of land (Baudeon *et al*.,2007).

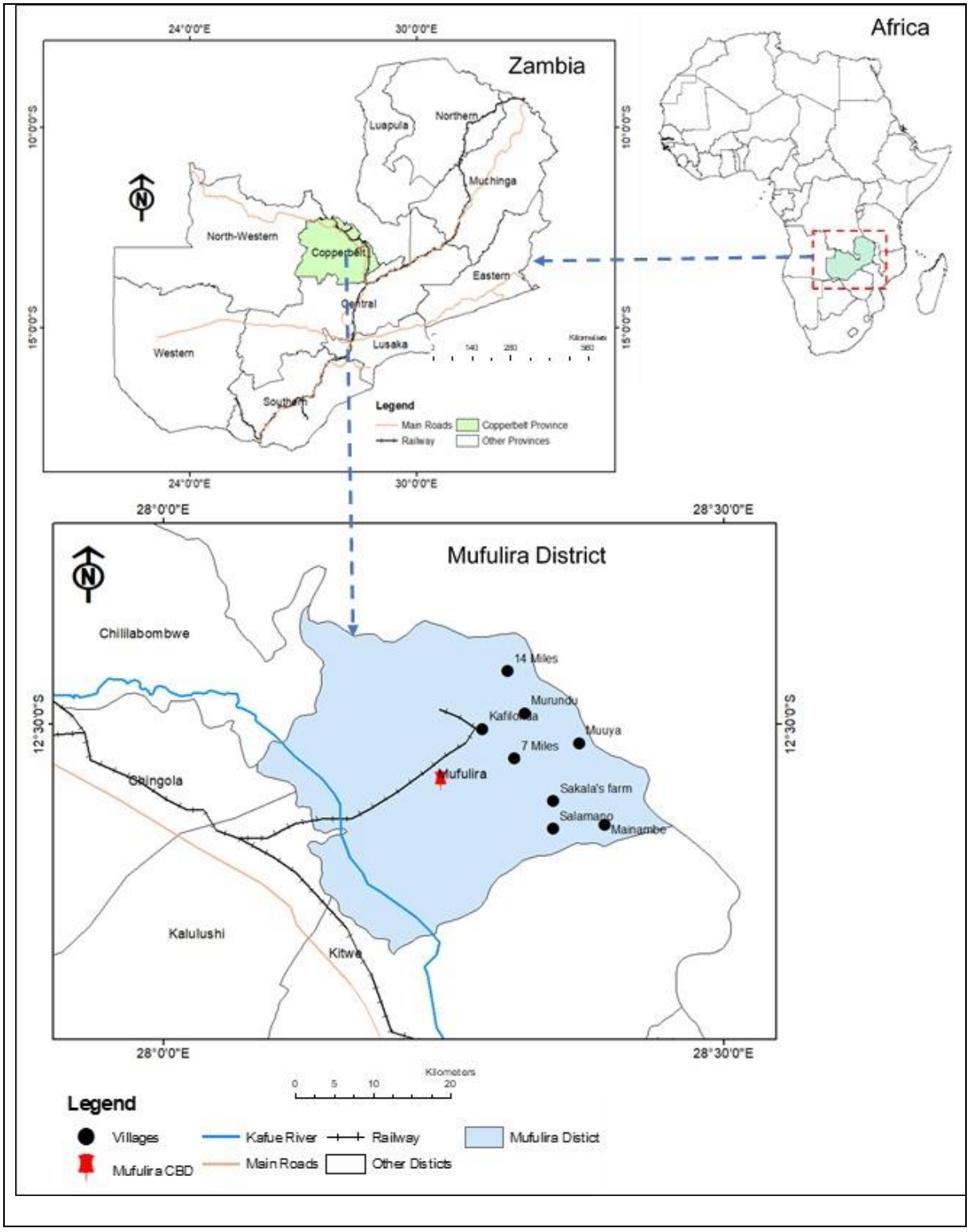

Fig. 3.1The geographical location of Mufulira district on the map of Zambia. The latter indicate the 8 selected villages visited during the rural household survey.

3.2 Data Collection

The illustration below (Fig.3.2) is a summary of the method that was employed to collect data and ensure that the objective of the research was achieved. The study employed interviews with the selected rural households and traders in the targeted local markets and focus group discussions with a sample of 220 respondents. The selected rural areas in Mufulira included were 8 in total; 7 miles, 14 miles, Kafilonda, Minambe, Muuya, Murundu, Salamano, and Sakala's farm.

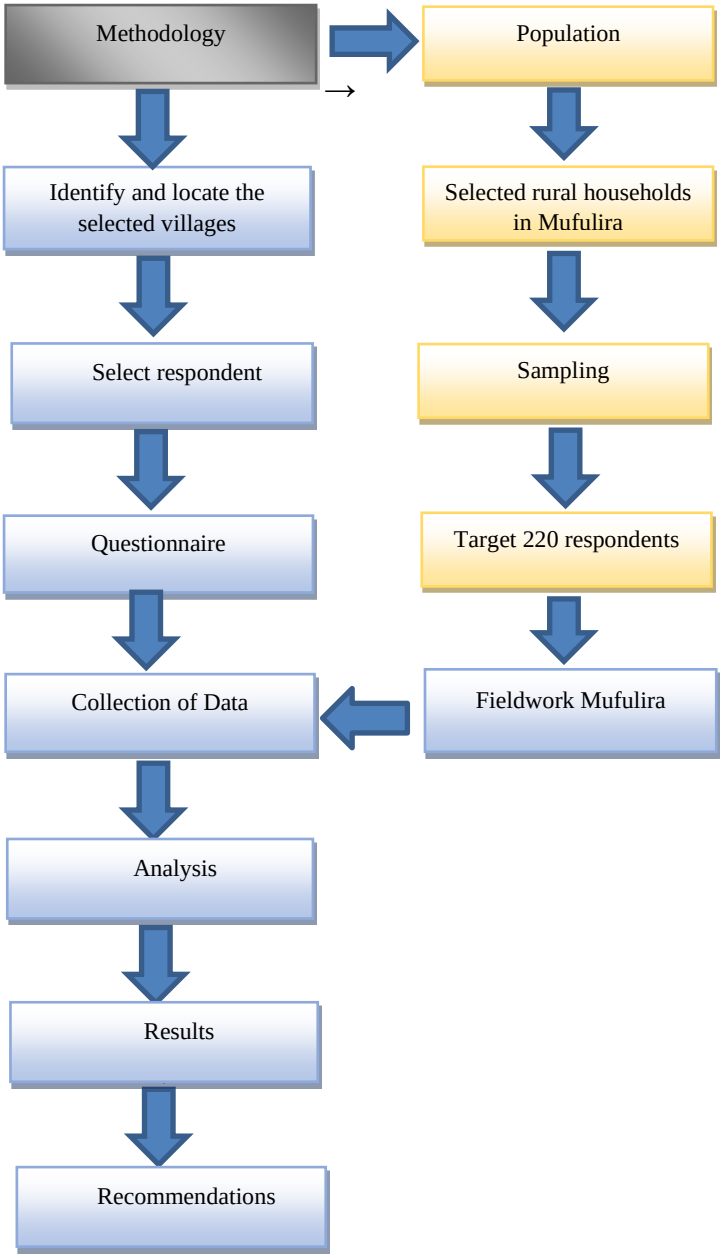

Fig. 3.2 A summary of the data collection strategy used

3.3 Sampling Strategy

However, the research comprised of both descriptive and quantitative-data-gathering approaches. Thus, two structured surveys were conducted. Namely, the household survey determines utilization and consumption and the traders' survey to determine how much income is generated from the wild edible mushroom. At least 220 respondents from rural households across eight selected villages in the Copperbelt province for the household survey were selected. The household survey was aimed to seek information on collection or foraging, consumption, and income from sales of wild edible mushrooms, including the perceived state of the wild population.

The trader's questionnaire was used to seek information on trade value by focusing and projecting on which species is collected and how much income is generated from resales and their value.

Prior to conduct the research informed consent was sought in each village initially and from each research respondent. All interviews and discussions were conducted in the Bemba, the commonly spoken local language and clear interpretations were employed were needed. Each interview lasted about 30 minutes. These, and the records thereof, were very confidential. One structured questionnaire format was used in all 8 selected rural households in Mufulira district of Zambia. Precise discussions were used on sections on household composition, assets and all socioeconomic following the instructions of the University of Reading Research ethics committee(Angelsen and Lund, 2011).

Six field assistants were recruited and trained to facilitate in the data collection and the questionnaire was piloted before finalizing.

3.4 Data Analysis

IBM SPSS (version 24) was used to analyse the results. Descriptive statistics (percentages) were calculated to determine the proportion of households involved in the collection, consuming and trading of wild edible mushrooms: amount of mushroom collected, consumed, and traded were transformed to logarithms, to normalize the data, and analysis of variance was performed to evaluate the effect of village or wealth category on mushroom collection, consumption or trading. Pearson product moment correlations were performed to assess possible associations amongst variables: amount of mushroom collection trips, time taken to reach mushroom hotspots, quantity collected, time taken to harvest all mushrooms, quantity consumed, quantity sold, and income earned.

Relatively activity month-by-month for mushroom and engagement in crop production were determined by each household from a scale of 0 to 10 (no activity [0] to greatest activity [10]: 10 scores). Rural households were surveyed on the value of mushroom sold.

Means and percentages were calculated for market traders' reports of the mean quantity purchased and cost of purchase, and the challenges they encountered, respectively. Data of the mean quantity(kg) and cost purchase (USD) of mushroom were collected. These were converted from local currency Zambian Kwacha at the rate USD 1 = ZMW 22.60.

Focus group discussions were synthesized to identify emerging themes categories. The discussants suggested several drivers of decline in Mushroom populations and were asked to rank these in order of importance.

Chapter 4 Results

4.1 Interviewed villages in Mufulira district

The majority of the 220 rural households interviewed results indicated that most households were female-headed (69.1%) and male (30.9%), respectively. The eight selected rural areas in the Mufulira were 14 miles, 7 miles, Murundu, Minambe, Salamano, Kafilonda, Sakala, and Muuya (Fig.4.1). Murundu recorded the highest number of interviews (28.6%), Minambe (20.0%), Muuya (14.1%), Kafilonda (12.3), while 7miles and Salamona recorded the same number of interviews (7.3%), Sakala with (5.5%). Finally, 14 miles recorded the lowest number of interviews as indicated below (5.0%) respectively.

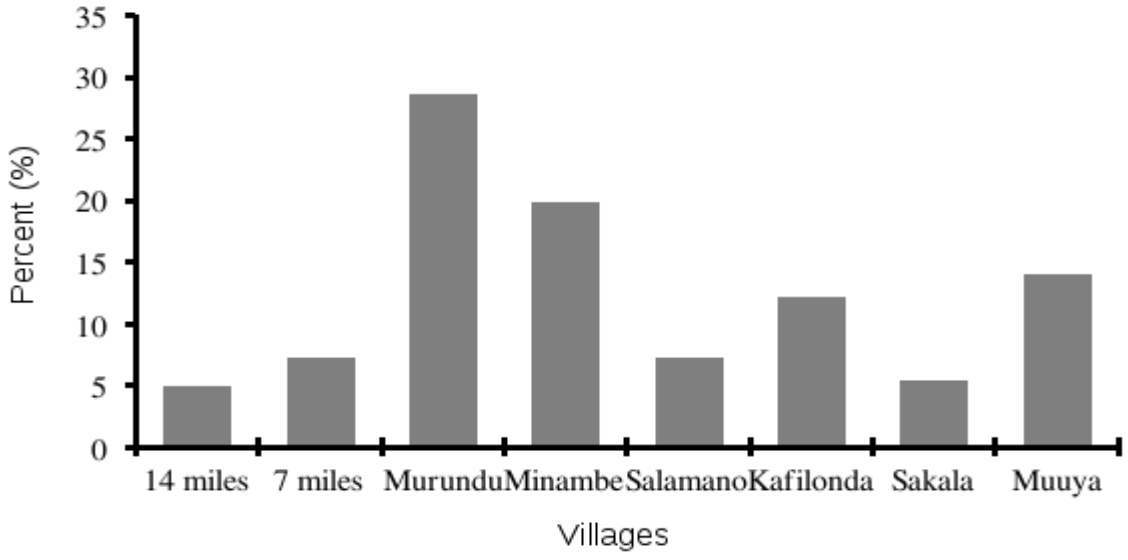

Fig. 4.1: Illustrates the level of participation in the collection of wild edible mushrooms according to selected villages.

4.2 Interviewed Tribes in Mufulira District

Tribes participated in the collection of wild edible mushrooms in Mufulira were Tonga, Nyanja, Bemba, Lozi, Kaonde, Luvale, Kachokwe, Mambwe, and Namwanga (Fig.4.2). The data collected shows that the Bemba tribe participants most collected wild edible mushrooms giving the highest percentage of 75.3%, Nyanja 9.1%, Kaonde 4.6%, Luvale 4.1%, Lozi 2.7%, Tonga 1.8%, Kachokwe 1.4%. Lastly, the Mambwe and Namwanga tribe participate in collecting wild edible mushrooms at the same rate. Thus, 0.5% was the recorded percentage for both tribes.

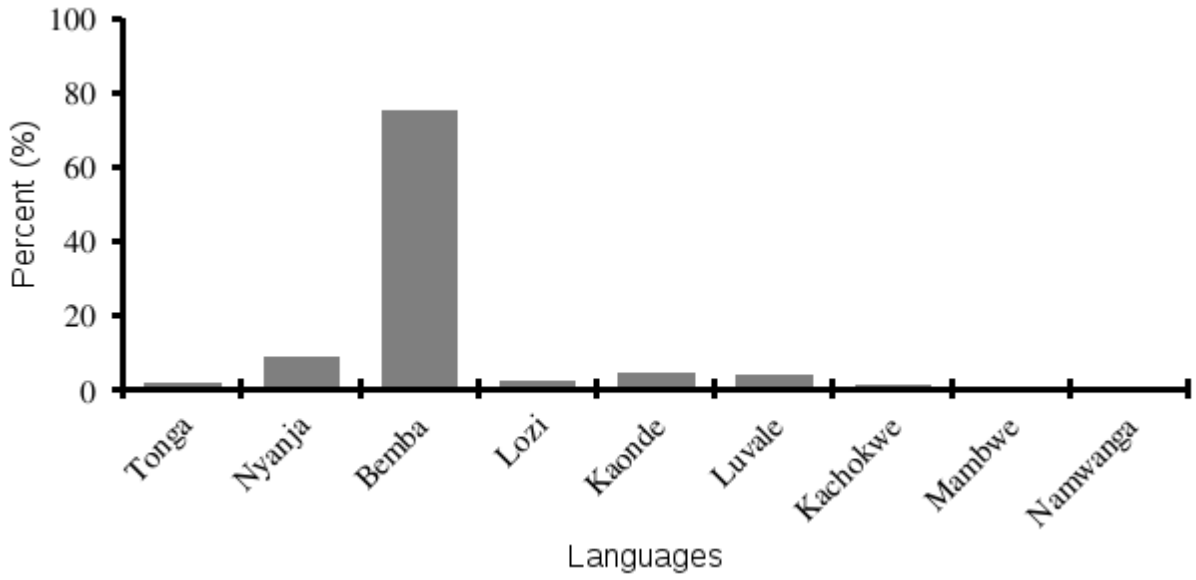

Fig. 4.2: The various types of tribes that collect wild edible mushrooms and their involvement in the activity.

4.3 The Occurrence of each Mushroom in Mufulira District

Mushroom occurrence in the wild coincided with the rainfall pattern, as shown in Fig.43. This coincided with the normal rainfall pattern flow in Zambia, with the average amount of rainfall ranging from November to December. The pattern for wild edible mushroom collected is expected to be similar to other districts of Zambia because of the rainfall pattern. The occurrence pattern for wild edible mushrooms indicated that they highly occur in January. Thus, there is a significant difference in January. There was no significant difference between February and March in mushroom occurrence. From June to September, the rainfall pattern showed that zero or no rainfall was received. This means that no mushroom activity takes place in these months. Meanwhile, in months like May and October, little or few rains are expected, but the mushroom occurrences are very minimal.

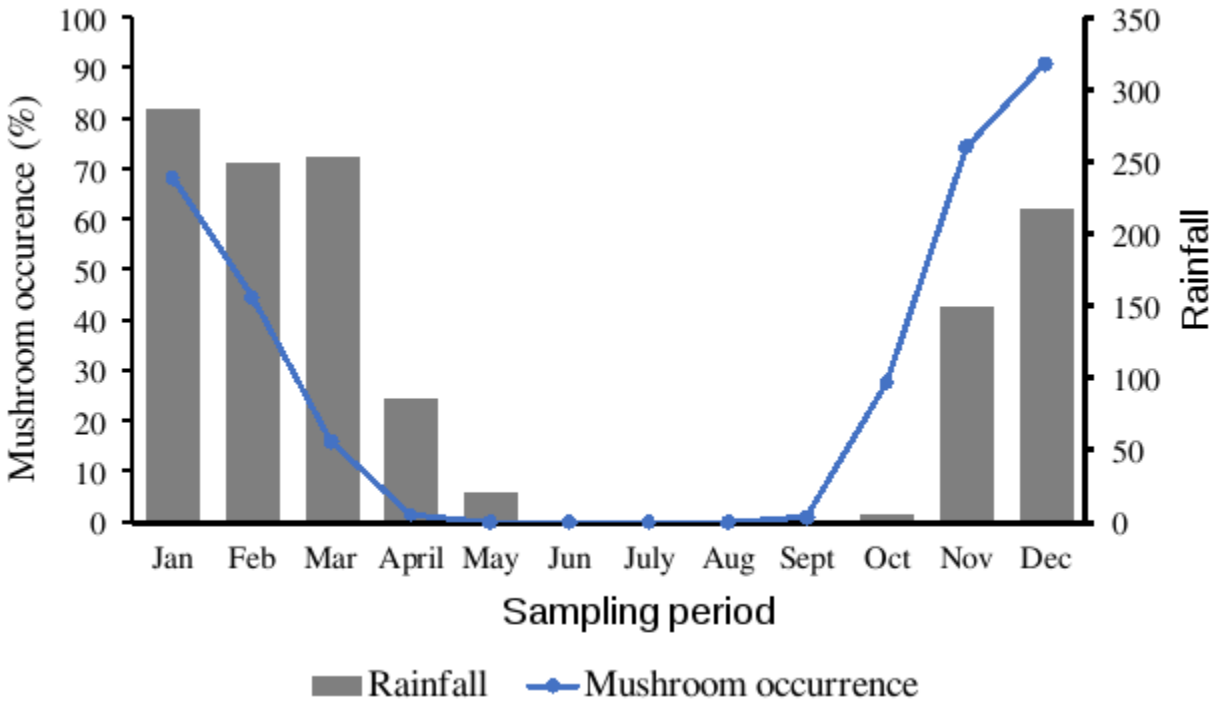

Fig. 4.3: The level of occurrence of wild edible mushrooms in each month.

4.4 The Different types of Mushrooms Collected in Mufulira district

There are various types of wild edible mushrooms, and out of many other types of wild edible mushrooms, only 16 types of wild edible mushrooms were captured in this survey (Fig.4.4). These include Tente, Busefwe. Kabansa, Kasununu, Ichingungwa, Katoto, Kapunda, Munya, Chitondo, Lubosa, Ifikolowa, Ichisuku, Tande, Umusanfu, Ubupukutu and last but not the least Sepa. The five commonly collected mushrooms are Tente 97%, Kabansa 88%, Busefwe 75%, Chitondo 71%, and Katoto 59%. Meanwhile, the least 5 collected wild edible mushrooms include; Ichisuku (8.2%), Umusanfu (3.2%), Sepa (2.7%), Kapunda (2.3%), Kasununu (0.5%), respectively.

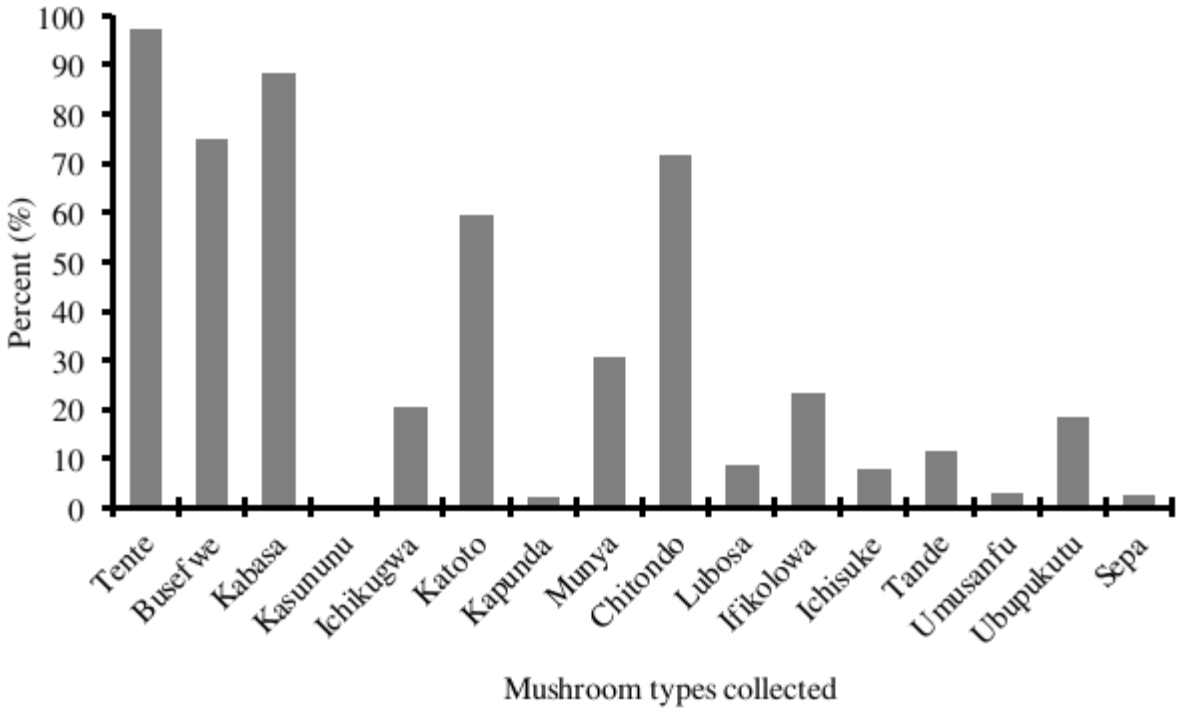

Fig. 4.4: The different types of wild edible mushrooms commonly collected from the interviewed households.

Mushroom name list

Katoto (termitomyces letestui)

Ifikolowa (termitomyces titanicus)

Tente (Amanita Zambiana)

Chitondo (Cantharellus Cibarius)

Kabansa (Lactarius Kabansus)

Umusamfu (Termitomyces Microcarpus)

Busefwe (Lactarius Gymnocarpus)

Sepa (Schizophyllum Commune)

Pumfya (Amanita Species)

Tande (termitomyces species)

Ubumpukutu (Cantharellus Species)

Munya (Lactarius Species)

Fig. 4.5 Illustrating the various types of wild edible mushrooms commonly collected in Mufulira district Source: Health benefits of Mushrooms (2020)

4.5 The Time-taken to reach Wild Edible Mushroom in Hotspot in Mufulira District

The analysis of variance (ANOVA) revealed no significant differences among the villages in time taken to reach forest hotspots for wild edible mushrooms ($F(7,212)=1.34$, $p=0.23$ Fig.4.5). Generally, it takes the mushroom collectors a lot of time to reach mushroom hotspots. It took the collectors about 119±14.78 minutes to reach the furthest mushroom hotspot (7 miles village), and the nearest place took 59±9.89 minutes (Salamano village).

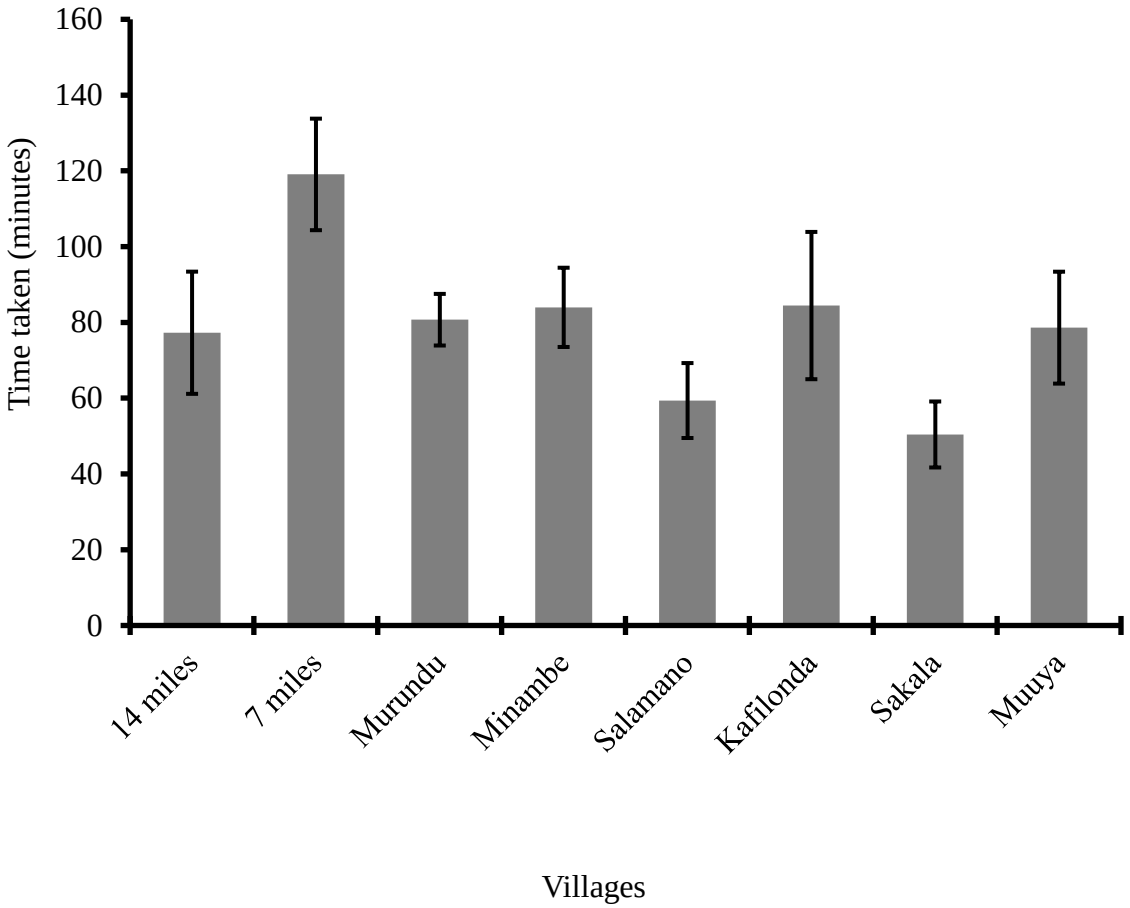

Fig. 4.6: Displays the amount of time it takes for the selected rural villages to reach the hotspot of wild edible mushrooms.

4.6 Level of Involvement in the Collection of Wild Edible Mushrooms in Mufulira District

Mushroom foraging is mostly done by mothers (85%) and often helped by fathers (28.2%), boys (33.6%), and girls (46.8%). Most foragers collect mushrooms from other farmers' forests (75%), with 18.2% and 16.8% of households collecting mushrooms from their own and communal forests (Fig.4.6).

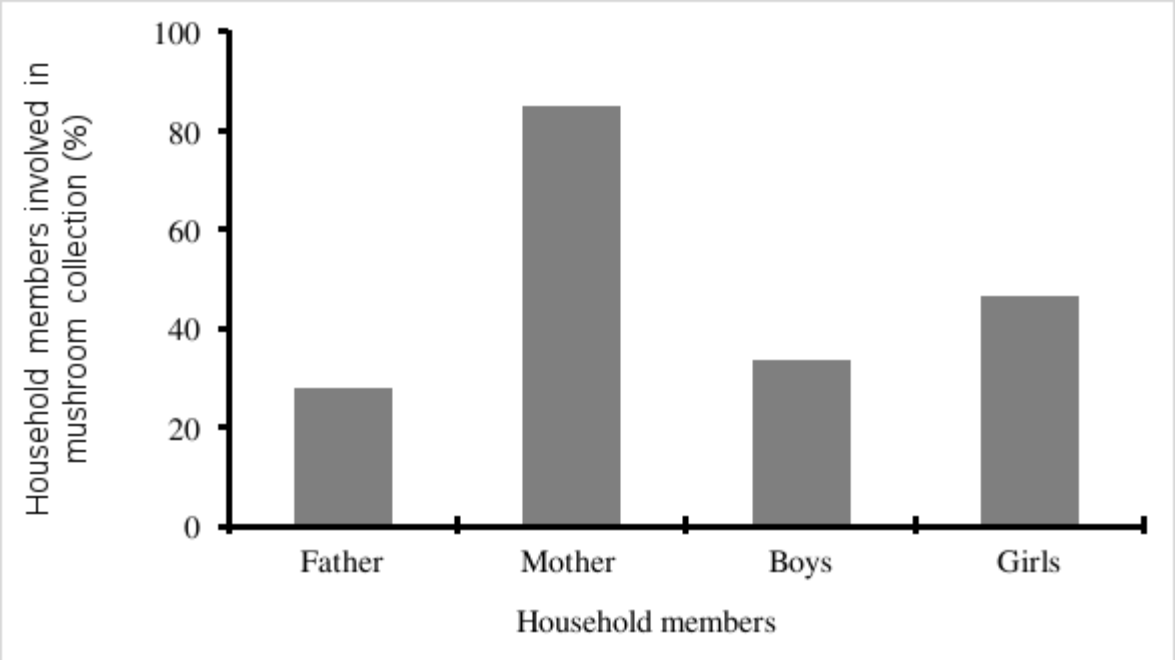

Fig. 4.7: The household members who are mainly involved in the collection of wild edible mushrooms.

4.7 Level of Availability of Wild Edible Mushrooms in Mufulira District

Following the number of households interviewed, it was indicated that the majority of them articulated that the availability of wild edibles mushrooms has greatly reduced with the highest percentage rate of 93.2%, this was followed by the household that stated the availability of wild edible mushroom was still the same (4.1%). On the other hand, some households said the availability of wild edible mushrooms increased with time (2.7%) (Fig4.7).

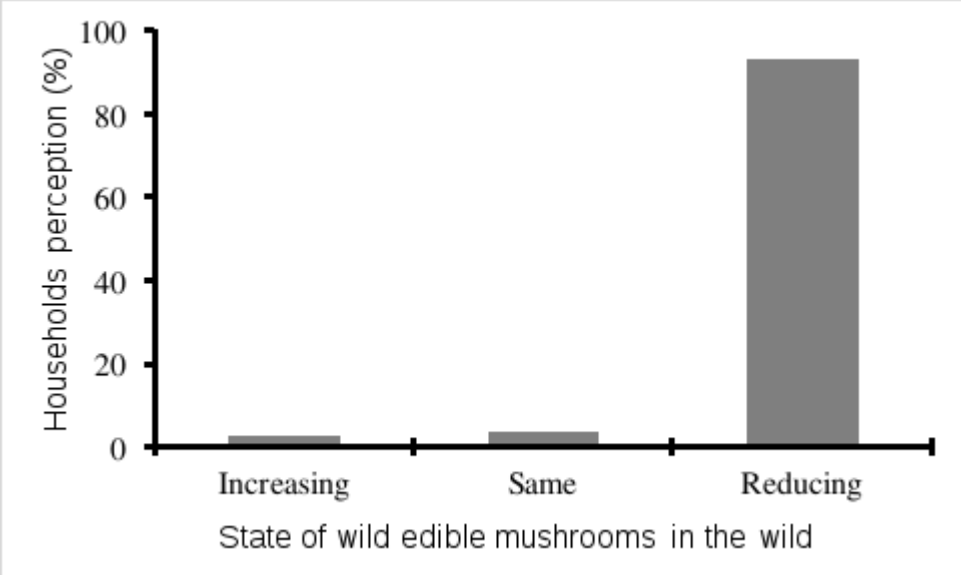

Fig. 4.8: The state of availability of wild edible mushrooms in the Mufulira District

4.8 Factors Contributing to the Decline of Wild Edible Mushrooms in Mufulira District

The preliminary scope of the study indicated several reasons that have led to the decline in the availability of wild edible mushrooms (Fig.4.8). These included; deforestation (83.4%), forest fires (44.9%), local policies (9.3%), over-harvesting (2.0%), construction of houses (1.5%) (Fig.4.8). The results indicated that deforestation and forest fires are the major reasons contributing to the decline in the availability of wild edible mushrooms, whilst construction of houses and over-harvesting are the least leading factors to mushrooms' availability.

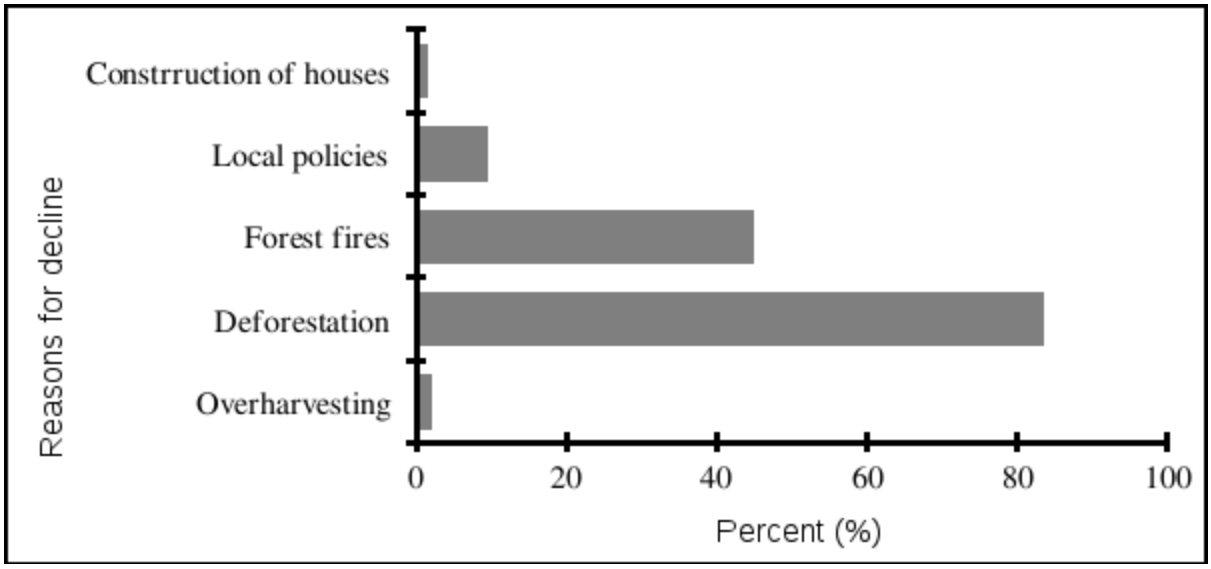

Fig. 4.9: The major factors contributing the availability of wild edible mushrooms.

4.9 Monthly Income from Wild Edible Mushrooms in the Interviewed Villages

All the interviewed rural households (N=220) engage in mushroom foraging. Most of the households (92.3%) do sell part of the foraged mushrooms (Fig.4.9). About 53.5% of the households that engage in trade sell their mushrooms at village markets, 44.1% at districts market, 31% sell to middlemen (traders), and 29.7% sell at roadside markets. Household income from mushroom sales in the month of January 2021 ranged from K252.5±63 in Sakala village to K522.7±130 in 14 miles village. The Analysis of Variance (ANOVA) did not detect any significant differences in the mean income from mushroom sales among villages ($F(7,212)=1.42$, $P=0.20$) and wealth categories ($F(2, 217)=0.55$, $p=0.58$)

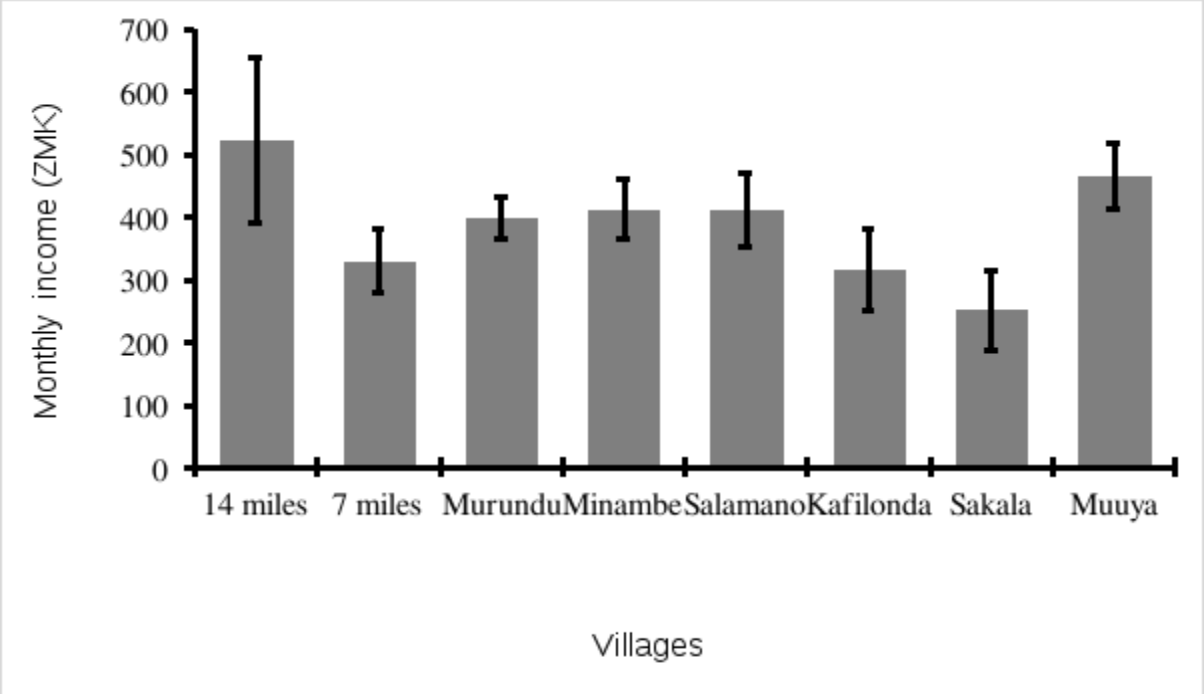

Fig. 4.10: The monthly income gained from wild edible mushroom trade and points of trades.

4.10 Monthly Income for the Three Wealth Categories in Mufulira District

During the household survey, three wealth categories were identified; the rich, intermediate, and the poor (Fig. 4.10). The study reviewed that the class of people categorized as intermediate participate mostly in the trade of wild edible mushrooms because they showed the highest rate of the monthly income generated from trading this non-wood forest product. Meanwhile, there was no significant difference between the rich and poor category about the monthly income generated from the trade of wild edible mushrooms.

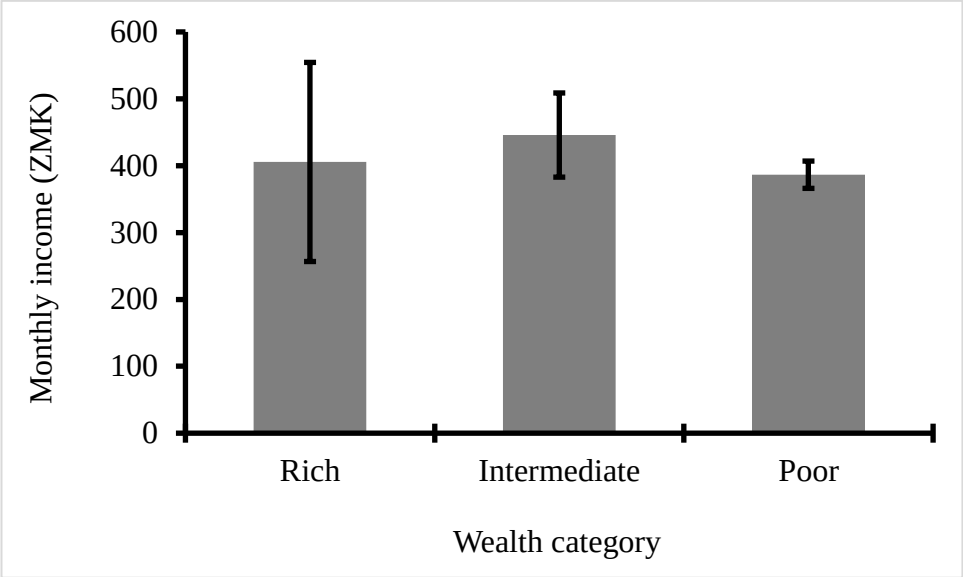

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Fig. 4.11: Monthly income generated from the trade of wild edible mushrooms from 3 wealth categories.

Chapter 5 Discussion

The study revealed high utilization (collection, consumption, and trade) of wild edible mushrooms in the rural Mufulira district. All the interviewed households engaged in the collection/foraging and consume mushrooms. About 92% of households engage in selling part of the collected/foraged wild edible mushrooms.

This current study revealed 16 different mushroom types foraged for food and income in the rural Mufulira district. Pegler and Piearce (1980) found a total of 18 edible mushroom types in Zambia, while Bourdeaux *et al*. (2003) found 47 different wild edible mushrooms in Mpongwe. Wild edible mushrooms are highly sought after in Zambia for their unique taste and nutrition.

The high utilization of wild edible mushrooms in Mufulira corroborates with previous studies on the Copperbelt province, where they demonstrated the important contribution to local diets in the miombo ecoregion (Bourdeaux *et al*., 2003). Kalaba et al. (2013) revealed a similar high trend with about 72% of households interviewed where involved in the collection/foraging of wild edible mushrooms for food and income in the Copperbelt province. They provide vital nutritious food to the local people when rainfed crops are not ready for harvesting. Wild edible mushrooms in Zambia appear during the rainy season. The slight variation in utilization between studies could be due to tradition and culture, where ethnicity plays a bigger role (Kalaba *et al.*, 2013). Wild edible mushroom consumption seems to be highly associated with the Bemba ethnic group in the case of this study.

The contribution of the forestry sector to the general national economy is usually quantified in terms of the gross domestic products and from other factors such as export revenue, rate of employment creation and state of the industry. According to (Ng'andwe *et*

al.,2015) non-wood forest products and wood products contribute a lot to the household's food security and income generation in response to poverty alleviation.

A review by (Ratnasingam *et al*. 2014) indicates that Zambia has the largest forest resources in the entire southern Africa with approximately 66% of its land mass is under forest cover. Nevertheless, unsustainable harvesting of various valuable timber resources such as sawn-timber, charcoal and edible products are the major drivers to deforestation. However, other disputes occur as a result of customary-lands, land tenure, lack of documentations on usefulness of forest resources including weak consultancy institutions are major contributing factors that have speed the causes of deforestation in the Zambia. Thus, there is need to invest in forest product resources by structuring equal sharing of benefits with all local dwellers should be viewed as pre-requites to jump into higher value-added manufacturing of all forest products.

The high proportion of households involved in the collection, consumption, and trade in wild edible mushrooms agree with studies on edible non-timber forest products, which are a common feature of rural livelihoods and heavily depended on by rural households in most developing countries (Bakkegaard et al., 2017; Heaubach et al., 2011; Kalaba et al., 2013; Paumgarten and Shackleton 2009; Shelef et al., 2017). For example, Zulu et al. 2019 found high utilization of wild edible yam *Dioscorea hirtiflora* among rural households in southern Zambia, with over 80% collecting and consuming the wild tuber.

Wild edible mushrooms are highly prized in the Copperbelt province of Zambia. They are a highly prized delicacy and are a common feature along roadsides and in local markets (Pegler and Vanaecke, 1994), where they fetch a good price.

The local knowledge of wild edible mushrooms in Mufulira in the Copperbelt province of Zambia was considerable, respondents possessed considerable depth of knowledge about

the subject; most interviewed rural households knew much about the mushrooms even those that maybe termed as poisonous. Some types of mushrooms can be toxic for consumption use (Poomima and Ravishankar, 2009). Thus, there is a document indicating that some wild mushrooms are poisonous but also notes in other part of the world for example West Africa is gathered and eaten and well used for medicinal purposes.

Through discussions local people stated that wild edible mushrooms are not chewed raw but well cooked. Part of the cultural knowledge and inter-generational options identified through discussions that correct identification of wild edible mushrooms must be followed to avoid the collection of other or similar species. A high proportion of rural households across all 8 villages involved in the collection and consumption of wild edible mushrooms noted that wild edible mushroom are highly sought after for energy, ability to blend with other foods and taste very good. There is no evidence in this study indicating that wild edible mushrooms are exploited for anything than what was indicated.

According to (Kalaba *et al*.(,2013) 90% of households in Zambia's Copperbelt obtained food from forests with 72% of households involved in the collection of wild edible mushrooms. Also notes that traditional and the associated local cultural perceptions, attitudes and beliefs usually have an impact on the types of plants commonly utilised, meanwhile, others are compiled to participate due hunger seasons as a result of drying up of crops due to droughts and out of economic desperation (Agustiona *et al*.,2011). Wild edible mushrooms are not poverty delicacy. This statement is supported by the substantial participation of the wealthier and intermediate rural households on the collection, consumption and trade of wild edible mushroom.

The relationship between wealth and NWFPs utilisations is mixed and quite complex to justify (Paumagarten and Shackleton, 2004). For instance, in Zambabwe wealthy households

consumed more environmental or forest resources (Cavendish, 2004). However, the poorer households tend to be more involved and dependant on non-wood forest products in proportional terms (Cavendish, 2004; Angelsen *et al*.,2011)

This current study did not investigate the total household income due to limited time and resources. However, the income scope was limited to collecting information on income from mushroom sales in the month of January 2021, the period the study was conducted. Using the estimation for wild edible mushroom sales for the month of January and the relative engagement in mushroom sales from January to December, an annual income from the sale of mushrooms was computed and estimated as $89 per household. This could be an underestimation because rural households rarely keep records for wild edible foods. The study relied on the recall method to estimate income and other utilization variables. Generally, wild edible mushrooms are expected to contribute significantly to the total household income in the Copperbelt province due to high utilization. A study on the Copperbelt province revealed that non-timber forest products, in general, contributed significantly to rural household income, with about 44% of household income contributed by non-timber forest products (Kalaba et al., 2013).

Almost all the interviewed households in Mufulira district reported that wild edible mushrooms declined in the wild due to indiscriminate forest fires and deforestation. Forest fires could reduce wild mushroom populations through the destruction of the fungi spores. Deforestation, which is principally driven by human population growth, could also be playing a huge role in the perceived reduction in the populations of wild edible mushrooms. The human population in Zambia, for example, has increased from 5 million in 1974 to over 16 million in 2016 (CSO, 2015). The increase in the population generally drives the demand for wood energy, timber products and leads to more forested lands cleared for agricultural crop fields. Zambia is losing between 250,000 and 300,000 ha of forests annually (Mukosha and Siampale, 2009).

Most wild edible mushrooms foraged in Zambia are ectomycorrhizal fungi with a symbiotic relationship with some miombo trees. The mycorrhizal fungi offer an extension beyond the plant root system to access water and nutrients that are transported to the root zone, hence making available water and nutrients that would otherwise be inaccessible to the trees. In return, the trees offer mushrooms energy in the form of simple sugars and vitamins produced during photosynthesis. These nutrients are transported to the roots of trees for the fungus to access. Therefore, when trees are cut and harvested, mycorrhizal fungi die and can no longer produce sporocarps until new trees re-establish back (Molina et al., 1993; Bourdeaux *et al.*, 2003). Deforestation, therefore, has a direct negative impact on populations of ectomycorrhizal fungi.

As with most non-timber forest products, the activity of collecting/foraging for wild edible mushrooms was dominated by women (Kalaba et al., 2013; Kiptot and Franzel, 2012; Shackleton and Shackleton, 2004; Zulu et al., 2019). Women are normally more knowledgeable about food non-timber forest products (Agustino et al., 2011).

The role of all wood and non-wood forest products in the national's economy and their ability to alleviate poverty is a common topic of many discussions by many countries globally. The demand for such products is and has continued to grow massively, hence creating opportunities for improved marketing strategies of forest products by focusing on excellent resource base and other vital incentives from the government which are commonly aimed at establishing a beneficial and profitable environment (Ng'andwe *et al*., 2015).

Sustainable management of natural and all plantation forest resources is very vital and critical to the country's development if it is fully governed by strong policies and legislations. Such issues have led to issues related with carbon management and means of adapting and

mitigating climate change and finally drastic increase of forest for carbon management (Kalabe *et al*.,2014).

Chapter 6 Conclusion and recommendation

On the Copperbelt province of Zambia, wild edible mushrooms were collected and consumed by all interviewed households, indicating high utilization of this edible non-timber forest product. Wild edible mushrooms are an important seasonal addition to the diets and incomes of rural households. However, populations of wild edible mushrooms are declining in the wild due to forest fires and deforestation. Sustainable utilization strategies are needed to support food security. Research into sustainable utilization is crucially needed to continue sustaining rural livelihoods and meet the demands of both urban and rural human populations. Forest zoning should be done to set aside wild mushroom production sites where operations that compromise the growth and sustainability of mushrooms are forbidden. Areas with high diversity and abundance should be identified for zoning to promote sustainable growth and utilization of wild edible mushrooms. Traditional structures such as chiefdom and village headmen should be engaged to enact bylaws that would curtail deforestation and forest fire that would impact the occurrence and growth of mushrooms in the wild.

The collection and marketing of non-wood forest products in Zambia should highly be promoted as a potential to the current high rates poor health in rural populations and vividly raising bars to alleviate poverty and mitigate climate change. Achieving such goals and objections calls for a deliberate common understanding of how NWFPs must be extracted, protected, preserved, marketed and well documentation across all parts of the country especially rural areas as this study aimed at understanding the collection, consumption and trade of mushrooms in Mufulira district in the Copperbelt province of Zambia and their contribution to poverty reduction. Since results indicated that wild edible mushrooms contribute to the food security there is need to;

- Establish consultation with key informants, administration and corelate with potential stakeholders for poverty reduction in Zambia.
- A call for further research to eliminate scenarios of uncertainty about prices and yields of NWFPs.
- Promote the development and commercialisation of these on permanent grounds and increase knowledge on the importance of forest products.
- Enormously assist to create more sustainable use of forest products and create more employment and income-generation opportunities and improve the livelihood of local communities.
- Establish a number of critical factors which the hinder the sustainable management of forest products, lack of documentation on the topic and commercialization of NWFPs in Zambia and elaborate strategies for re-addressing the value of forest products.

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Appendix

Questionnaire

Questionnaire Identity Number

Questionnaire for rural households (harvesters)

1. **Interviewer Name**……
2. **Date of interview**……
3. **District**…….
4. **Chiefdom**…….
5. **Village**…….

HOUSEHOLD CHARACTERIZATION

6. **Gender of household head** 1. Male 2. Female
7. **Household size**……..
8. **Age of household head**…….
9. **Number of years in school for household head** (1 – 20; e.g., Grade 9 = 9) ……
10. Number of people in the household with the following qualifications

Grade 7	Grade 9	Grade 12	Diploma and above

11. **Ethnic group** 1. Tonga 2. Nyanja 3. Bemba 4. Lozi
    5. Others specify…….

ASSETS

12. What type of infrastructure and assets do you have access to? Tick

Number of houses	
Type of house 1 – 1 roomed thatch , 2 – 2 roomed thatch, 3 – 2 roomed iron sheets, 4 – >2 rooms iron sheets	
Energy source 1 – wood and paraffin, 2 – gas, 4 – solar, 4 – electricity	
Communication 1 – cell phone/landline	
Sanitation 1 – no toilet, 2 – blair/pit latrine toilet, 3 – flushable toilet and bathroom	
Water 1 – river water, 2 – open well 3 – community borehole, 4 – own borehole, 5 – piped water	
Assets 1 – radio, 2 – bicycle, 3 – Lounge suit 4 – TV, 5 – Car	
Equipment 1 – hoes, 2 – plough, 3 – planter	
Livestock 1 – cattle, 2 – Goats, 3. – Chickens	

SOCIO ECONOMICS

13. When was your household established (*starting a family*)? .....

14. When did you settle in this village? ……

15. Does any member of your household collect *wild mushrooms*? 1. Yes 2. No

16. If yes, during which months do they collect/access/buy *wild mushrooms*? (Tick)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

17. On a scale of 0-10 rate the level of *wild mushroom* harvesting activities (mushroom availability in the wild) in your area.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

18. What types of wild mushrooms do you collect? When does each wild mushroom spout and collected?

a. ……

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

b. ……

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

c. ……

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

d. ……

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

e. ……

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

f. ……

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

g. ……

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

h. ……

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

i. ……

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

j. ……

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

19. Do you preserve the collected wild mushrooms for future consumption/sale?

20. How do you preserve them? ....

21. On a scale of 0-10 (use 10 stones to rate involvement per month), rate the involvement of your household in crop production (land preparation, planting, weeding, harvesting) per month? (*to assess workload, labor demands etc*)

Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

22. How often do they visit the forest to harvest wild mushrooms in a month (30 days)? .....……
……

23. How long (*in terms of minutes)* does it take any member of your household to reach the forests where they normally harvest *wild mushrooms?* .....

24. How would you rate the abundance of *wild mushrooms* now compared to 10 years ago?

1. Increasing 2. Same 3. Reducing

25. Give reasons for your answer in 21 above

1. Overharvesting 2. Deforestation 3. Forest fires 4. Local policies/management practice (specify the policy or management practices……..

Others
specify……
……
……
……

26. Who is normally involved in the collection of *wild mushrooms* in your household?

1. Father 2. Mother 3. Boys 4. Girls

Male 1. Below 15 years 2. 15 – 25 years 3. 26 – 40 years 4 Above 40 Years

Female 1. Below 15 years 2. 15 – 25 years 3. 26 – 40 years 4. Above 40 Years

27. Where do you normally collect *wild mushrooms* from?

1. Own forest 2. Other farmers forest 3. Communal forest
4. others (specify)……

28. Do you sell *wild mushrooms*? 1. Yes 2. No

29. Where do you sell?

1. Village market 2. District market 3. Traders 4. Others specify……

30. What were the quantities of *wild mushrooms* members of your household collected for both own consumption and sale over the past 14 days (2 weeks)?

Days	Quantity collected		Hours taken in harvesting	Quantity consumed (own use)		Quantity sold		Price/unit	Marketing costs (transport)
	Local Units	Kgs		Local Units	Kgs	Local Units	Kgs		
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

31. Consumption

Consumption of *wild mushrooms* by its appearance in meals the last seven consecutive days in each household. Ask participants what they had for lunch and supper.

Food consumed daily						
Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7

국문 초록

야생 식용버섯은 전 세계적으로 널리 분포한다. 잠비아에서 중요한 이 비목재임산물(NTFP)은 사람들에게 유용한 식량과 경제적 수입을 재공하고 특히 지역 가계(rural household)의 생활이 지속가능하게 유지되도록 기여한다. 그러나 잠비아의 비목재임산물연구에서 야생 식용버섯과 관련된 연구는 매우 미비하다. 몇몇 연구들이 있지만 최소 20 년 전에 수행되어 현재의 야생 식용버섯 채취 및 경제적 활용 방식을 설명하기 어렵고, 그 외의 연구들도 대부분 생물다양성, 생태학, 영양학적 분석에 집중하고 있어 현재의 경향성을 반영한 채취, 소비, 혹은 거래의 관점에서 지역주민의 생계에 야생 식용버섯이 미치는 영향을 설명하는 연구는 존재하지 않는다. 따라서 본 연구는 다음의 세 가지 목적으로 수행되었다. 첫째, 잠비아 쿠퍼벨트 주에서 식용으로 섭취되거나 거래되는 야생 식용버섯의 종을 확인하는 것이다. 둘째, 잠비아 쿠퍼벨트 주에서 선정된 몇몇 농촌마을에 대해 가계(household)의 야생식용버섯 채취비율, 소비, 거래를 측정함으로서 야생식용버섯의 중요성을 검토하는 것이다. 셋째, 실제 숲 안에서 확인되는 야생 식용 버섯 개체군 현재 상태를 조사하는 것이다. 잠비아 쿠퍼벨트 주 무풀리라 지역에 거주하는 220 가구가 응답한 사회경제학적조사 결과, 이 지역에서 야생 식용버섯의 중요성이 확인되었고 총 16 종의 버섯이 식용으로 채취되고 있음이 밝혀졌다. 해당 연구 지역 내 일반적인 식용 버섯 종은 *Amanita zambiana, Lactarius kabansus, Lactarius gymnocarpus, Cantharellus cibarius, and Termitomyces letestui* 이었다. 높은 비율의 가계가 채집에 동원되고 있음이 드러났고(100%), 채집에 동원되는 가계는 동시에 버섯을 섭취하고 있었으며(100%), 그 중 유의미하게 높은 비율로 대부분의 가계가(92%) 채집된 버섯을 거래하고 있음을 알 수 있었다. 채집활동은 대부분 여성과 어린이에 의해 행해졌으며, 야생식용버섯이 많이 자라는 지역(hotspot)에 도달하기 위해 평균 60~119 분 가량이 소요되고 있었다. 그러나 인터뷰에 응한 농촌 가계 중 93%는 산림파괴(deforestation)와 산불(forest fire)로 인하여 야생에서 자라는 버섯의 양이 점점 감소하고 있다고 답변했다. 2021 년 1 월 버섯판매로 인한 가계소득은 sakala 마을의 경우 K252.5 ± 63, 14mile 마을의 경우 K522.7 ± 130 까지 다양했다. 이처럼 농촌의 생계를 유지하고 지역 주민들의 요구를 충족시키기 위해서는 야생 식용 버섯의 지속 가능한 이용에 대한 연구가 추가적으로 필요하다. 야생 식용버섯 채취를 위한 산림 구역 지정(Forest

zoning)이 필요하며, 구역 지정 시 야생식용버섯의 종다양성이 높고 개체수가 풍부한 지역을 식별 후 우선적으로 지정하는 것이 필요하다.

키워드: 야생식용버섯, 지역 가계, 채집 활동, 인터뷰 조사, 잠비아
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