MNYORORO WA THAMANI WA MAZAO YA MISITU

FORVAC

FORESTRY AND VALUE CHAINS DEVELOPMENT PROGRAMME

ASSESMENT OF MUSHROOM VALUE CHAIN, BUSINESS FEASIBILITY AND BUSINESS POTENTIAL IN MBINGA AND NYASA DISTRICTS

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Assessment of mushroom value chain, business feasibility, and business potential in Mbinga and Nyasa Districts

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SUMMARY

Study objectives	Key findings
1) Production	
a) To identify mushroom species harvested and processed, seasons (including fluctuation in the availability of mushrooms between seasons – 'good' years / 'bad' years), production areas/sites, current harvesting techniques/practices and their sustainability, perceived threats/conservation status of mushroom habitats, potential volumes;	o Overall, 42 edible mushroom species recognized corresponded to different *ethnotaxa* 38 representing eleven (11) genera under four broad categories: i). Ectomycorrhizal fungi represented by six genera (or 55% of all genera): *Afroboletus, Amanita, Boletus, Cantharellus, Lactarius and Russula* ii). Termite mushrooms represented by one genus: *Termitomyces* iii). Saprophitic fungi represented by two genera: *Macrolepiota and Scleroderma* iv). Decaying wood fungi represented by two genera: *Polyporus and Auricularia* o Marketable mushroom species identified are from five genera i.e. *Cantharellus, Russula, Amanita, Lactarius* and *Termitomyces.* ✓ These corresponded to six ethnotaxa i.e. Unguyuwu, Uhinda, Ulelema, Upoo, Kagenjwa/Kalungeya and Luhano. ✓ Unguyuwu, Uhinda, Ulelema and Upoo are common to all study villages ✓ Kagenjwa/Kalungeya (*Cantharellus CF. floridula*) was unique to Kindimbachini village ✓ Luhano (*Termitomyces aurantiacus*) was unique to both Hinga and Litolomero villages o Mushroom season begins in December and ends in April, sometimes goes up to May. o Estimated harvested quantities of fresh mushrooms vary within and between villages (expressed in litres): ✓ Kindimbachini: 240 to 5,600 with median of 2,240 ✓ Litolomero: 200 to 4,000 with median of 620 ✓ Hinga: 180 to 4,800 with median of 720 ✓ All villages: 180 to 5,600 with median of 800 o Harvesting practices were similar across villages: ✓ Scientifically, the most appropriate mushroom picking practice is by cutting the stem above the soil surface. Proportions of households practicing that desired practice were 10%, 45% and 85% for Kindimbachini, Litolomero and Hinga villages, respectively. ✓ Scientifically, the proportion of immature mushrooms harvested should be low [exact level not yet known, but conservative value is hereby set between 30% and 50%] to ensure smooth reproduction succession. Findings showed that the proportions of immature fruiting bodies harvested were similar across study villages and were within the acceptable range. The recorded median values were from 40% (Litolometo and Hinga) to 50% (Kindimbachini)
b) To determine estimate of number of people involved in the mushroom business in above mentioned villages, and estimation of % of women among the producers including list of individuals identified, description and contact information;	o In the study villages, mushroom harvesting in the forest including transporting to home is done by both men and women; women take over later along the value chain; they are responsible for cleaning, sorting/grading, processing (boiling and drying), and overall marketing. ✓ Women are the ones who sell mushrooms, but all estimates in the report are given on household basis, which was adopted as the unit of analysis; and more meaningful for communicating with policy- and decision- makers starting from the village to national level o Participation in mushrooms harvesting for subsistence: ✓ Kindimbachini: 86% or 394 households out of 458 ✓ Litolomero: 94% or 121 households out of 129 ✓ Hinga: 83% or 369 households out of 444 o Participation in trading of fresh mushrooms: ✓ Kindimbachini: 12.9% or 51 households out of 394

Study objectives	Key findings
	✓ Litolomero: 0.0% or 0 households out of 121 ✓ Hinga: 27.8% or 102 households out of 369 o Participation in dried mushrooms trading/business: ✓ Kindimbachini: 61.3% or 281 households out of 458 ✓ Litolomero: 5.9% or 8 households out of 129 Hinga: 0.0% or 0 households out of 444
2) Processing	
o To identify and evaluate methods of storage and processing including possible drying or other appropriate processing and packing methods;	o Participation in mushrooms processing (boiling followed by sun-drying) ✓ Kindimbachini: 83.9% or 384 households out of 394 ✓ Litolomero: 88.2% or 114 households out of 121 ✓ Hinga: 69.4% or 308 households out of 369 o The main method of processing mushrooms is boiling followed by sun-drying; practiced by 90% of those who process mushrooms across villages
3) Market	
a) To identify current mushrooms market outlets, species preferred in the market and the respective prices, market demand for fresh/dried goods and types of buyers (larger bulk buyers or individuals);	o Market outlets: ✓ Kindimbachini: Within the village and nearby villages of Lituhi, Ndumbi and Mbaha; besides there is a young man originating from the village but currently residing in Dar es Salaam; he buys dried mushrooms annually on religious ground; he is a member of a religion that command followers to be vegetarian; being allowed to eat mushrooms and other vegetables but never eat any meat. ✓ Litolomero: No internal market because everybody has access to plenty mushrooms. The end markets are nearby villages of Hinga, Mbuli, Ngumbo, Litoho and Lundumatu ✓ Hinga: They sell to the nearby villages of Lundu, Mbuli and Ngumbo o There is an interest fresh mushrooms value chain operating in Mbinga district, though not directly involving the study villages. It began spontaneously through friendship and trust between town and rural women [Litumbandyosi and Luhagala (and possibly other villages along Kitai-Ruanda-Lituhi road)]; the town women became sales representatives who are also linked to other retailers in town. During the mushroom season, the rural women send mushrooms via daily buses that arrive in Mbinga town at around 9:00 am; sales agents receives mushrooms and distribute to retailers, leaving some portions for them also to sell on retail. Gross profit margin for sales agents is 317% and for retailers is 60% to 80%. Therefore, instead of starting from the scratch, already there is an interesting starting point or learning opportunity for establishing commercialization of mushrooms in the FORVAC villages.
b) To identify bottle necks related to the mushroom business;	o Limited market linkages was observed across all villages; but this is much pronounced in Kindimbachini due to extremely poor road o Lack of appropriate drying technology is the major problem across villages. This means that only small amount can be dried, there are losses due to rotting whenever there is heavy consecutive rains; another loss is due to foregone harvesting as people tend due to fear of incurring losses once it is raining frequently o Decline in mushroom productivity due to clearing of forests for farmlands, and/or overgrazing; other causes of clearing forest for farmlands, to a small extent, are timber and charcoal making; there are also frequent wild fires. ✓ The underlying cause of clearing forests for farmlands, in the perspective of the local communities, is increasing human population. The researcher identified inadequate agricultural extension services as an additional intermediate cause of the problem

Study objectives	Key findings
4) Capacity of local mushroom processing/marketing enterprises	
a) To assess the capacity of the four mushroom businesses (2 in Kindimbachini, 2 in Amanimakoro) currently supported by FORVAC through community level business support and mentoring, and grant support; and	○ Generally they are not better than the rest of the community members where they belong, in terms of the capacity to do business as follows: ✓ Access to capital: No reliable access to capital ✓ Annual income generated from mushrooms: 30,000 – 360,000 TZS against median value of 351,200 TZS and maximum value of 1,280,000 TZS recorded at Kindimbachini for the entire village ✓ Folk taxonomic knowledge: judged to average; there are other relatively knowledgeable persons
b) To assess the possibility of growing one of these businesses to perform mushroom processing/branding, and marketing or creating market linkages for others.	○ The study has noted and appreciated the robust and transparent process that was used to earmark the individual women mushroom entrepreneurs for the planned subsequent support. ○ However, after a thorough analysis they have proved not to be effective entry points in case wider and far reaching impacts are desired. Key reasons for this proposition are: ✓ Going through the earmarked women is likely to achieve very meagre impacts; also can cause division/conflict in the village rather than cooperation; the ultimate outcome of such conflict would be the downfall of the same women supported, in the first place. That may not happen overnight, but in the medium-term such upheaval can be expected. ✓ Operating as two persons in the entire village will deny them the existing treasure of folk knowledge and skills among the majority in the village members. ✓ The vision of the village leaders is to see many people progressing not only two individuals; now operating against the perspective of the leaders is likely to be another source of failure. ✓ Also, specific to Amanimakoro village, the Village Executive Officer does not consider wild mushrooms do be a viable business venture; he instead suggests that FORVAC could have promoted mushroom farming; in the same vein, he also noted that the choice of Amanimakoro village was actually wrong since the village does not have adequate mushrooms because of limited forest cover. Thus, he insisted that FORVAC should go to villages with plenty mushrooms such as Luhagala, Litumbandyosi, Mabani and Kingole ○ Therefore, it is recommended that a support be provided to the community as a whole i.e. the earmarked women inclusive as members of the community ✓ This can be done by formulating a village level cooperative with membership open to all members of the village at any time down the timeline; of course membership will be on voluntary basis, which will be instigated through proper and adequate mobilization/awareness creation. There are many advantages of going through the cooperative than individuals. For example, enhancing strong linking and bonding within the community and between the community and other actors horizontally and vertically; such 'strong and denser' networking would then facilitate sharing of resources and incentivize observance of applicable rules and regulations. Another advantage could be increased market power while at the same time decreasing their vulnerability to external shocks. ✓ It is insisted that, for this model to work properly, adequate mobilization/awareness creation should be done at a reasonable depth and width i.e. starting from sub-village level before reaching the whole

Study objectives	Key findings
	village, and providing information in a way that create an environment for participatory analysis. ✓ Along the process of getting the software right, a solar dryer integrated with external power supply with automatic regulated heating element [to be ordered via SIDO approved dealer in Morogoro], can then be installed for use by all that will have joined the cooperative on their own will. Users will be required to pay fee at an agreed rate and practical but effective mechanism; setting the rate will ensure that experts are involved to guide the threshold needed to ensure subsequent maintenance and operation will be determined with the support of appropriate expert. Each solar dryer unit costs between 10,000,000 TZS and 12,500,000 TZS depending on size; it is advised that each solar dryer should also be integrated with automated temperature and relative humidity monitoring system fabricated using low-cost utilize low-cost Arduino microcontrollers capable of transmitting real time data on website or mobile phone. Each set of the monitoring system costs USD 2,500 inclusive of installation costs. o For Amanimakoro village, there is a need to re-confirm the validity of choosing it; the village leader could be wrong but even if he might be wrong still has a reason behind his comments. Nevertheless, the villages he mentioned are the same villages that are renowned for supplying mushrooms to dealers based in Mbinga town.

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ABBREVIATIONS AND ACRONYMS

FBD	Forestry and Beekeeping Division
FGDs	Focus group discussion
FORVAC	Forestry and Value Chains Development Programme
MIS	Management Information System
MNRT	Ministry for Natural Resources and Tourism
MNRT	Ministry of Natural Resources
NWFPs	Non-wood forest products
PFRA	Participatory Forest Resource Assessment
PO-RALG	President's Office Regional Administration and Local Government
SEDIT	Business Mentor from Social and Economic Development Initiatives of Tanzania
SUA	Sokoine University of Agriculture ()
SPSS	Statistical Package for Social Science
TFS	Tanzania Forest Serviceand
TZS	Tanzanian shillings
URT	United Republic of Tanzania
USD	American dollars
VLFRs	Village Land Forest Reserves
VNRCs	Village Natural Resource Committees
%	Percent
χ^2	Chi-square

1.0 INTRODUCTION

1.1 Background

With the funding from the governments of Tanzania and Finland the Forest and Beekeeping Division (FBD) of the Ministry for Natural Resources and Tourism (MNRT), in close cooperation with Tanzania Forest Service (TFS) and the President's Office Regional Administration and Local Government (PO-RALG) has been implementing "the Forestry and Value Chains Development Programme (FORVAC)" since July 2018. FORVAC is being implemented in three different cluster areas of Tanga, Ruvuma and Lindi; and is expected to end by July 2022.

FORVAC aims to contribute in increasing economic, social and environmental benefits from forests and woodlands while reducing deforestation in the context of Community Based Forest Management. The expected outcome is *"Improved forest-based income, livelihoods and environmental benefits"; this outcome* is envisaged to be achieved through four outputs:

- Output 1: Improved Value Chains and increased Private Sector Involvement in the forest sector.
- Output 2: Stakeholder capacity to implement and promote forestry value chain development enhanced.
- Output 3. Functional extension, communication, monitoring systems; and Management Information System (MIS) in place.
- Output 4. Supportive legal and policy frameworks to forest value chain and sustainable forest management developed.

The purpose of FORVAC is to promote sustainable forest businesses around timber, charcoal, and non-wood forest products (NWFPs). The core idea is to contribute to increased income for communities a whole, individuals/households and groups by promoting forest-based businesses/enterprise development while ensuring the existence of forests now and in the future, in the context of community based forest management. Relevant businesses include but not limited to the raw material from Village Land Forest Reserves (VLFRs) such as honey processing, carpentery, mushroom processing, bamboo product making.

Within the Ruvuma cluster, FORVAC is working with 14 villages who own a large joint Namswea-Lilengalenga VLFR established since early 2000s covering about 23,000 ha. The VLFR primary management objective is watershed protection, but also provides an important base for individual businesses especially for NWFPs such as mushroom production. FORVAC identified the mushroom production as a potential value chain during interviews with communities in Mbinga district. The entrepreneurs engaging in mushroom business are mainly female mostly selling fresh mushrooms both in the surrounding villages and near-by town centres during the season. A few interviewed individuals are also engage in drying and off-season selling of dried mushroom to distant markets as far as in Dar es Salaam city. However, the extent of involvement of different communities in mushroom harvesting and marketing has not been quantified.

As part of interventions to contribute to "Output 1-Improved Value Chains and increased Private Sector Involvement in the forest sector", FORVAC has recognized the need to solicit technical

support from a consultant to assess mushroom value chain including business potential and feasibility in five villages within Mbinga (Kindimba Chini, Ndongosi and Amani Makoro villages) and Nyasa (Hinga and Litolomero villages) Districts and two outlet markets of Mbinga town / Songea Town markets. This report presents findings of the study conducted to assess mushroom value chain, business feasibility, and business potential in Mbinga and Nyasa Districts.

1.2 Objective of the study

1.2.1 General objective

Based on the terms of reference (Appendix 1), the general objective of the consultancy was to conduct quick assessment of mushroom value chain including business potential and feasibility in the selected villages and markets within Mbinga and Nyasa Districts, in order contribute to development of the mushroom value chain and improved livelihoods in the area. The study also assessed the feasibility of previously identified mushroom business in Amanimakoro and Kindimbachini villages in Mbinga Districts, in order to recommend a way forward for FORVAC to enhance development of the value chain in a sustainable manner.

1.2.2 Specific objectives

Specific objectives covered four functional areas:

5) **Production:**
   c) To identify mushroom species harvested and processed, seasons (including fluctuation in the availability of mushrooms between seasons – 'good' years / 'bad' years), production areas/sites, current harvesting techniques/practices and their sustainability, perceived threats/conservation status of mushroom habitats, potential volumes;
   d) To determine estimate of number of people involved in the mushroom business in above mentioned villages, and estimation of % of women among the producers including list of individuals identified, description and contact information;
6) **Processing:**
   - To identify and evaluate methods of storage and processing including possible drying or other appropriate processing and packing methods;
7) **Market:**
   c) To identify current mushrooms market outlets, species preferred in the market and the respective prices, market demand for fresh /dried goods and types of buyers (larger bulk buyers or individuals);
   d) To identify bottle necks related to the mushroom business;
8) **Capacity of local mushroom processing/marketing enterprises**
   c) To assess the capacity of the four mushroom businesses (2 in Kindimbachini, 2 in Amanimakoro) currently supported by FORVAC through community level business support and mentoring, and grant support; and
   d) To assess the possibility of growing one of these businesses to perform mushroom processing/branding, and marketing or creating market linkages for others.

2.0 METHODOLOGY

2.1 Sampling strategy

2.1.1 Selection of study villages and sample size determination for questionnaire survey

Four[1] study villages were selected purposively based on their participation in harvesting and trading edible mushrooms and having received previous support from FORVAC:

- Two villages from Mbiga districts: Kindimbachini and Amanimakoro villages
- Two villages from Nyasa district: Hinga and Litolomero villages

2.1.2 Selection of mushroom collectors to be interviewed

Stratified random sampling was applied to select mushroom collectors to be interviewed based on wealth status. The stratified random sampling was chosen to ensure representativeness of the sample by wealth status. This was necessary because of the increasing evidences on the linkage between use, dependence and trading on mushrooms and other non-wood forest products (NWFPs) versus household wealth status (e.g. Shackleton and Shackleton, 2006; Belcher and Schreckenberg, 2007; Christensen et al., 2008; Vyamana, 2009). Therefore, participatory wealth ranking was conducted in each village prior selection of households/interviewees.

Participatory wealth ranking was done in conjunction with identification of mushroom collectors/harvesters. Wealth ranking focused on establishing poverty profiles based on people's own perceptions of their situation. The whole process involved five steps (Figure 1; Ravnborg, 2003; Vyamana, 2009):

a) Four sub-village representatives (2 males and 2 females) were selected from each sub-village to participate in a one day participatory discussion workshop. These individuals were purposively selected with the help of sub-village leaders, and the leaders were among the four informants. The informants were selected on the basis of having lived in the sub-village long enough and ability to know other members in their respective sub-village.
b) All sub-village representatives were engaged in a joint discussion sessions to identify and agree on wealth criteria and indicators. During the discussions, the participants were guided to identify and characterize three wealth categories i.e. poorest, poor and non-poor using locally relevant indicators and criteria.
c) Participants were then split into sub-village specific sub-groups where they were facilitated to categorize each household from the sub-village household list into respective wealth categories based on the criteria and indicators developed in joint discussion session. Prior grouping of the households into respective wealth categories, each name of the household heads was written on a separate manila card. Each name of the household was written on a manila card. All cards for households involved in mushroom collection were differentiated from those not involved in mushroom collection through simple colour coding (i.e. yellow or purple for households without mushroom collectors; green or light blue for households with at least one individual involved in mushroom collection).

[1]Five villages were initially specified in the terms of reference; Ndongosi village was dropped during the actual field work in Mbinga district due to time constraint.

Figure 1: Processes involved during wealth ranking

d) Thereafter, the informants from each sub-village were facilitated to group each of the cards with names of the household heads into their respective wealth categories based on indicators and criteria agreed in the joint discussion.
e) The list of households involved in mushroom collection grouped by the wealth categories was used as sampling frame for stratified random sampling of the mushroom collectors to be interviewed.

Stratified random sampling in proportion to the size of the wealth categories was applied to select interviewees. The sample size for each village set at minimum of 30 households, allowing for precision of about 90% (Aday and Cornelius, 2006). Interviewees were selected by households; and for each selected household the most experienced adult (18+ years) mushroom collector present was interviewed. The minimum number of households/interviewees for each wealth category within each study village was set to five (5), but that could not be achieved for the non-poor wealth category across all study villages due to non-turn up of the households/individuals (Table 1).

Table 1: Number of sampled households by wealth categories

Wealth category	Number of households sampled from … village			
	Kindimbachini (N = 458)	Litolomero (N = 129)	Hinga (N = 444)	All villages (N = **1,031**)
Non-poor	3*	4*	4*	11
Poor	20	9	14	43
Poorest	8	21	18	47
Total number of households	31	34	36	101
Sampling intensity (%)	6.8%	26.4%	8.1%	9.8%

*The number of households did not reach the required minimum number of 5 as some of respondents could not be found due to overlap with the peak of farming season.

This happened because the timing of the study coincided with the peak of farming season during which most of the community members were busy tending their farms. However, such overlap was inevitable as it was necessary that the timing of the study be matched with the phenology of edible wild mushrooms (Härkönen et al., 2003).

2.1.3 Selection of community key informants and participants of focus group discussions

In each village, twelve most experienced mushroom collectors (6 females-3 youths and 3 elders, 6 males-3 youths and 3 adults) were purposively selected with the help of village leaders to become key informants who participated in group interviews, different group-based qualitative data collection sessions including value chain analysis; and guided tour.

2.2 Data collection

2.2.1 Qualitative data

Qualitative data were collected using five main techniques (Albuquerque et al., 2014b; Campos et al., 2018) as described in the following subsections.

2.2.1.1 Analysis of relative importance of different livelihood strategies

The participants were facilitated to undertake analysis of relative importance of different livelihood strategies in two steps (Figure 2):

(i). Participants were facilitated to list all livelihood strategies in their village;

(ii). After listing the livelihood strategies, the participants were then asked to use beans to assign a score in a Likert scale from 1 to 5 for each livelihood strategy whereby 1 represented the least important and 5 the most important livelihood strategies respectively; based on their own perspectives and experience.

Figure 2: Processes for analysis of relative importance of different livelihood strategies

2.2.1.2 Participatory mapping, marketability ranking and trend analysis

The participants were facilitated to draw a map of their village including all surrounding forest lands; and indicate all the sites where they collect different species of mushrooms. There after the participants were facilitated to undertake marketability ranking and trend analysis in four steps (Figure 3):

(i). The "free list" technique (Albuquerque et al., 2014b) was applied to invite participants to list the edible mushroom species used in the community in their vernacular language. The guiding question was: Which edible mushroom species do you know?

(ii). After listing the mushroom species, the participants were then asked to use beans/stones to assign a score in a Likert scale from 1 to 5 for each edible mushroom whereby 1 represented the least marketable/delicious mushroom species and 5 the most marketable/delicious mushroom species based on their own perspectives and experiences.

Figure 3: Processes for ranking marketability of different edible wild mushrooms

Thereafter, the participants were asked to indicate abundance of the topmost marketable/delicious mushroom i.e. mushroom species that scored 4 to 5 points in the marketability ranking exercise. The abundance trend analysis for the marketable wild edible mushroom species conducted for the 1980-2020 timeframe in five periods of ten years i.e. 1980, 1990, 2000, 2010 and 2020[2] . The scheme used for the mushroom abundance trend analysis is presented in Appendix 2.

The whole process was accomplished in two steps (Figure 4).

(i). First, participants were guided to assign between 0 and 5 points, using beans counts, in each cell of the table to indicate abundance of each mushroom species used and traded in the village over the specified timeframe. No point (i.e. 0) corresponded to non-existence or extinction of respective mushroom species in a given village at a particular time whereas 5 points corresponded to the largest possible population size for a particular mushroom species at a given time.

(ii). Second, participants were guided to use the last two columns of the table to identify and document historical perspectives of the causes of the observed decline in abundances of different mushroom species (threats) and the associated impacts/consequences on their livelihoods.

[2]The actual starting year was based on the age ranges for the participants/key informants

Figure 4: Processes involved in trend analysis for edible wild mushroom abundances

2.2.1.3 Value chain analysis

Edible wild mushroom value chain analysis was undertaken with the same participants involved in participatory mapping and trend analysis. The analysis involved two steps (Belcher and Schreckenberg, 2007; Mahonya et al., 2019):

(i). Participants were facilitated to identify actors involved in the mushroom trade and draw respective value chain diagram. Actors were identified in relation to several sub-sets of edible mushroom value chain activities/functions: collection/harvesting, processing, storage, transportation, marketing and sale.

(ii). Participants were facilitated to identify services required and their sources for each node.

2.2.1.4 Characterization and identification of edible wild mushrooms

Edible wild mushroom marketability ranking was undertaken with the same participants involved in participatory mapping, trend analysis and value chain analysis. The task involved three steps (Figure 5):

Figure 5: Processes involved in characterization of edible wild mushrooms with local communities from selected villages within Mbinga and Nyasa districts of Ruvuma region, Tanzania

(i). Male and female participants were asked to characterize each of the identified mushroom species named in vernacular language, based on important morphological/macroscopic features (colour, shape, smell, and association with other plants). Thereafter, the key informants were guided to identify colour pictures from a mycology book (e.g. Härkönen et al., 2003) that corresponded to each of the identified mushroom species named in their vernacular language.

(ii). Separate sessions were facilitated with female and male informants as a means for cross-referencing to ensure validity and reliability of the data (Albuquerque et al., 2014a).

(iii). Female and male participants were asked to come in a joint plenary session where each sub-group was asked to present the identified colour photo mushrooms for each of the mushroom species indentified with the vernacular language names. In case of discrepancies or any differences in contents or views/perceptions between females and males, participants were guided to reach a consensus.

2.2.1.5 Guided tour

The same participants involved in participatory mapping, trend analysis, value chain analysis and characterization and identification of edible wild mushrooms were involved in guided tour. The researcher together with the participants visit selected mushroom harvesting site with abundant

mushrooms based on the findings from the mapping and trend analysis exercises (Albuquerque et al., 2014b). In the selected site, transects were established in four cardinal directions (north, south, east, and west) from the approximate central point. Along each cardinal direction, mushrooms were observed in 100 m transect belt on both sides of the transect line with a total length of 1 km from the centre. For each macrofungi species encountered along the transect belt, at least 3 representative specimens (young, mature and old) mushrooms were examined for macroscopic features using the following protocol (Tibuhwa et al., 2008; Bloesch and Mbago, 2009; Onduso et al., 2018):

(i). The researcher took a photograph of the mushroom specimen in-situ prior picking;
(ii). The entire specimen of mushroom was then carefully uprooted using a sharp stick without causing any damage of the delicate fruiting bodies;
(iii). The researcher in collaboration with the local experts examined and discussed observable macroscopic features for each specimen. Key macroscopic features examined were:
- Cap: cap colour, size (small, medium, or large)
- Annulus-ring of tissue on a mushroom stem left by a torn partial veil: recorded as present/absent; if present describe the way it looks, and
- Stem: stem-colour and shape
- Presence and shape of pseudorhiza, i.e. a tap-root-like extension at the base of a mushroom stem (recorded as present/absent)
- Presence of sack-like *volva* at the stripe base or surrounding young developing fruit body emerging
- Presence and colour of latex after gentle injuring the specimen (recorded as present/absent)

(iv). Photograph of the uprooted specimen was taken in the field in different possible orientation i.e. lying sideways, upside-down, etc;
(v). The mushroom specimen was identified with the help of participants in conjunction with mycology book (Härkönen et al., 2003);

2.2.2 Quantitative data

Mushroom collectors were interviewed using structured questionnaire covering both closed and open ended questions (Appendix 3). Data collection was carried out in January and February 2021, at a time when the mushrooms season had just began. Questions were set to elicit quantification of edible wild mushrooms harvested, consumed and traded by focusing on situation for the previous season i.e. 2019/2020. This ensured that the actual amounts harvested, consumed and traded over a full season were capture. Quantification of the mushrooms involved asking respondents to identify months of the year when edible wild mushrooms are harvested, average days of harvesting per month and quantities harvested per each day of harvesting; average amount consumed, sold and processed on each harvesting day. Respondents were free to report quantities in their own convenient measures.

In addition, semi-structured interview guides were used to conduct interview with the following groups of key informants:

a) FORVAC Business Mentor from Social and Economic Development Initiatives of Tanzania (SEDIT) based in Mbinga district (Appendix 4);

b) Leaders for Mbinga town market (Appendix 5);
c) Mushroom traders selling mushrooms within Mbinga town market premises and street vendors (Appendix 6);
d) A representative from Mamaland Mushroom Farms based in Morogoro (Appendix 7); and
e) Village leaders across all study villages (Appendix 8).

2.2.3 Mushroom enterprise assessment

Data for mushroom enterprise assessments were collected through individual interviews with entrepreneurs previously earmarked by FORVAC for support based in Amanimakoro and Kindimbachini villages (Appendix 9). The protocol for assessment of village-based wild mushroom entrepreneurs was developed based on Marshall et al. (2006), Belcher and Schreckenberg (2007), Mahonya et al. (2019), Caporale et al. (2020) and Sharma et al. (2020). Interviews were recorded as both handwritten notes and, where possible and when agreed with specific interviewee, audio-recorded voice notes.

2.3 Data analysis

Data analysis began by converting every unit of measure for quantification of mushrooms to litres; the latter was adopted since it was the most common measure of expressing quantities of both fresh and dried mushrooms as determined during respective FGDs, which preceded questionnaire survey in each village. Income values with respect to fresh and dried mushrooms were computed as non-cash and cash incomes. The former refers to the monetary values of edible mushrooms consumed at respective households, whereas the latter is the actual cash money received through selling of fresh and dried mushrooms (Vyamana, 2009; Mahonya et al., 2019). The monetary values of the respective household incomes were calculated using the previously estimated unit prices that were captured during FGDs and KIIs.

The textual quantitative data obtained from questionnaire survey were coded before the analysis; and all the questionnaire data were analyzed using Statistical Package for Social Science (SPSS) version 16.0. Descriptive statistics were used to calculate frequencies, percentages, means, medians and range. Cross-tabulations were also used with some variables; and the Pearson's Chi-Square analysis was used to discover any significant relationship/association between two categorical variables. The qualitative data were analyzed in two stages using thematic approach. First, the data were transcribed by typing up the field notes and supplementary researcher's observations (Appendix 10). Second, final analysis was done through reading, examining and identifying passages of the text linked by a common theme. This allowed categorization of the information and establishment of a framework of thematic ideas which addressed the research objectives and questions. Similarities and differences were analyzed between different villages and groups of mushroom collectors or traders, and village leaders.

3.0 FINDINGS AND DISCUSSION

3.1 Findings

3.1.1 Poverty profiles

Common characteristics used to define wealth categories across study villages are summarized in Table 2. Detailed account of the wealth criteria and indicators for each of the survey villages is given in Appendix 11. The term "non-poor" in the context of this study is used as a relativity term and does not necessarily suggests income much above the conventional poverty line.

On the basis of the community defined wealth criteria, non-poor households are characterized by having houses made of brick walls with plaster, cement/tile floor and first grade iron roofs imported from South Africa (also known as '*bati za Msauzi'*); land holdings of 3 - 30 acres, up to 20 cattle, 5 - 20 or more goats, 1 to 4 or more pigs, 10 - 30 chicken, hiring labour, sometimes owning varying numbers of motorbike taxis and non-farm businesses, and normally being food sufficient all the year.

Table 2: Overall indicators and criteria for wealth at Kindimbachini in Mbiga district, and Litolomero and Hinga villages in Nyasa district, in Ruvuma region, Tanzania

Community defined indicators	**Community defined wealth categories and criteria**		
	Non-poor	Poor	Poorest
House and housing condition	○ Roof made of iron sheets in some cases imported from South Africa (also known as '*bati za Msauzi*'), burnt bricks and cement plastered walls ○ Smooth floor made by cement and or tiles	○ Roof made of ordinary iron sheets, burnt bricks walls but without plaster ○ Few of them may have cement floor but never tiles; most of them have dusty floor	○ Grass thatched roof, wall made of poles and mud ○ Dusty floor
Number and type of livestock owned	Cattle 5 to 50 or more, goats 5 to 50 or more, mostly 1 to 6 pigs but may be as high as 50, mostly 10 to 20 chickens/ducks but may reach 100	Cattle 1 to 9, goats 1 to 6, pigs 0 – 3, chicken/ducks 4 to 10	Never own cattle or goats/sheep in most cases, in a few cases may own up to 3 cattle or 3 goats/sheep, the majority has 1 – 3 pigs but a few may never own any pig; chicken/ducks 1 to 5.
Size of farm/land owned	4 - 50 acres	1 - 25 acres	A few may own 1-2.5; majority own less than one acre
Food security (number of meals a day)[3]	Three meals a day and is able to choose what to eat	Two meals a day and may not choose what to eat	Two meals a day and may not choose what to eat; and may not be starving most of the time
Ability to access health services[4]	Able to send their sick ones up to referral private hospitals anywhere and without any delay	Able to send their sick ones up to referral private hospitals but with significant delays and may not choose hospitals	Cannot afford costs for health services; depends on village dispensary
Income generating activity undertaken (Off-farm	Retail shops and restaurants; trading in agricultural produces, milling machines, own motor bike taxis	Small kiosks (*magenge*) and food vending; trading in wild edible mushrooms	Casual labour; trading in wild edible mushrooms

[3]This wealth indicator applies to Litolomero village only
[4]This wealth indicator applies to Kindimbachini village only

activities)			
Ownership of fishing gears[5]	3 or more canoes, 2 or more oars, 2 or more sardine nets, 2 or more fish nets, and more than 200 fish hooks	Majority have no fishing gears, but a few may own one of each of the fishing gears (canoe, oar, sardine net, fish net); and may own 30 or less fish hooks	Never own any fishing gear

The poor and poorest are characterised by increasingly fewer of all these assets, increased reliance on selling labour, and worsening ephemeral food insecurity, and reliance on wild edible mushroom trading to generate income. Across all villages studied, one pertinent feature of the non-poor was the tendency to engage in more non-farm activities such as retail shops, milling machines and motorbike taxis (*bodaboda*).

Based on the criteria summarized in Table 2, proportions of household in each wealth category across the study villages are given in Table 3.

Table 3: Percent of households in each wealth categories wealth at Kindimbachini in Mbiga district, and Litolomero and Hinga villages in Nyasa district, in Ruvuma region, Tanzania

Villages	Total households	Wealth categories			**Total**
		Non-poor	Poor	Poorest	
Kindimbachini	458	11%	66%	22%	**100%**
Litolomero	129	8%	35%	57%	**100%**
Hinga	444	6%	43%	51%	**100%**
Overall	**1,031**	**9%**	**52%**	**39%**	**100%**

Findings in Table 3 clearly indicates that the majority of household in the surveyed villages are poor (52%) poorest (39%) all together accounting for 91% of total households.

3.1.2 Characteristics of respondents

The demographic features of the 101 individuals who participated in the study are summarized in Table 4. Majority (> 77%) had attained primary education; on average female respondents were 45.5%, but these represented households for which female heads of households were only 27.7%. This echoes the deliberate efforts that were made to reach female respondents as much as possible. The proportion of the different respondents age groups were 10.9% for 18 and 24 years, 46.5% for 25 and 44 years, 27.7% for 45 and 60 years and 14.9% for above 60 years. Distribution of the age groups of the respective heads of households showed the same pattern with corresponding values of 7.9%, 45.5%, 29.7% and 16.8. Majority (79.2%) of the respondents were married, and they represented households whose majority of their heads were also married (81.20%).

[5]This wealth indicator applies for Hinga village only

Table 4: Socio-economic profile of sample households

Characteristics	Values for … village			
	Kindimbachini	**Litolomero**	**Hinga**	**All villages**
a) Education				
Percent of respondents without any formal education (%)	0.0	6.5	0.0	2.0
Percent of respondents attended some primary education (%)	9.7	6.5	10.3	8.9
Percent of respondents attended primary school education (%)	77.4	80.6	84.6	81.2
Percent of respondents attended secondary education (%)	12.9	6.5	5.1	7.9
Percent of respondents attended college education (%)	0.0	0.0	0.0	0.0
Percent of respondents attended university education (%)	0.0	0.0	0.0	0.0
b) Gender of the household heads				
Percent of female head of household (%)	25.8	22.6	33.3	27.7
Percent of male head of household (%)	74.2	77.4	66.7	72.3
c) Gender of respondents				
Percent of female respondents (%)	29.0	48.4	56.4	45.5
Percent of male respondents (%)	71.0	51.6	43.6	54.5
d) Age group of household head				
Percent of household head with age between 18 and 24 years (%)	9.7	9.7	5.1	7.9
Percent of household head with age between 25 and 44 years (%)	38.7	51.6	46.2	45.5
Percent of household head with age between 45 and 60 years (%)	32.3	25.8	30.8	29.7
Percent of household head with age above 60 years (%)	19.4	12.9	17.9	16.8
e) Age group of respondents				
Percent of respondents with age between 18 and 24 years (%)	16.1	12.9	5.1	10.9
Percent of respondents with age between 25 and 44 years (%)	38.7	51.6	48.7	46.5
Percent of respondents with age between 45 and 60 years (%)	29.0	22.6	30.8	27.7
Percent of respondents with age above 60 years (%)	16.1	12.9	15.4	14.9
f) Marital status of household heads				
Percent of household head who are Married (%)	87.10	77.40	79.50	81.20
Percent of household head who are single (%)	0.00	9.70	7.70	5.90
Percent of household head who are divorced (%)	6.50	9.70	2.60	5.90
Percent of household head who are window/widower (%)	6.50	3.20	10.30	6.90
g) Marital status of respondent				
Percent of respondent who are married (%)	80.6	77.4	79.5	79.2
Percent of respondent who are single (%)	3.2	9.7	7.7	6.9
Percent of respondent who are divorced (%)	6.5	9.7	2.6	5.9
Percent of respondent who are window/widower (%)	9.7	3.2	10.3	7.9
h) Residence status of the household heads				
Percent of households who are native (%)	96.8	96.8	100.0	98.0
Percent of households who are immigrant (%)	3.2	3.2	0.0	2.0
i) Residence status of the respondents				
Percent of respondent who are native (%)	96.8	100.0	100.0	99.0
Percent of respondent who are immigrant (%)	3.2	0.0	0.0	1.0
j) Household size				
Percent of households with 1 to 2 members (%)	6.5	6.5	7.7	6.9
Percent of households with 3 to 7 members (%)	80.6	83.9	79.5	81.2
Percent of households with 8 to 10 members (%)	12.9	9.7	12.8	11.9
Percent of households with 11 or more members (%)	0.0	0.0	0.0	0.0

Majority of respondents (99.0%) were native to their respective villages representing heads of households whose majority were also native to their respective villages. Household size distribution was such that 6.9% had 1 to 2 members, 81.2% had 3 to 7 members, 11.9% had 8 to 10 members and 0.0% had 11 or more members

3.1.3 Traditional knowledge about edible wild mushrooms

3.1.3.1 Overall folk taxonomic knowledge

This study investigated self-reported knowledge to identify ecological niches for mushrooms (i.e. specific forest sites where mushrooms grow abundantly) and differentiate edible from inedible mushrooms. Findings in Table 5 revealed high knowledge that had similar pattern across study villages, regarding proportions of respondents who reported being able to identify specific forest sites where mushrooms grow abundantly (greater than 70%, $\chi^2 = 6.60$; df = 4; p = 0.159), and/or differentiate edible from inedible mushrooms (more than 93%, $\chi^2 = 4.607$; df = 4; p = 0.100).

Table 5: Proportion of respondents on perceived self-reported abilities to practice skills related to locating sites with abundant mushrooms and differentiating edible form inedible mushrooms

Parameters for self-reported knowledge perceptions	Proportion of respondents from…village (%)				Chi-square statistics
	Kindimbachini	Litolomero	Hinga	All	
Ability to locate sites with abundant mushrooms	90.3	70.6	83.3	81.2	$\chi^2 = 6.60$; df = 4; p = 0.159
Ability to differentiate edible from inedible mushrooms	93.5	100	100	98.0	$\chi^2 = 4.607$; df = 4; p = 0.100

These findings suggest high self-confidence among the studied communities with respect to their ability to locate specific forest sites with abundant mushrooms and differentiate edible from inedible mushrooms. In line with these findings, there were no historical incidences of any mushroom poisoning in all of the villages studied. However, findings showed significant variation between villages when respondents were asked about specific techniques or skills applied to locate specific sites with abundant mushrooms (Figure 6).

Respondents from Kindimbachini village were significantly more knowledgeable on identification of sites where mushrooms grow than the rest of the villages ($\chi^2 = 10.756$; df = 4; p = 0.029). Corresponding proportions of respondents with demonstrated knowledge to locate forest sites with abundant mushrooms were 90.3%, 77.8% and 61.8% for Kindimbachini, Hinga and Litolomero villages respectively. The technique that was reported to be used to identify areas with abundant mushrooms relates to distinctive mushroom ecological niches as defined by dominant vegetation or tree species, soil types and topography.

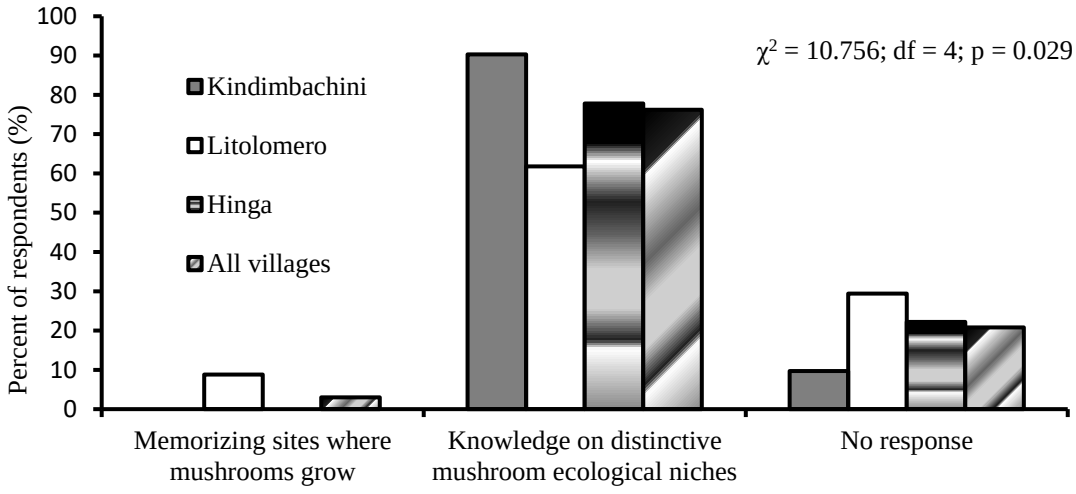


Figure 6: Percent of responses on local techniques used to locate sites with abundant mushrooms

Besides, findings from focus group discussions (FGDs) and field observations revealed at least seven macroscopic features used to differentiate different mushroom species, and/or distinguishing edible from inedible mushrooms:

(i). Size and color of the basidiomata
(ii). Shape and size of preudorrhiza,
(iii). Smell and taste,
(iv). Presence and colour of latex especially for Upoo/Upohu (species from the genius Lactarius)
(v). Volva for species from the genius *Amanita*; and
(vi). Habitat especially dominant miombo tree species and presence of deep soils or stony soils;
(vii). Those not to a large extent sign of certain kind of flies eating the fruit bodies was considered as an important aspect to distinguish edible from inedible mushrooms.

The same parameter was also investigated through questionnaire survey using open ended questions. When asked about their perceived ability to differentiate edible from inedible mushroom species, a total of 99 out of 101 respondents (or 98%) responded to the question affirming their self-confidence in differentiating different mushroom species. Each of these was then asked to explain how he/she differentiated edible from inedible mushroom species. There were multiple responses to the latter, which interestingly enough, conformed to the macroscopic features that had been previously identified from the FDGs (Figure 7). Findings in Figure 7 were generated from pooled data after confirming none significant association between frequencies of mentioning of each of the responses versus villages, and/or wealth categories in each of the study villages.

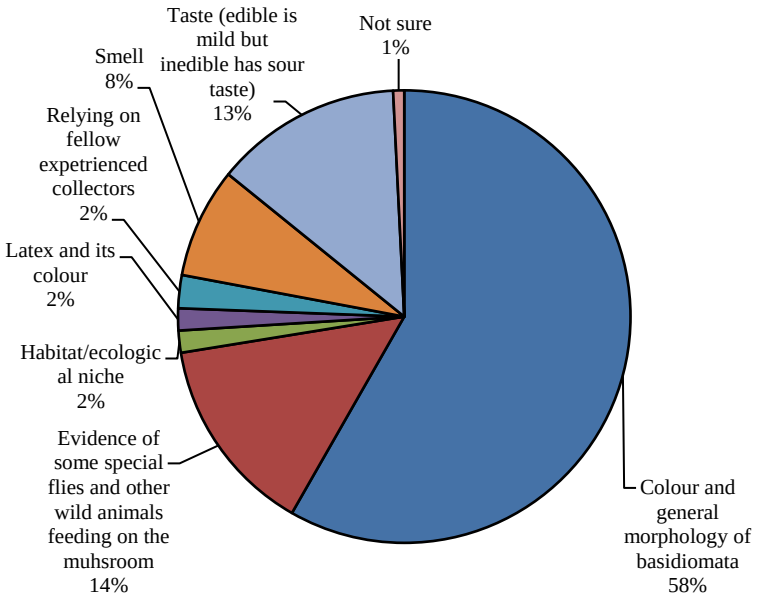


Figure 7: Percent of responses on features used to differentiate edible from inedible mushrooms

Overall, quantitative analysis showed that the most important macroscopic features for differentiating mushroom species were colour and morphology of basidiomata such as size and shape (58% of responses), evidence of some specialized flies and other wild animals feeding on the mushroom (14%); and taste, where mild taste is attributed to edible mushrooms as opposed to bitter or sour taste that signify inedible mushrooms (13%).

When asked how they had acquired their folk taxonomic knowledge, respondents from different villages provided similar responses (Table 6). Overall, more than 88% of respondents across the study villages reported that they had acquired the folk knowledge from parents and grandparents, especially mothers and grandmothers.

Table 6: Proportion of respondents on ways used to acquire folk taxonomy skills

Broad categories of folk taxonomy skills	Ways used to acquire the skills	Percent of respondents from … village(s)				
		Kindimbachini	Litolomero	Hinga	All	Chi-square statistics
Skills for locating sites with abundant mushrooms	Learned from parents and grand parents	92.0	88.9	100	93.7	$\chi^2 = 2.157$; df = 2; p = 0.340
	Self initiative	8.0	11.1	0.0	6.3	
Skills for differentiating edible from inedible mushrooms	Learned from neighbours	6.9	0.0	0.0	2.2	$\chi^2 = 5.336$; df = 4; p = 0.254
	Learned from parents	89.7	96.9	100.0	95.6	
	Personal initiatives and experience	3.4	3.1	0.0	2.2	

Similarly, findings from FGDs revealed a less appreciated but potentially most effective means of transmitting folk taxonomic knowledge for mushrooms that to a large extent conforms to principles of competency-based training approach. The system adopted under the folk taxonomic knowledge transfer involves offering training practically through actual filed orientations where trainees are given opportunity and guided to practice field mushroom identification and picking activities. The training process begins at the age of 7 years, and continues up to about 14 years (i.e. just at completion of primary education). During the early stages of such training, the minors to be trained accompany their mothers, and/or grandmothers for mushroom collection trips where they learn by doing; gradually they are occasionally allowed to work independently but with subsequent stringent validation of all mushrooms collected upon returning home on each day of such independent mushroom collections; finally after reaching the desired standard of proper identification of edible from inedible mushrooms they are then trusted.

3.1.3.2 Nomenclature, traditional classification and species commonly harvested

A total of 42 edible mushroom species were recognized across all four study villages[6]. The species corresponded to 38 different ethnotaxa (Table 7). Table 7 integrates a column for colour photo reference numbers that refer to the colour photos of fresh edible mushroom specimens in the field for mushrooms that were fruiting at the times of field data collection in different villages; these are presented in Appendix 12 with reference numbers corresponding to the ones referenced in Table 7. Other species listed that could not be found in the field were solely identified with the help of colour photos and descriptions in the mycology book (Härkönen et al., 2003), readers are encouraged to consult the book for respective colour photos. The recognized mushroom species belong to eleven (11) genera under four broad categories:

v). Ectomycorrhizal fungi represented by six genera (or 55% of all genera): *Afroboletus, Amanita, Boletus, Cantharellus, Lactarius and Russula*
vi). Termite mushrooms represented by one genus: *Termitomyces*
vii). Saprophitic fungi represented by two genera: *Macrolepiota and Scleroderma*
viii). Decaying wood fungi represented by two genera: *Polyporus and Auricularia*

Table 7: Species of edible wild mushrooms and their vernacular names as recognized by local communities from selected villages within Mbinga and Nyasa districts of Ruvuma region, Tanzania

S/N	Mushroom species (Scientific names)	Local names recognized at …village[7]				Colour photo reference numbers
		Amanimakoro	Kindimbachini	Hinga	Litolomero	
1.	*Cantharellus isabellinus*	Unguyuwu (Ngoni)	Unguyuwu (Ngoni)	Unguyuwu (Mpoto)	Unguyuwu (Nyasa)	9, 18, 24, 28
2.	*Cantharellus platyphyllus*					17, 23
3.	*Russula cellulata [Sensu lato]*	Uhinda (Ngoni)	Uhinda (Ngoni)	Uhinda (Mpoto)	Uhinda (Nyasa)	02, 03, 04, 10, 15

[6]The four villages were Amanimakoro and Kindimbachini in Mbinga district; and Litolomero and Hinga villages in Nyasa district. Amanimakoro did not participate in the final questionnaire survey due to overlap with farming activities.
[7]NA = Not applicable

S/N	Mushroom species (Scientific names)	Local names recognized at …village[7]				Colour photo reference numbers
		Amanimakoro	Kindimbachini	Hinga	Litolomero	
4.	*Amanita loosii*	Ulelema (Ngoni)	Ulelema (Ngoni)	Ulelema (Mpoto)	Ulelema (Nyasa)	30, 31, 32, 33, 34
5.	*Lactarius edulis*	Upoo (Ngoni)	Upoo (Ngoni)	Upohu (Mpoto)	Upoo (Nyasa), Ulondi (Matengo)	
6.	*Lactarius volemoides*					22
7.	*Lactarius xerampelinus [Sensu stricto]*					29
8.	*Lactarius gymnocarpoides*					
9.	*Lactarius sp1*	Kilembesi (Ngoni)	Kilembesi (Ngoni)	NA	NA	14
10.	*Termitomyces letestui*	Ukufu (Ngoni)	Mkufu (Ngoni)	Nkuhu (Mpoto)	Nkuhu (Matengo)	
11.	*Termitomyces eurrhizus*	Ungala (Ngoni)	Mpeta	NA	NA	
12.	*Amanita sp1*	NA	NA	Uhanga-Mwekundu (Mpoto)	NA	37, 38
13.	*Amanita sp2*	NA	NA	Uhanga-Mweusi (Mpoto)	NA	39
14.	*Unknown 2*	NA	NA	NA	Uhanga (Nyasa)	25
15.	*Lactarius sp2 [Sensu lato]*	Uharakata (Ngoni)	Uharakati (Ngoni)	NA	NA	06
16.	*Termitomyces sp1*	Upelepeta (Ngoni)	NA	Upelepeta (Ngoni)	NA	11, 12
17.	*Termitomyces sp2*	Kisanga (Ngoni)	NA	NA	NA	13
18.	*Russula sp1*	Ukolombi (Ngoni)	Lukolombi (Ngoni)	NA	NA	16
19.	*Russula compressa*	Mbatata (Ngoni)	NA	NA	NA	01, 05, 07
20.	*Afroboletus luteolus*	Mandodo (Ngoni)	NA	NA	NA	
21.	*Cantharellus cf. floridula [Sensu lato]*	Kalungeya (Ngoni)	Kalungeya (Ngoni)	NA	NA	08
22.	*Cantharellus symoensii*	NA	NA	Unguyuwu-ukulu (Mpoto)	NA	
23.	*Amanita masasiensis [Sensu stricto]*	Ugongolo (Ngoni)	Magongolo (Ngoni)	NA	Magongolo ya ulelema (Nyasa)	19, 20, 27
24.	*Termitomyces aurantiacus*	Luhano (Manda)	Mandondo (Ngoni)	NA	NA	
25.	*Scleroderma* sp	Matunguhululuku (Ngoni)	NA	Matongohuruku (Mpoto)	NA	
26.	*Russula roseoviolacea*	Undyelesa (Ngoni)	NA	NA	NA	
27.	Cantharellus sp	Uyoga-Joni (Ngoni)	NA	NA	NA	
28.	*Auricularia polyricha [Sensu lato]*	Mangaukau (Ngoni)	Mangaukau (Ngoni)	NA	NA	
29.	*Lactarius tanzanicus*	Umbavala (Ngoni)	NA	NA	NA	

S/N	Mushroom species (Scientific names)	Local names recognized at …village[7]				Colour photo reference numbers
		Amanimakoro	Kindimbachini	Hinga	Litolomero	
30.	*Clavulina wisoli{Sensu lato]*	Ubihi (Ngoni)	NA	Kayunju (Hairy mushroom) (Mpoto)	Kayunju (hairly mushroom) (Nyasa)	21
31.	*Russula hiemisilvae [Sensu lato]*	NA	Uyoga-teleza	Utelesyi (Mpoto)	Utelesyi (Nyasa)	26, 35
32.	*Amanita mafingensis*	NA	NA	NA	Uhanga (Nyasa)	
33.	*Boletus spectabilissimus*	NA	NA	Mandodi (Mpoto)	Mandodi (Nyasa)	
34.	*Lactarius kabansus [Sensu lato]*	NA	NA	Chimemena (Mpoto)	Kamemena (Nyasa)	36
35.	Unknown 3	NA	Upelepeta (Ngoni)	Upelepetu (Mpoto)	Upelepele (Matengo)	
36.	Unknown 4	NA	NA	NA	Moyoumu (Matengo)	
37.	*Termitomyces tyleranus*	Ulundi (Ngoni)	Ulundi (Ngoni)	Ulundi (Mpoto)	NA	
38.	*Termitomyces microcarpus*	NA	Upuli (Ngoni)	NA	NA	
39.	*Macrolepiota dolichaula*	NA	Kibhaya	NA	NA	
40.	Unknown 5	NA	NA	Lulimi lwa ng'ombi (Mpoto)	NA	
41.	*Termitomyces clypeatus*	NA	NA	Nghunda (Mpoto)	NA	
42.	*Polyporus moluccensis [Sensu lato]*	NA	NA	Mangaukau (Mpoto)	NA	
Total number of ethnotaxa recognized		**23**	**18**	**19**	**14**	

There were 23, 18, 19 and 14 ethnotaxa of edible mushrooms recognized by local communities from Amanimakoro, Kindimbachini, Hinga and Litolomero villages respectively. This study focused specifically on edible mushrooms; nevertheless, it was realized that across all the study villages communities did not bother to differentiate different species of inedible mushrooms. All inedible mushrooms were given one name of '*makoko*' for the study villages in Mbinga district or '*Likoko*' for study villages in Nyasa district.

In line with edible wild mushroom species recognized in the study villages (sub-section 3.1.3.2), findings in Table 8 showed that more than 70% of the sample households across all study villages harvested one or more of mushroom species from five genera, namely (in order of importance), *Cantharellus*, *Russula*, *Amanita*, *Lactarius* and *Termitomyces.* The harvested mushroom species corresponded to six ethnotaxa, namely, Unguyuwu, Uhinda, Ulelema, Upoo, Kagenjwa/Kalungeya and Luhano. The first four ethnotaxa were common across all the study villages; and they were consistently listed among the marketable species identified across the study village (see sub-section 3.1.8, Appendix 10). On the other hand, harvesting of Kagenjwa/Kalungeya (*Cantharellus CF. floridula*) was unique to Kindimbachini village (χ^2 = 63.512; df = 2; p = 0.000), whereas harvesting of Luhano (*Termitomyces aurantiacus*) was unique to both Hinga and Litolomero villages (χ^2 = 39.916; df = 2; p = 0.000).

Table 8: Percent of households on mushroom species and respective ethnotaxa commonly harvested

Species	Ethnotaxa	Percent of households in …village			All villages	Chi-square statistics comparing villages
		Kindimbachini	Litolomero	Hinga		
Cantharellus spp	Unguyuwu	**96.8**	**97.1**	**100.0**	**98.0**	$\chi^2 = 1.137$; df = 2; p = 0.566
Russula cellulata [Sensu lato]	Uhinda	**96.8**	**88.2**	**77.8**	**87.1**	$\chi^2 = 5.416$; df = 2; p = 0.067
Amanita loosii	Ulelema	**96.8**	**100.0**	**100.0**	**99.0**	$\chi^2 = 2.281$; df = 2; p = 0.320
Lactarius spp	Upoo	**58.1**	**76.5**	41.7	**58.4**	$\chi^2 = 8.722$; df = 2; p = 0.013
Termitomyces letestui	Mkufu	29.0	2.9	0.0	9.9	$\chi^2 = 18.521$; df = 2; p = 0.000
Termitomyces eurrhizus	Mpeta	9.7	0.0	0.0	3.0	$\chi^2 = 6.981$; df = 2; p = 0.030
Russula sp1	Lukolombi	0.0	14.7	2.8	5.9	$\chi^2 = 7.277$; df = 2; p = 0.026
Cantharellus CF. floridula	Kagenjwa/ Kalungeya	**71.0**	0.0	0.0	**21.8**	$\chi^2 = 63.512$; df = 2; p = 0.000
Termitomyces aurantiacus	Luhano	0.0	**76.5**	**52.8**	**44.6**	$\chi^2 = 39.916$; df = 2; p = 0.000
Amanita masasiensis[Sensu stricto]	Magongolo	22.6	0.0	0.0	6.9	$\chi^2 = 16.983$; df = 2; p = 0.000
Lactarius tanzanicus	Umbavala/ Mandondo	0.0	8.8	5.6	5.0	$\chi^2 = 2.726$; df = 2; p = 0.256
Clavulina wisoli [Sensu lato]	Ubihi	0.0	38.2	13.9	17.8	$\chi^2 = 16.777$; df = 2; p = 0.000
Termitomyces microcarpus	Upuli	0.0	2.9	0.0	1.0	$\chi^2 = 1.990$; df = 2; p = 0.370
Macrolepiota dolichaula	Kivaya	0.0	5.9	0.0	2.0	$\chi^2 = 4.021$; df = 2; p = 0.134

3.1.4 Importance of mushroom collection and trading

The relative importance of mushroom collection and trading were investigated both qualitatively and quantitatively through FGDs and questionnaire survey respectively. Corresponding findings are presented in Table 9 and Figure 8.

As expected, farming was valued as among the most important livelihood activities across all the studied villages where it scored 5 out of 5 points in the participatory livelihood ranking exercises across all the study villages. On the other hand, mushroom collection for consumption as foodstuffs at the household level was ranked highest similar to farming across all study villages. However, the relative importance of mushroom trading varied between villages. Amanimakoro and Kindimbachini villages of Mbinga district ranked mushroom trading with highest scores just as farming whereas the opposite was true for both of the villages in Nyasa district.

For Kindimbachini village, ranking of mushroom trading with highest scores is rather surprising since the village is relatively remote and known to have very limited market access due to poor road compared to the rest.

Table 9: Importance of collection and trading in edible wild mushrooms versus other livelihood activities

Livelihood strategies	Scores on relative importance (1 = least important; 5 = most important)					
	Mbinga district			Nyasa district		
	Amanimakoro	Kindimbachini	Average score for Mbiga district	Hinga	Litolomero	Average score for Nyasa district
Farming	5	5	**5**	5	5	**5**
Livestock keeping	3	5	**4**	5	5	**5**
Business or small enterprises	5	3	**4**	3	4	**3.5**
Beekeeping	2	1	**1.5**	0	0	**0**
Mushroom collection for consumption	5	5	**5**	5	5	**5**
Mushroom trading	5	5	**5**	2	2	**2**
Wild fruits collection for consumption	3	0	**1.5**	0	0	**0**
Firewood collection for consumption	2	2	**2**	5		**5**
Lumbering	2	1	**1.5**	2	1	**1.5**
Charcoal making	2	1	**1.5**	1	1	**1**
Loading coal in trucks (youth)	4	0	**2**	0	0	**0**
Gardening	5	0	**2.5**	0	3	**1.5**
Handcraft	0	1	**0.5**	0	5	**2.5**
Casual labour	0	1	**0.5**	0	0	**0**
Fish farming	0	1	**0.5**	0	0	**0**
Local brewing	0	0	**0**	0	4	**2**
Fishing	0	0	**0**	5	0	**2.5**

However, it was also reported that the village had specific historical incidence of famine of 2010 where trading in dried mushrooms to the neighbouring villages helped most community members to survive the famine. More details are provided in sub-section 3.1.5 and Part IV (b) of Appendix 10.

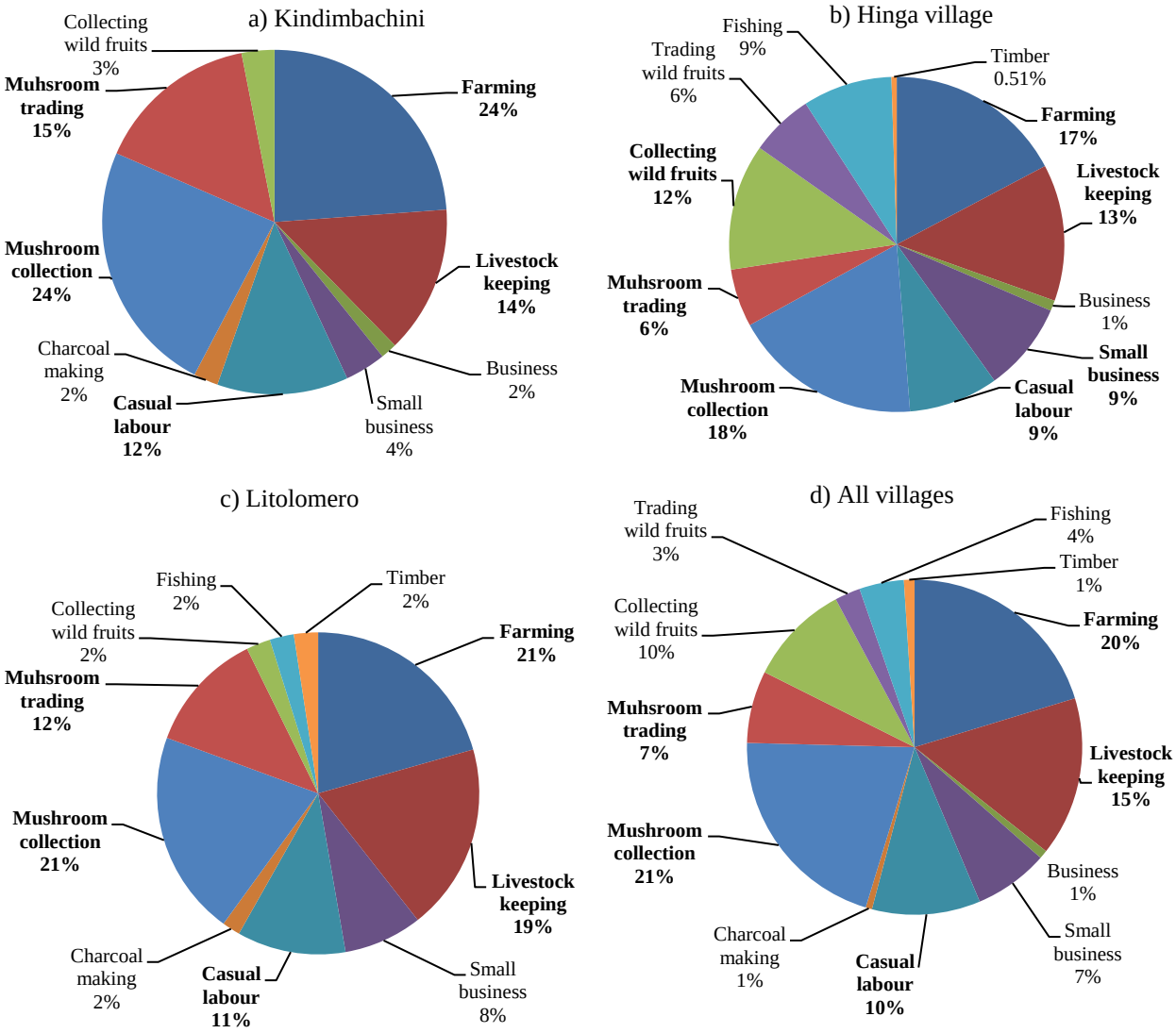


Figure 8: Percent of responses on livelihood activities

3.1.5 Participation in mushroom collection, consumption, processing and trading

Overall census records obtained with the help of village and sub-village leaders indicated that majority (> 77%) of households were involved in collection of edible wild mushrooms (Table 10). This fact was also confirmed by all FGDs and interviews with village leaders (Appendix 10). In all villages, key informants and participants of FGDs confirmed that edible will mushrooms were appreciated as important foodstuffs that were necessary for food security; this was particularly most crucial because their phenology coincides with the peak of food shortages where it was being used as an alternative to meat or fish stews.

An interesting importance of mushrooms was particularly noted in Kindimbachini village; several people from the village recounted incidences of famine that happened in 2010 where they survived by means of dried mushroom reserves.

Table 10: Proportions of total households involved in collection of wild edible mushrooms

Village	Wealth categories			
	Non-poor	Poor	Poorest	All wealth categories
Kindimbachini (n = 458)	79%	91%	74%	86%
Litolomero (n = 129)	100%	89%	96%	94%
Hinga (n = 444)	65%	89%	79%	83%
Overall (n = 1031)	**77%**	**90%**	**81%**	**85%**

Source: Wealth ranking using census records obtained from sub-village leaders

It was reported that during the famine most families survived using their reserves of dried mushrooms which they took to Lituhi, Ndumbi and Mbaha villages to exchange with cereal grains, and/or cassava. A quoted from Kindimbchini village chairperson is revealing (Kindimbachin Village Chairperson, January 26th, 2021):

> "…Just before rainy season of the year 2010, famine became fiercer; many families used their dried mushroom serves to survive, we were carrying dried mushrooms to the nearby villages of Lituhi, Ndumbi and Mbaha villages along the coast of Lake Nyasa... exchanged our dried mushrooms with maize grains and cassava that took us through the famine…mushrooms are highly respected…keeping reserves of dried mushrooms has become an important aspect of not only livelihoods but also the overall culture of our society".

Regarding trading in fresh mushrooms, findings in Table 11 revealed that households from both Hinga ($\chi^2 = 11.019$; df = 1; p = 0.001) and Kindimbachini ($\chi^2 = 4.675$; df = 1; p = 0.031) villages were significantly more likely to engage in selling of fresh edible wild mushrooms than their counterparts in Litolomero village. The 27.8% of household selling fresh mushrooms in Hinga village was the highest compared to 12.9% and none in Kindimbachini and Litolomero village respectively. The main reason for not selling fresh mushrooms in Litolomero village, as reported by the village leaders during group interview, was the fact that almost every person in the village had free and easy access to mushrooms that grow abundantly in every part of the village;

Table 11: Proportion (%) of households (n = 101) involved in processing (drying) edible wild mushrooms, and selling fresh and dried mushrooms

Village	Wealth category	Selling fresh mushrooms	Processing (drying) fresh mushrooms	Selling dried mushrooms
Kindimbachini	Non-poor	0.0	100.0	100.0
	Poor	20.0	75.0	60.0
	Poorest	0.0	100.0	50.0
	Overall	**12.9**	**83.9**	**61.3**
	Chi-square statistics comparing wealth categories	$\chi^2 = 2.526$; df = 2; p = 0.283	$\chi^2 = 3.279$; df = 2; p = 0.194	$\chi^2 = 2.339$; df = 2; p = 0.331
Litolomero	Non-poor	0.0	100.0	0.0
	Poor	0.0	88.9	22.2
	Poorest	0.0	85.7	0.0
	Overall	**0.0**	**88.2**	**5.9**
	Chi-square statistics comparing wealth categories	Not applicable	$\chi^2 = 0.666$; df = 2; p = 0.717	$\chi^2 = 5.903$; df = 2; p = 0.052
Hinga	Non-poor	0.0	50.0	0.0
	Poor	14.3	57.1	0.0
	Poorest	44.4	83.3	0.0
	Overall	**27.8**	**69.4**	**0.0**
	Chi-square statistics comparing wealth categories	$\chi^2 = 5.301$; df = 2; p = 0.071	$\chi^2 = 3.348$; df = 2; p = 0.188	Not applicable
All villages	Non-poor	0.0	81.8	27.3
	Poor	14.0	72.1	32.6
	Poorest	17.0	87.2	8.5
	Overall	**13.9**	**80.2**	**20.8**
	Chi-square statistics comparing wealth categories	$\chi^2 = 2.163$; df = 2; p = 0.339	$\chi^2 = 3.262$; df = 2; p = 0.196	$\chi^2 = 8.200$; df = 2; p = 0.017
Chi-square statistics comparing villages		**Overall test:** $\chi^2 = 11.334$; df = 2; p = 0.003 **Hinga vs Litolomero:** $\chi^2 = 11.019$; df = 1; p = 0.001 **Hinga vs Kindimbachini:** $\chi^2 = 2.230$; df = 1; p = 0.135 **Litolomero vs Kindimbachini:** $\chi^2 = 4.675$; df = 1; p = 0.031	**Overall test:** $\chi^2 = 4.268$; df = 2; p = 0.118	**Overall test:** $\chi^2 = 44.912$; df = 2; p = 0.000 **Hinga vs Litolomero:** $\chi^2 = 2.180$; df = 1; p = 0.140 **Hinga vs Kindimbachini:** $\chi2 = 30.798$; df = 1; p = 0.000 **Litolomero vs Kindimbachini:** $\chi^2 = 22.763$; df = 1; p = 0.000

On the other hand, field observations (Figure 9) and interview with village leaders from Litolomero village revealed that the village is endowed with ubiquitous healthy forests in which mushrooms are growing abundantly almost everywhere (Village Chairperson and Village Executive Officer, March 5th 2021)[8]:

> "…we are the main producers of mushrooms in this area; as you might have observed, we have healthy forests everywhere that are producing abundant mushrooms every year…we do not even need to go to forests at Nahinga hills to get the quantities of mushrooms needed…only few people residing in Kingw'ina sub-village are the ones who collect mushrooms from the hill …we sell dried mushrooms to our neighbors residing in Hinga, Ngumbo and Litoho villages; they have limited supply of mushrooms since they have converted most of their forests into farms… now, they have to walk long distances to Nahinga hill to get mushrooms of which most people fail…all they get is fresh mushrooms that they consume during the season, they have little surplus for drying, so they are good customers of our dried mushrooms"

Figure 9: A snapshot showing a part of healthy forest endowment in Litolomero village

Though no significant difference was noted between wealth categories with respect to selling fresh mushrooms within Hinga village (χ^2 = 5.301; df = 2; p = 0.071), the poorest households (44%) were more involved in selling fresh mushrooms than the poor (14.3%) and non-poor (0%). The pattern was less clear in Kindimbachini village with only some of the poor households being involved in selling fresh mushrooms (20%) against none of the poorest and non-poor. On the other hand, findings clearly indicated a consistent pattern across all study villages where none of the non-poor households interviewed was involved in selling fresh mushrooms. With exception of Litolomero village, it can be seen that selling fresh mushrooms was an activity for the poor and poorest but not the non-poor. The reverse pattern was true for trading dried mushrooms with respect to pooled data (see below). Additional qualitative information from Litolomero village revealed that during mushroom season every household, including a few civil servants mostly teachers, have access to plenty mushrooms since they are abundantly available in every part of the village, even close to homesteads. Because of this fact, there was no demand for fresh mushrooms within the village; and even the markets in the neighbouring villages are almost oversaturated during the mushroom season.

[8]These were interviewed through the phone and voice note was recorded

Findings in Table 11 further revealed that mushrooms drying as food reserve for use during dry season and famine times was common and similar across all the surveyed villages ($\chi^2 = 4.268$; df = 2; p = 0.118). More than 50% of households were involved in the practice regardless of their wealth status. Also, variation within villages among wealth categories with respect to selling dried mushrooms was not significant across all villages. However, the pooled data showed significant variation between wealth categories in their participation in selling dried mushrooms ($\chi^2 = 8.200$; df = 2; p = 0.017); the non-poor and poor were more likely to sell dried mushrooms than the poorest. Also, though not significant, findings showed a unique pattern regarding differences in wealth categories for selling dried mushrooms in Litolomero village ($\chi^2 = 5.903$; df = 2; p = 0.052), where slightly more poor household (22.2%) were involved in selling dried mushrooms than the non-poor (0%) or poorest (0%) households.

Wealth categories did not differ significantly in their involvement in selling of dried mushrooms across villages. However, there was significant difference between villages on proportion of households involved in selling dried mushrooms ($\chi^2 = 44.912$; df = 2; p = 0.000), where the proportion of households involved in selling dried mushrooms was highest in Kindimbachini (61.3%) than Hinga (0.0%) and Litolomero (5.9%) villages. It is worth noting that none of the households in Hinga were engaged in selling dried mushrooms at all. Overall, it can be seen that the non-poor in Kindimbachini village were attracted to sell dried mushrooms in a similar way as the poor and poorest than it was for the case of fresh mushrooms.

3.1.6 Phenology and marketability of edible wild mushroom species identified

Details on phenology and marketability analysis of edible wild mushroom species indentified in the study villages are provided in Appendix 13; a matrix of marketable mushroom species is shown in Table 12. From Appendix 13, the phenology of mushrooms in the study villages begin in December, peaks in January and continues up to April.

The number of identified marketable mushroom species was highest in Kindimbachini (15 species) and least in Litolomero (4 species). Three genera of *Amanita*, *Cantharellus* and *Russula* were simultaneously identified as being marketable across all the study villages. These matches the top three species that simultaneously scored highest frequencies of mentioning for being the most harvested species as presented in Table 8. This list also matches the list provided by the mushroom traders in Mbinga town (Appendix 10 Part V(b), (c)).

Table 12: Marketable mushroom species in the study villages within Mbinga and Nyasa districts of Ruvuma region, Tanzania

Mushroom species	Ethnotaxa	Presence of marketable mushrooms species in …village*			
		Amanimaro	Kindimbachini	Hinga	Litolomero
Amanita loosii	Ulelema (Ngoni, Nyasa)	√	√	√	√
Amanita masasiensis [Sensu stricto]	Ugongolo (Ngoni)	√	X	X	X
Auricularia polyricha [Sensu lato]	Mangaukau (Ngoni)	√	√	X	X
Cantharellus cf. floridula [Sensu lato]	Kalungeya (Ngoni)	X	√	X	X
Cantharellus spp	Unguyuwu (Ngoni)	√	√	√	X
Cantharellus symoensii	Unguyuwu-ukulu (Mpoto)	X	X	√	X
Clavulina wisoli	Kayunju (hairy mushroom) (Mpoto)	X	X	√	X
Lactarius kabansus [Sensu lato]	Kamemena (Nyasa)/Chimemena (Mpoto)	X	X	X	√
Lactarius sp1	Kilembesi (Ngoni)	√	√	X	X
Lactarius sp2	Uhalakati (Ngoni)	X	√	X	X
Lactarius spp	Upoo (Ngoni, Nyasa); Ulondi (Matengo)	X	√	X	√
Polyporus moluccensis[Sensu lato]	Mangaukau (Mpoto)	X	X	√	X
Russula cellulata [Sensu lato]	Uhinda (Ngoni, Nyasa)	√	√	√	√
Russula hiemisilvae [Sensu lato]	Uyoga-teleza	X	√	X	X
Russula sp1	Lukolombi (Ngoni)	X	√	X	X
Termitomyces aurantiacus	Mandondo (Ngoni)	X	√	X	X
Termitomyces clypeatus	Nghunda (Mpoto)	X	X	√	X
Termitomyces eurrhizus	Ungala (Ngoni)/Mpeta (Ngoni)	√	√	X	X
Termitomyces letestui	Mkufu (Ngoni)/Nkuhu (Mpoto)	X	√	√	X
Termitomyces microcarpus	Upuli (Ngoni)	X	√	X	X
Termitomyces tyleranus	Ulundi (Ngoni, Mpoto)	√	X	√	X
Unknown 3	Upelepeta (Ngoni)/Upelepetu (Mpoto)	X	√	√	X
Total number of marketable species identified		**8**	**15**	**10**	**4**

*√ = Present; X= Absent

3.1.7 Harvesting practices

This study investigated harversting practices pereformed in different study villages in order to gauge their sustainability based on sustainability of different practices as evaluated in the mainsteam literature (e.g. Hosford et al., 1997; Boa, 2004; Egli et al., 2006; Luoma et al., 2006; He at al., 2011; Zotti et al., 2013). The harvesting practices assessed were: the way picking of mushrooms is done, propotion of mushrooms of different growth stages in each harvesting occasion and utensils used to carry mushrooms from harvesting sites. Respective findings are presented in the following sub-sections.

3.1.7.1 Mushroom picking practices

The question sked was open ended[9], with predetermined multiple response categories: 1) complete uprooting using hands, 2) cutting stem using fingers, 2) using stick to uproot mushrooms, 3) using knife or machete to cut the mushroom stem, 4) using knife or machete to uproot mushrooms, 5) covering with soil spots where muhsrooms are uprooted, and 6) Others. Findings revealed that use of knife, sticks and machetes; and covering soils on spots where mushrooms are picked were consisitently not practiced at all across villages (Figure 10).

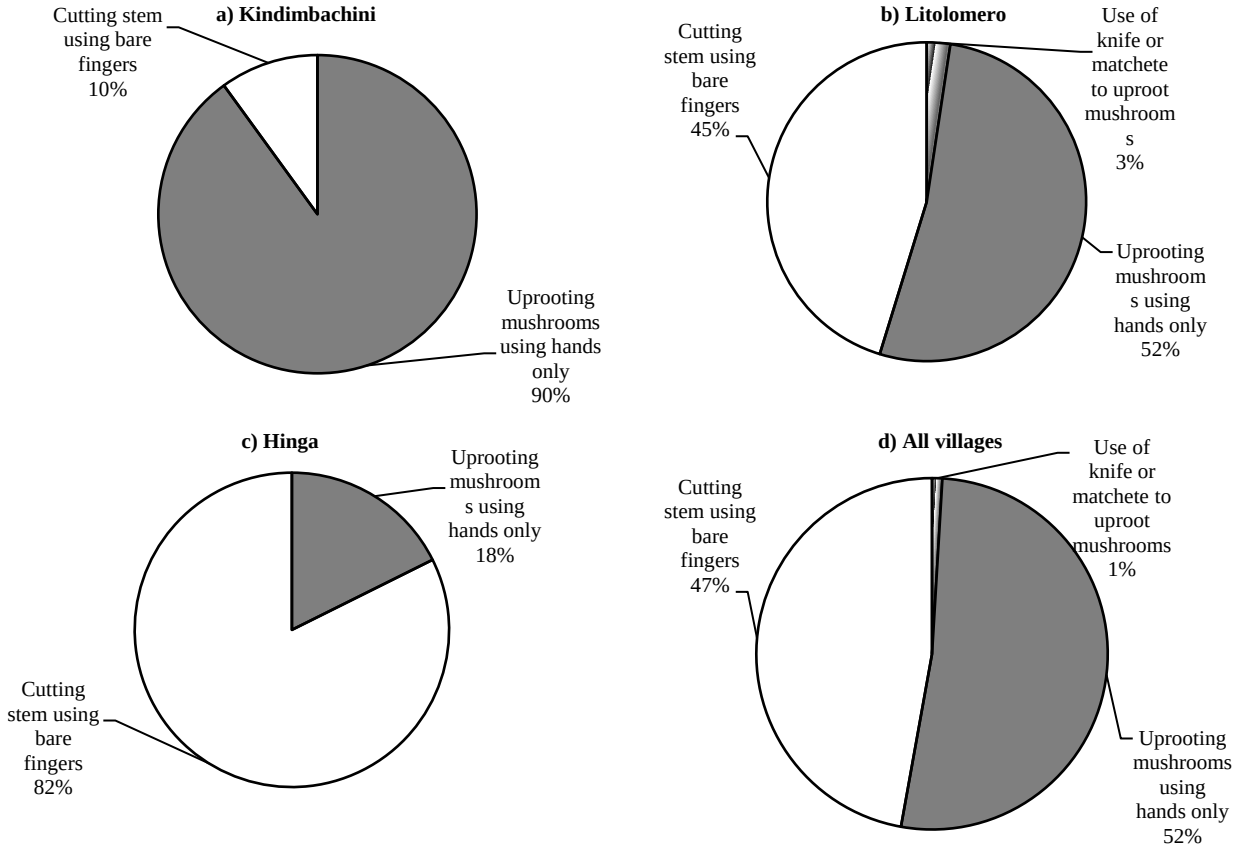


Figure 10: Proportions of responses on mushroom picking practices by villages

Conversely, cutting stems with fingers and complete uprooting using hands were the only popular practices used; these exhibited significant variation between villages with chi-square statistics of $\chi^2 = 35.485$; df = 2; p = 0.000 and $\chi^2 = 31.736$; df = 2; p = 0.000, respectively. Proportions of household practicing uprooting were high and similar in Kindimbachini (87%) and Litolomero (65%) compared to Hinga (17%). On the other hand, the pattern for proportions of respondents practicing cutting stems with fingers was in the reverse order compared to the former. Corresponding proportions of households that practiced cutting mushroom stems with fingers were 10%, 56% and 78%. On the other hand, qualitative information indicated that the motive behind cutting mushroom stems with finger was entirely hyigienic, the purpose being to avoid contamination with soil particles.

[9]Once you are in a mushroom harvesting site, how do you harvest mushrooms (tools, equipments and the process of harvesting used)?

3.1.7.2 Proportions of mushrooms of different growth stages

For young mushrooms having closed caps and intermediate maturity stage having caps half opened, in all cases, though very close, the mean values were slighty lower than the median values. However, the pattern was similar but reversed for complete mature mushrooms having completely opened caps (Table 13).

Table 13: Percent distribution of mushrooms harvested at different growth stage

Village	Young mushrooms having closed caps					Intermediate maturity stage having caps half opened					Complete mature mushrooms having completely opened caps				
	Mean	Median	Minimum	Maximum	Range	Mean	Median	Minimum	Maximum	Range	Mean	Median	Minimum	Maximum	Range
Kindimbachini (n = 31)	47.4	50.0	20.0	100.0	80.0	24.7	30.0	0.0	40.0	40.0	27.9	25.0	0.0	50.0	50.0
Litolomero (n = 34)	47.4	40.0	10.0	60.0	50.0	24.7	30.0	20.0	40.0	20.0	27.9	25.0	10.0	70.0	60.0
Hinga (n = 36)	35.0	40.0	0.0	60.0	60.0	29.2	30.0	0.0	40.0	40.0	33.1	30.0	0.0	60.0	60.0
All villages (n =101)	40.4	40.0	0.0	100.0	100.0	27.8	30.0	0.0	40.0	40.0	30.8	30.0	0.0	70.0	70.0

The closeness of the mean and median values shows that the distribution of proportions of the different growth stages of mushrooms was closer to normal. Cearlly, there was very low variation between villages; and the median values for proportions of young mushrooms having closed caps were always below or exactly 50%. Litolmero and Hinga registerd equal median value of 40% for young mushrooms having closed caps; the value for Kindimbachini was 50%. The pattern for mushrooms of intermediate maturity stage having caps half opened and complete mature mushrooms having completely opened caps was similar to that of young mushrooms having closed caps but with values nnot exceeding 30% regardless of the village.

3.1.7.3 Utensils used to carry mushrooms

Utensils used in the study villages for carrying food items were bamboo baskets; palm leaves baskets, sisal sacks and plastic buckets. There were no significant variation on proportion of respondents using different untensils for carrying mushrooms, except for use of plastic buckets where there was significantly high and similar proportions of respondents ($\chi^2 = 31.736$; df = 2; p

= 0.000) who reported to use plastic buckets for carring mushrooms in Litolomero (94.1%) and Hinga (86.5%) than Kindimbahini village (58.1%). Overall, findings were multiple responses as presented in Figure 11.

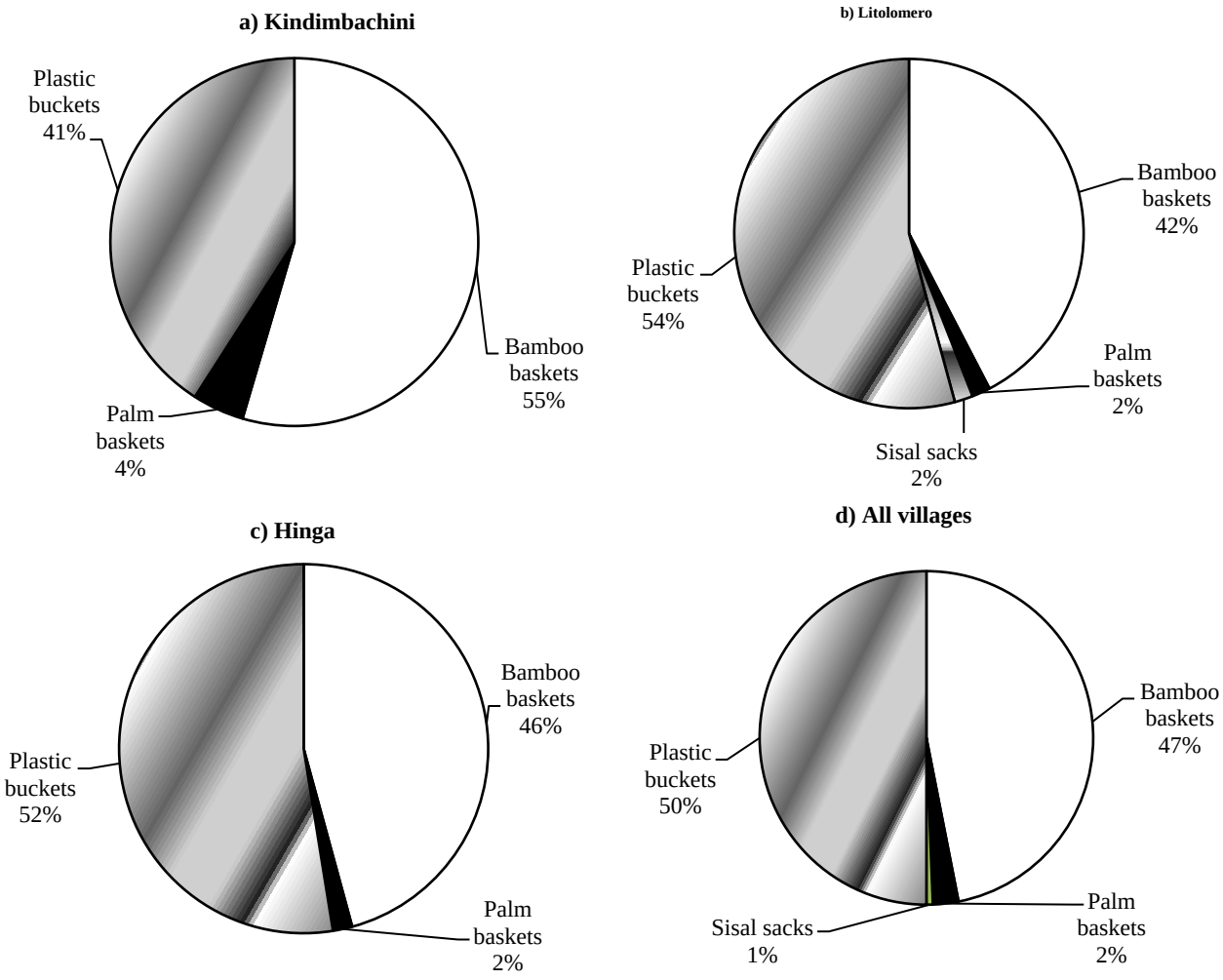


Figure 11: Percent of responses on utensils used to carry mushrooms from harvesyting sites

Findigs clearly showed that the main utensils for carrying mushrooms were bamboo baskets and plastic buckets of various sizes with overall percentages of 47% and 50%. Taken in totality, it appears that there were no marked differences between villages with regard to frequencies of use of bamboo baskets and buckets. The slight difference between the frequencies of mentioning of plastic buckets in relation to other utensils versus the frequencies of individuals who reported to use buckets means that the utensils are used in combination

3.1.7.4 Willingess to change harvesting practices due to technological development

Findings on proportions of respondents on their willingness to change mushroom harvesting practices whenever proved sustainable practices are promnoted did not vary between villages (Figure 12).

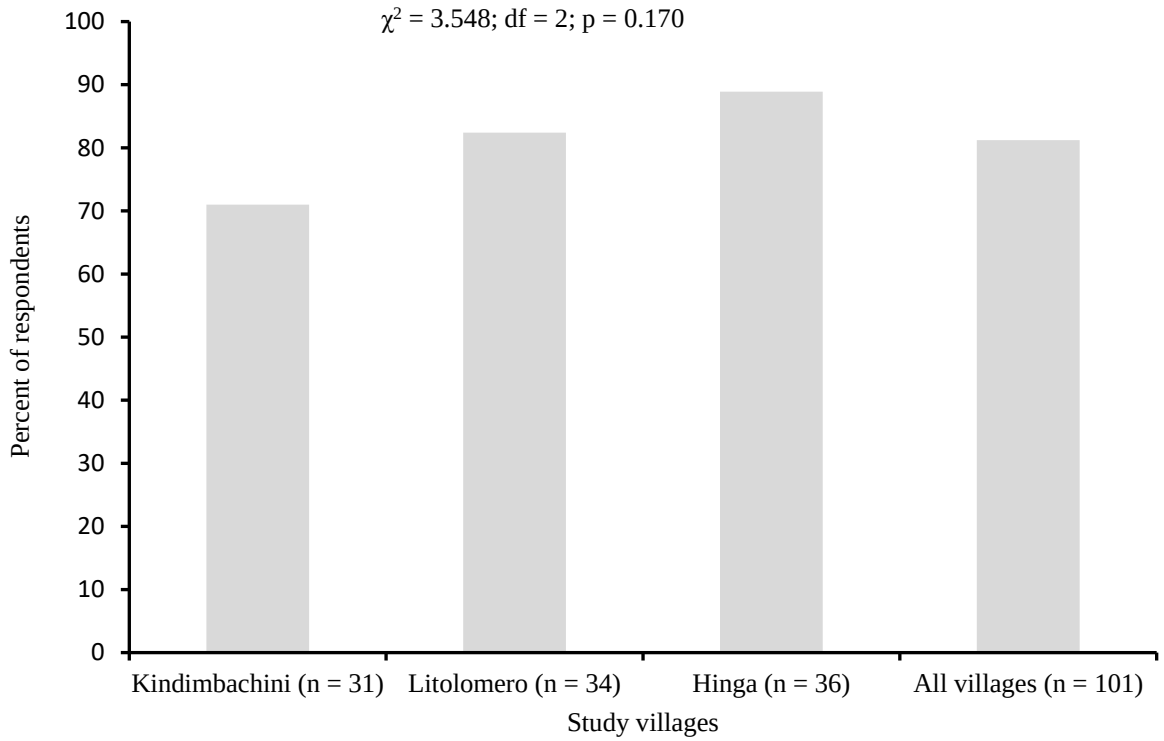


Figure 12: Proportions of respondents on their willingness to change harvesting practices with advent of more sustainable practices

Majority of the respondents (> 71%) across villages indicated that they were willing to change mushroom harvesting practices once sustainable practices are discovered and proved.

3.1.8 Quantities of fresh mushrooms collected, consumed, processed and traded

Based on median values for fresh mushrooms harvested presented in Table 14, it is evident that within villages variation due to wealth categories was more pronounced in Kindimbachini than the rest of the villages. The rest of the villages tended to have similar median values for the amount of fresh mushrooms harvested across wealth categories. For Kindimbachini village, the median values of the quantities of fresh mushrooms harvested were higher and similar for the poor (2540 litres) and non-poor (2,400 litres) than the poorest (280 litres); the median values for each of non-poor and poor were 8 folds of that of the poorest.

Though not so conspicuous, the reverse pattern was consistently observed in Litolomero and Hinga villages, where the median values of the quantities of fresh mushrooms harvested tended to be slightly higher for the poorest than the poor and non-poor households. In Litolomero village, the median value of fresh mushrooms collected by the poorest was 50% and 88% higher compared to the values for the poor and non-poor, correspondingly. The pattern in Hinga village was similar to that of Litolomero; where the median value for the quantity of fresh mushrooms harvested by the poorest was 83% and 50% higher compared to the values for the poor and non-poor, respectively.

Table 14: Total annual quantities of fresh edible wild mushrooms collected, consumed, processed and sold expressed in litres per household

Village	Wealth category	Fresh mushrooms collected				Fresh mushrooms consumed				Fresh mushrooms processed				Fresh mushrooms sold			
		Median	Minimum	Maximum	Range	Median	Minimum	Maximum	Range	Median	Minimum	Maximum	Range	Median	Minimum	Maximum	Range
Kindimbachini	Non-poor (n = 3)	2,400	2,240	3,840	1,600	224	192	800	608	2,016	1,600	3,648	2,048	-	-	-	-
	Poor (n = 20)	2,540	320	5,600	5,280	380	96	1,000	904	1,760	720	4,640	3,920	760	640	840	200
	Poorest (n = 8)	280	240	1,200	960	176	140	800	660	140	48	1,040	992	-	-	-	-
	Overall (n = 31)	2,240	240	5,600	5,360	320	96	1,000	904	1,520	48	4,640	4,592	760	640	840	200
Litolomero	Non-poor (n = 4)	384	240	600	216	156	144	360	192	204	96	288	-	-	500	500	-
	Poor (n = 9)	480	300	1,280	618	180	150	768	618	300	150	768	-	-	500	500	-
	Poorest (n = 21)	720	200	4,000	880	210	80	960	2,940	400	100	3,040	-	-	500	500	-
	Overall (n = 34)	620	200	4,000	880	201	80	960	2,944	310	96	3,040	-	-	500	500	-
Hinga	Non-poor (n = 4)	588	480	900	420	294	240	300	60	294	240	600	360	-	-	-	-
	Poor (n = 14)	480	180	1,500	1,320	210	45	800	755	300	96	1,080	984	500	500	500	-
	Poorest (n = 18)	880	450	4,800	4,350	392	225	1,200	975	450	90	2,400	2,310	1,080	630	2,000	1,370
	Overall (n = 36)	720	180	4,800	4,620	300	45	1,200	1,155	360	90	2,400	2,310	864	500	2,000	1,500
All villages	Non-poor (n = 11)	600	240	3,840	3,600	240	144	800	656	288	96	3,648	3,552	-	-	-	-
	Poor (n = 43)	1,280	180	5,600	5,420	300	45	1,000	955	744	96	4,640	4,544	680	500	840	340
	Poorest (n = 47)	800	200	4,800	4,600	300	80	1,200	1,120	400	48	3,040	2,992	1,080	630	2,000	1,370
	Overall (n = 101)	800	180	5,600	5,420	300	45	1,200	1,155	400	48	4,640	4,592	784	500	2,000	1,500

Regarding the maximum amounts of fresh mushrooms harvested, Kindimbachini village recorded exceptionally highest values and unique pattern than the rest of the villages. For Kindimbachini village, the maximum amount of fresh mushrooms harvested was highest for the poor household and similar to non-poor households, whereas the poorest recorded the least value.

The reverse was true for each of Litolomero and Hinga villages where the least maximum values of fresh mushrooms collected was recorded in the non-poor households, with the poorest consistently registering the highest values. Overall, Kindimbachini had the highest median values, and minimum and maximum values of quantities of fresh mushrooms harvested than the rest of the villages. The overall median value for quantity of fresh mushrooms harvested in Kindimbachini was 261% and 211% higher in comparison to the values recorded in Litolomero and Hinga villages, respectively. The corresponding values for minimum and maximum values were 20% and 33%, and 17% and 40%.

The variation in the amount of fresh mushrooms consumed did not vary much both within and between villages. This suggests that the variation observed for the quantities of fresh mushrooms collected reflected the amount needed for processing and subsequent trading in dried mushrooms than mere household consumption. Indeed, as for fresh mushrooms harvested, within village variation due to wealth categories was much pronounced in Kindimbachini than the rest of the villages with respect to quantities of fresh mushrooms processed i.e. dried.

On the other hand, findings on quantities of mushrooms processed matches the total amounts of fresh mushrooms collected; which, as it will be seen later in sub-section 3.1.10, are further linked the incomes generated from trading in dried mushrooms. Thus, for Kindimbachini village, the median values of the quantities of fresh mushrooms processed were higher and similar for the poor (1760 litres) and non-poor (2016litres) than the poorest (140 litres); the median values for each of non-poor and poor were 13 and 12 folds of that of the poorest. Similarly, the overall median value of the fresh mushrooms processed for Kindimbachini village was higher by 390% and 322% compared to the values for Litolomero and Hinga villages, respectively.

As expected, findings on the quantities of fresh mushrooms sold mirrored respective participation in trading of fresh mushrooms as presented in Table 11. In Litolomero village, trading in fresh mushrooms was not practiced at all; whereas in Kindimbachini and Hinga villages, the tendency was the poor and poorest being the only partakers of the fresh mushrooms trading where they sold up to 500 liters and 2000 litres respectively.

3.1.9 Quantities of dried mushrooms produced, consumed, processed and traded

As to be expected, quantities of dried mushrooms produced per household (Table 15) varied in accordance to the quantities of fresh mushrooms processed, which also relate to the total quantities of fresh mushrooms produced as already shown in Table 14. Within village variation of the quantities of dried mushrooms produced per household was more pronounced in Kindimbachini than the other study villages. For Kindimbachini, the median values of dried mushrooms produced by the non-poor and poor households were 842% and 213% higher than the value for the poorest households.

Table 15: Total annual quantities of dried edible wild mushrooms produced, consumed and sold expressed in litres per household

Village	Wealth category	Total dried mushrooms produced				Total dried mushrooms consumed				Dried mushrooms sold			
		Median	Minimum	Maximum	Range	Median	Minimum	Maximum	Range	Median	Minimum	Maximum	Range
Kindimbachini	Non-poor (n = 3)	518	269	800	531	80	40	160	120	438	229	640	411
	Poor (n = 20)	172	80	438	358	37	10	80	70	131	20	379	359
	Poorest (n = 8)	55	2	148	146	19	2	40	38	95	68	108	40
	Overall (n = 31)	176	2	800	798	49	2	160	158	180	20	640	620
Litolomero	Non-poor (n = 4)	10	5	14	10	10	5	14	10	-	-	-	-
	Poor (n = 9)	16	8	38	31	10	-	18	18	18	15	20	5
	Poorest (n = 21)	14	2	25	23	11	-	25	25	8	8	8	-
	Overall (n = 34)	14	2	38	36	11	-	25	25	14	8	20	12
Hinga	Non-poor (n = 4)	7	3	10	7	5	-	10	10	-	-	-	-
	Poor (n = 14)	10	4	20	16	6	-	20	20	3	3	3	-
	Poorest (n = 18)	40	5	120	116	33	-	120	120	-	-	-	-
	Overall (n = 36)	26	3	120	117	20	-	120	120	3	3	3	-
All villages	Non-poor (n = 11)	162	3	800	797	30	3	160	157	438	229	640	411
	Poor (n = 43)	87	4	438	434	29	4	80	76	110	3	379	376
	Poorest (n = 47)	31	2	148	146	24	2	120	118	73	8	108	100
	Overall (n = 101)	69	2	800	798	27	2	160	158	145	3	640	637

The pattern was reverse for Litolomero and Hinga villages, where production of dried mushrooms per household was highest in the poor and least in the non-poor households. In Litolomero village, the median values of dried mushrooms of 14 litres for the poorest and 16 litres for the poor households were 100% and 129% higher than the value of 7 litres for the non-poor households. A similar pattern but slightly reversed pattern was observed in Hinga village, where the poorest and non-poor recorded the highest and least median values, respectively.

Similarly, based on the median values of dried mushrooms produced per household, annual production of dried mushrooms per household in Kindimbachini suppressed the ones for Litolomero and Hinga villages by 1157% and 577%, respectively. However, variation in the quantities of dried mushrooms consumed at households followed the same pattern as production though the differences within and between villages tended to be less pronounced compared to the pattern exhibited for production levels.

3.1.10 Incomes generated from trading of edible wild mushrooms

Income generated from trading in fresh and dried mushrooms epitomize the quantities of fresh and dried mushrooms produced and sold (Table 14, 15). Since trading in fresh mushrooms was less common, total income from fresh mushrooms reflects the values of mushrooms consumed at the household level; which is dependent on the amount consumed. On the other hand, total incomes from dried mushrooms and overall total incomes bring in the variations associated with the quantities of dried mushrooms traded (Table 16). Similar to the pattern observed for the quantities of dried mushrooms, the total incomes from dried mushrooms tended to higher for the non-poor and poor households for Kindimbachini, whereas the reverse was true to the rest of the studied village when total incomes from dried mushrooms tended to be similar across wealth categories. In Kindimbachini, the overall total incomes from fresh and dried mushrooms went up to 2,000,000 TZS (or USD 869), 1,212,000 TZS (or USD 527) and 296,000 TZS (or USD 303) for the non-poor, poor and poorest households. Corresponding values for the overall maximum cash incomes from fresh and dried mushrooms in Table 16 were 1,280,000 TZS (or USD 557), 758,000 TZS (or USD 330) and 216,000 TZS (or USD 94). The maximum value of the overall total incomes from fresh and dried mushrooms in Kindimbachini village was higher than that of Litolomero and Hinga villages by 285% and 25%, respectively. Similarly, the maximum value of the overall cash incomes from fresh and dried mushrooms in Kindimbachini was higher than that of Litolomero and Hinga villages by 3100% and 28%, respectively (Table 17).

Table 16: Total annual incomes from consumption and trading of edible wild mushrooms (TZS /household/year; US$1 = TZS 2,300)

Village	Wealth category	Fresh mushrooms (TZS/Year)				Dried mushrooms (TZS/Year)				Combined overall income fresh and dried mushrooms (TZS/Year)			
		Median	Minimum	Maximum	Range	Median	Minimum	Maximum	Range	Median	Minimum	Maximum	Range
Kindimbachini	Non-poor (n = 3)	112,000	96,000	400,000	304,000	972,800	537,600	1,600,000	1,062,400	1,068,800	649,600	2,000,000	1,350,400
	Poor (n = 20)	240,000	48,000	800,000	752,000	354,000	160,000	876,000	716,000	475,600	120,000	1,212,000	1,092,000
	Poorest (n = 8)	88,000	70,000	400,000	330,000	40,000	4,800	296,000	291,200	110,000	81,600	696,000	614,400
	Overall (n = 31)	160,000	48,000	800,000	752,000	296,000	4,800	1,600,000	1,595,200	451,200	81,600	2,000,000	1,918,400
Litolomero	Non-poor (n = 4)	78,000	72,000	180,000	108,000	20,400	9,600	28,800	19,200	100,800	81,600	204,000	122,400
	Poor (n = 9)	90,000	75,000	384,000	309,000	22,600	15,000	76,800	61,800	110,000	90,000	435,200	345,200
	Poorest (n = 21)	105,000	40,000	480,000	440,000	29,500	4,000	50,000	46,000	145,000	44,000	520,000	476,000
	Overall (n = 34)	100,500	40,000	480,000	440,000	24,600	4,000	76,800	72,800	113,500	44,000	520,000	476,000
Hinga	Non-poor (n = 4)	147,000	120,000	150,000	30,000	16,000	6,000	20,000	14,000	157,000	126,000	166,000	40,000
	Poor (n = 14)	105,000	22,500	500,000	477,500	20,000	8,000	40,000	32,000	105,000	32,000	524,000	492,000
	Poorest (n = 18)	280,000	112,500	1,400,000	1,287,500	40,000	9,000	240,000	231,000	300,000	135,000	1,600,000	1,465,000
	Overall (n = 36)	150,000	22,500	1,400,000	1,377,500	22,500	6,000	240,000	234,000	180,000	32,000	1,600,000	1,568,000
All villages	Non-poor (n = 11)	120,000	72,000	400,000	328,000	22,000	6,000	1,600,000	1,594,000	164,000	81,600	2,000,000	1,918,400
	Poor (n = 43)	150,000	22,500	800,000	777,500	64,000	8,000	876,000	868,000	204,800	32,000	1,212,000	1,180,000
	Poorest (n = 47)	150,000	40,000	1,400,000	1,360,000	40,000	4,000	296,000	292,000	190,000	44,000	1,600,000	1,556,000
	Overall (n = 101)	150,000	22,500	1,400,000	1,377,500	40,000	4,000	1,600,000	1,596,000	190,000	32,000	2,000,000	1,968,000

Table 17: Total cash incomes exclusive from trading of fresh and dried edible wild mushrooms (TZS /household/year; US$1 =TZS 2300)

Village	Wealth category	Cash income from fresh mushrooms				Cash income from dried mushrooms				Combined cash incomes from fresh and dried mushrooms			
		Median	Minimum	Maximum	Range	Median	Minimum	Maximum	Range	Median	Minimum	Maximum	Range
Kindimbachini	Non-poor (n = 3)	-	-	-	-	892,800	457,600	1,280,000	822,400	892,800	457,600	1,280,000	822,400
	Poor (n = 20)	380,000	320,000	420,000	100,000	252,000	40,000	758,000	718,000	351,200	40,000	758,000	718,000
	Poorest (n = 8)	-	-	-	-	216,000	136,000	216,000	80,000	216,000	136,000	216,000	80,000
	Overall (n = 31)	380,000	320,000	420,000	100,000	252,000	40,000	1,280,000	1,240,000	351,200	40,000	1,280,000	1,240,000
Litolomero	Non-poor (n = 4)	-	-	-	-	-	-	-	-	-	-	-	-
	Poor (n = 9)	-	-	-	-	35,000	30,000	40,000	10,000	35,000	30,000	40,000	10,000
	Poorest (n = 21)	-	-	-	-	16,000	16,000	16,000	-	16,000	16,000	16,000	-
	Overall (n = 34)	-	-	-	-	30,000	16,000	40,000	24,000	30,000	16,000	40,000	24,000
Hinga	Non-poor (n = 4)	-	-	-	-	-	-	-	-	-	-	-	-
	Poor (n = 14)	250,000	250,000	250,000	-	6,000	6,000	6,000	-	250,000	6,000	250,000	244,000
	Poorest (n = 18)	540,000	315,000	1,000,000	685,000	-	-	-	-	540,000	315,000	1,000,000	685,000
	Overall (n = 36)	432,000	250,000	1,000,000	750,000	6,000	6,000	6,000	-	384,000	6,000	1,000,000	994,000
All villages	Non-poor (n = 11)	-	-	-	-	892,800	457,600	1,280,000	822,400	892,800	457,600	1,280,000	822,400
	Poor (n = 43)	340,000	250,000	420,000	170,000	200,000	6,000	758,000	752,000	298,000	6,000	758,000	752,000
	Poorest (n = 47)	540,000	315,000	1,000,000	685,000	176,000	16,000	216,000	200,000	372,000	16,000	1,000,000	984,000
	Overall (n = 101)	392,000	250,000	1,000,000	750,000	216,000	6,000	1,280,000	1,274,000	351,200	6,000	1,280,000	1,274,000

3.1.11 Abundance of marketable mushrooms and drivers of change

Abundance trend analysis for the highly marketable[10] edible wild mushroom species is presented in Appendix 14. Overall, findings showed that communities in all study villages perceived a decrease in abundance of marketable edible wild mushrooms starting from 1990s onwards. However, the decrease was less pronounced in Kindimbachini than the rest of the villages. The proportions of marketable edible wild mushrooms that were identified to have declined in abundance since 1990s were similar and highest in Amanimakoro (100%), Litolomero (100%) and Hinga (80%) villages than Kindimbachini villages (7%). Furthermore, communities across all villages perceived that the major underlying and intermediate causes of the observed decline in marketable edible wild mushrooms, respectively, were increase in human and livestock population that resulted in deforestation and forest degradation due to clearing of forests for farming and charcoal making, and overgrazing. Other perceived causes were recurrent wildfires reported from Hinga village, pollution of mushroom habitats due to deposition of dusts from coal mining sites reported from Amanimakoro village; and increased incidences of drought due to climate change reported from all villages except Kindimbachini.

Similar pattern was exhibited by quantitative data; chi-square of association found no significant association between villages and perceived trend in mushrooms availability over the past ten years ($\chi^2 = 5.865$; df = 4; p = 0.209), and wealth categories ($\chi^2 = 1.979$; df = 4; p = 0.739). Thus, data were pooled and analyzed to generate overall descriptive statistics irrespective of villages or wealth categories (Figure 13). The majority (83%) perceived that mushroom availability had decresed over the last ten years.

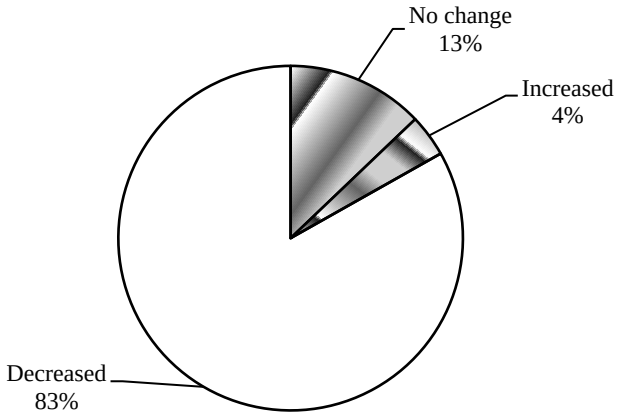


Figure 13: Proportions of respondents pooled across all study villages on their perceptions about availability of mushrooms over the past ten years

3.1.12 Potential yields of edible wild mushrooms

Table 18 presents estimates of the current mushroom production on dried mushroom basis synthesized from quantitative analysis of the questionnaire data and scenarios analysis perfumed with village leaders and field observations.

[10]Marketable mushroom species are those that scored 4-5 points out of 5 highest scores on marketability appraisal (see sub-section 2.2.2 for the methodological approach used for marketability scoring)

Table 18: Current production of mushrooms and projected production under improved access to drying facilities and market access

Village	Total number of households	Proportion of households involved in mushroom collection (%)	Current annual production per household (Liters)	Projected annual production per household under improved access to technology scenario (Liters)	Projected total production of dried mushrooms (Liters)
Kindimbachini	458	Opportunistic collectors: 60%	37.5	165	30,228
		Specialized collectors: 40%	165	375	103,050
	Sub-total-1				**133,278**
Litolomero	129	Opportunistic collectors: 95%	16	180	22,059
		Specialized collectors: 0%	-	-	-
	Sub-total-2				**22,059**
Hinga	444	Opportunistic collectors: 80%	20	200	71,040
		Specialized collectors: 0%			-
	Sub-total-3				**71,040**
Overall					**226,377**

Source: Author's calculations based on interviews with the village leaders and field observations

Under the current situation, production levels at Kindimba village are 37.5 litres for opportunistic collectors represented by 60% of all 458 households; and 165 litres for specialized collectors represented by 40% of the total households. The increase is expected to be gains from motivation to harvest more during rainy season since there will be no fear of any loss to due to drying failure; and avoided loss due to accidental rotting of mushrooms that in some cases is reported to account for 70% of the total production that would be produced in case there were no drying failures. Based on these scenarios Kindimbachini is expected to attain a total annual production of about 133,000 litres compared to 22,059 and 71,040 litres for Litolomero and Hinga villages, respectively. The highest projected quantities observed in Kindimbachini reflects the differences in the current production levels as already presented in Table 12 and Table 13. These scenarios signify increases in production by 1 to 3 folds for Kindimbachini; 9 and 10 folds for Hinga and Litolomero villages respectively. This is an indication that despite the current challenges of lack of drying technology, community in Kindimbachini villages are striving to process mushrooms close to the projected potential; as opposed to Litolomero and Hinga villages. This proposition reflects the pattern presented in Table 14 and Table 15; which show that despite high potential for mushroom production reflected in qualitative assessment in Litolomero and Hinga villages, the actual production recorded at the household level was very meager.

3.1.13 Processing and storage techniques

Findings from both qualitative and quantitative assessment revealed that the main processing technique was sun drying boiled mushrooms on traditional racks (Figure 14, 15).

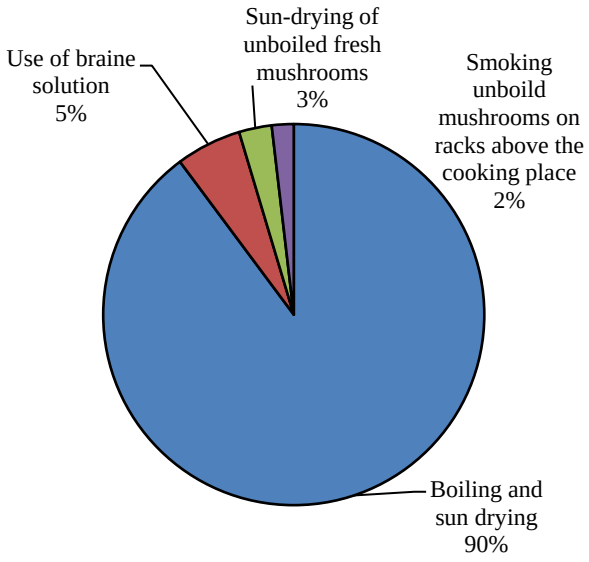


Figure 14: Proportion of responses on mushroom processing methods used

As already indicated in Table 10, quantitative data showed no significant differences between villages for the proportion of households that were processing mushrooms. When asked about the methods of processing there were multiple responses as presented in Figure 11. The most mentioned method of processing mushrooms was boiling and sun drying on traditional racks. However, a recurring concern in both FGDs and KIIs (Appendix 10 Part IV b-d) was lack of appropriate drying technology, which results in rotting of large quantities of mushrooms. They frequently elaborated that the rotting happens because mushroom phenology coincides with peaks of raining and cloudy days; there several occasions where sun may not be seen for three consecutive days; when that happens mushrooms get rotten.

Figure 15: Traditional racks used to dry mushrooms and other food items in study villages within Mbinga and Nyasa districts of Ruvuma region, Tanzania

The poorest and poor households are disproportionally affected than the non-poor; non-poor and a few poor households are able to avoid losses to some extent by use of plastic sheeting to protect their drying mushrooms; something that the majority of the poor and all of the poorest households cannot afford. The poorest and most of the poor tend to avoid drying mushrooms in fear of incurring losses. The losses due to lack of drying technology are about 90,000 TZS to 180,000 TZS for the opportunistic collectors, and 360,000 TZS to 720,000 TZS for regular/specialized collectors.

3.1.14 Edible wild mushroom value chain

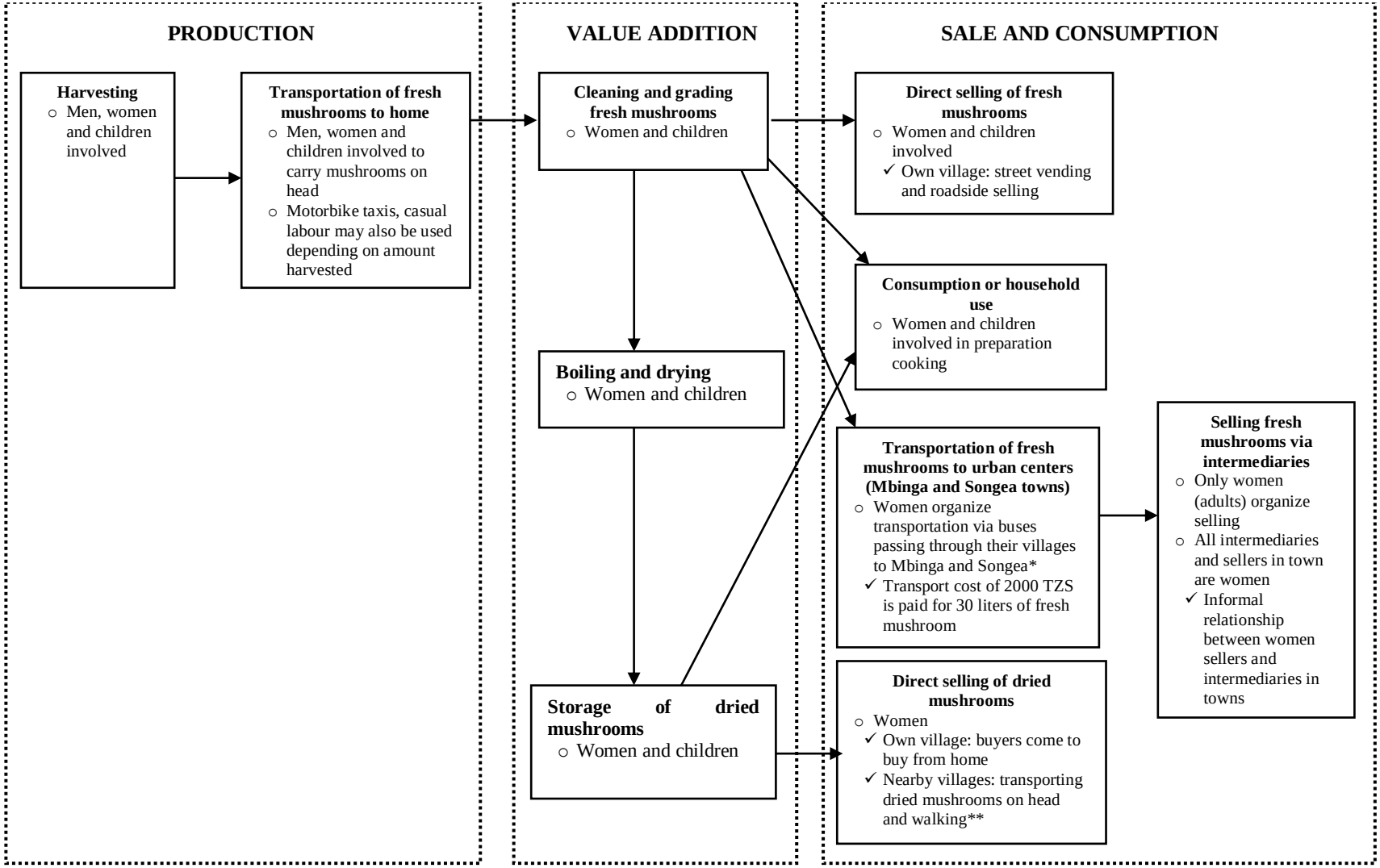
The diagram describing the edible wild mushrooms value chain in the study villages is presented in Figure 16. The value chain is short as it involves limited number of intermediaries; none of the intermediaries is currently linked to any of the study villages. The value chain begins with harvesting, followed by transportation to home where mushrooms are cleaned, a portion taken for household consumption, another portion taken for selling as fresh mushrooms within the villages, and yet another portion taken for boiling and sun drying to produce dried mushrooms for utilization and selling during dry season (off-season). As noted in sub-section 3.1.13, the main processing practiced across all study villages is boiling followed by sun-drying.

Though not directly linked to the study villages, there is an interesting development of fresh mushrooms value chain of its own, observed in Mbinga district. The value chain involves mushroom collectors residing in villages with good roads where there are daily bus services to Mbinga or Songea towns. Key participating villages are Litumbandyosi and Luhagala. A few collectors[11] residing in Litumbandyosi and Luhagala (and possibly other villages along Kitai-Ruanda-Lituhi road) have established informal, yet strong and reliable, friendly and trust based business networks with intermediaries/sales agents (Mawakala-plural/Wakala-singular, in Kiswahili) based in Mbinga town. During each mushroom season (usually from January to April), the collectors package fresh mushrooms in local bamboo baskets and send to the sales agents as parcels via daily buses coming from or passing by their villages; each of the collectors notifies the respective sales agent through mobile phone once baskets of mushrooms are loaded in a particular bus; the sales agent receives fresh mushrooms every morning at around 9:00 am; upon receiving the mushrooms parcel each of the sales agents pays transport charges to the bus operators on behalf of the respective collector; and uses the same bus to send money back to the collector for the previous day's consignment after deducting money paid for transport charges; ultimately the collectors bear all costs of transporting fresh mushrooms to town. Immediately after receiving the mushrooms, the sales agents sell part of the mushrooms received to retailers (also called 'Mawinga'[12]) on a wholesale price, reportedly, as set by the collectors; at the same time the sales agent keeps a portion of the mushrooms for retailing in the same way as '*Mawinga*'. Some retailers regard the sales agents as their bosses since they are the only ones who have personal relationships with mushroom collectors based in the villages.

There are about 5 to 7 mushrooms sales agents and about 15 to 20 retailers who are all females. There are two groups of retailers in Mbinga town; one group comprise retailers who are selling mushrooms in the streets (street vendors); and another comprises retailers who are permanently stationed within Mbinga town market. However, every retailer is registered as small entrepreneur and pays the 20,000 TZS annual charges for identification card through the local government as per Tanzania laws and regulations. During the study, one mushroom street vendor reported (February, 2021):

[11]The exact number could not be precisely established

[12]A colloquial Kiswahili word translated as football prayers on the side lines of the ground who have to pass the ball to those at the centre in order for the team to score a goal



*Common in villages along the good roads (e.g. Amanimakoro, Litumbandyosi and Luhagala) but impossible for remote villages with poor roads (e.g. Kindimbachini)
**Common in remote villages with poor roads (e.g. Kindimbachini and Litolomero)

Figure 16: Value chains for edible wild mushrooms in Mbinga and Nyasa districts of Ruvuma region, Tanzania

> "…Whether one sells in streets or stationed within the Mbinga town market is just a division of marketing niches; but we all have equal rights as registered small business entrepreneurs…"

The sales agents purchase fresh mushrooms at 300 TZS/liter and sell at 1,250 TZS/litre. This gives a gross profit margin of about 317%. On the other hand, retailers in Mbinga town purchase fresh mushrooms at a price of 1,250 TZS/litre and sell at 2000 – 2250 TZS/litre. Thus, the gross profit margin for retailers is 60% to 80%. On average, a mushroom retailer in Mbinga town can earn between 360,000/= TZS (or USD 157) to 1,200,000 TZS (or USD 522) per season from fresh mushrooms (January to April) as profit margin. This compares very well with the overall maximum cash incomes earned by collectors that ranges from 216,000 TZS (or USD 94) for poorest and 1,280,000 TZS (or USD 557) for the non-poor.

Occasionally, dried mushrooms are also supplied through the same business arrangement. For dried mushrooms, when available, the retailers purchase at a wholesale price of 1550 TZS to 1750 TZS/Liter; and sell at retail price of 2500 TZS to 2750 TZS/Litre. This gives a gross profit margin of 43% to 83%. However, incomes from retailing dried mushrooms are limited compared to fresh mushrooms due to inadequate supply of the commodity. This was reported by one mushroom street vendor in Mbinga town (February, 2021):

> "…There is high demand for both fresh and dried mushrooms, only that there are no suppliers of dried mushrooms…"

Furthermore, in the perception of Mbinga town market leaders, there is high potential to enhance demand for fresh mushrooms through awareness creation to the general public focusing on healthy benefits of mushrooms. During the interview, the Mbinga town market leaders reported in their words (February, 2021):

> "…when we first arrived in this town cattle meat used to be a rare commodity, only few people used to eat the meat but nowadays everybody wants to eat the meat; so in the same way, once mushroom supply is increased and sustained many will be convinced to start eating; especially when they are educated about the benefits of eating mushrooms…"

Furthermore, findings indicated that both sales agents and retailers for mushrooms were engaged in other businesses such as selling various types of vegetables and sardines. These businesses complement each other; none is superior to the other as reported by one street vendor in Mbinga town (February, 2021):

> "…I sell several commodities including mushrooms, vegetables such as tomatoes and fruits… commodities complement each other; since they are available in different seasons; so none is important than the other, they almost have equal importance…"

The businesses as a whole are important to ensure continuous flow of money to sustain their livings; each business comes at a particular season that tends to connect each other over the whole year, providing smooth access to income over the whole year.

3.1.15 Capacity of the previously identified local mushroom entrepreneurs

3.1.15.1 Theoretical background

The key purpose of assessing the entrepreneurs was to enhance their success once they receive the planned support from FORVAC. As noted by Marshall et al. (2006) and Belcher and Schreckenberg (2007), successful commercialization of non-wood forest products (NWFPs) such as edible wild mushrooms is characterized as a transparent, equitable and sustainable activity that has a positive impact on poverty reduction, gender equality and resource access, tenure and management. These dimensions of success relate to the resource being utilized and the overall welfare of the communities within which the entrepreneurs are operating. Thus, the assessment of the entrepreneurs entailed integration of perceptions from the entrepreneurs themselves and respective village leaders, and their business mentor from SEDIT. The assessment covered issues pertinent to entrepreneurs and the rest of mushroom collectors and traders in the respective local communities themselves.

3.1.15.2 Key issues

Review of records and interviews with the identified local mushroom entrepreneurs and village leaders revealed that FORVAC worked in partnership with Social and Economic Development Initiatives of Tanzania (SEDIT)-Local NGO to undertake initial capacity assessment processes of local entrepreneurs. The motive was an anticipation to use the entrepreneurs as entry points for supporting commercialisation of edible wild mushroom value chain in Mbinga district.

FORVAC had used objective and pragmatic process to identify five women entrepreneurs who were among many other men and women actively trading in edible wild mushrooms from two villages in Mbinga districts: two women from Kindimbachini village and three women from Amanimakoro village. After a series of practical and theoretical training through SEDIT, the earmarked women entrepreneurs were to be provided with mushroom processing tools and equipments to help them become progressive local mushroom processors through whom the rest of community members in their respective villages were to be gradually linked to market at local, regional, national and ultimately even international levels. A record of interviews with the women entrepreneurs is presented in Appendix 8 from section II to III; and interview with their professional business mentor from SEDIT and village leaders are detailed in Appendix 8 section I and IV(a) through IV(b).

In the context of the characteristics of the other local mushroom collectors and traders of edible wild mushrooms sampled, the earmarked entrepreneurs were no better than the rest, in terms of local knowledge about edible wild mushrooms, quantities of mushrooms harvested and traded, access to capital, and challenges they face and strategies they use to deal with the challenges. The earmarked women entrepreneurs do not have reliable access to capital.

Similarly, interview with the village leaders from Kindimbachini revealed that, as a community, they positively commended the objectivity and robustness of the procedures used to earmark the individual women mushroom entrepreneurs. However, they were concerned that earmarking only two women would not be effective in bringing significant impacts/outcome on lifting people out of poverty; since the village has about 90% of households effectively involved in mushroom collection and trading. Thus, they recommended that FORVAC program implementers to consider how more people could be directly involved in the necessary processes to enhance edible wild mushroom collection, drying and marketing. The following quote illustrates these propositions:

A quote to illustrate robustness of the process to identify the entrepreneurs to be supported by FORVAC (Kindimbachini village leaders, 26th January, 2021):

> "…The process to identify women mushroom entrepreneurs involved the following steps: 1) Village Leaders attended a seminar in Mbinga, 2) the whole village community was then informed about the opportunity from FORVAC to support forest-based enterprises, 3) each of interested villagers had to write proposal for the businesses idea that were evaluated with anticipation that the best proposal would be provided with a capital ranging from 1 to 15 million; 4) proposals were written and submitted to FORVAC officers, and names of those with good proposals were announced in a village general assembly meeting, 5) Those with good proposals were invited for personal interviews with FORVAC officers community, 6) final winners were then announced through the village assembly meetings in which FORVAC officers were invited. …. 2 names were for the mushrooms entrepreneurs and 3 for beekeeping entrepreneurs…"

A quoted to illustrate inadequacy of the two identified entrepreneurs for achieving poverty reduction impacts (Kindimbachini village leaders, 26th January, 2021):

> "…about 90% of households are involved in collection of edible wild mushrooms for consumption, and 40% of the households are involved in trading of edible wild mushrooms (fresh and dry)…. Our dream for the next five years is to see the average annual income of the mushroom collectors increased up to 1,000,000/= TZS …at present the average annual income is below 100,000/= TZS…. But this dream is not possible with the only two entrepreneurs identified for FORVAC support…we request that more people be recruited for the support from FORVAC…"

Similarly, commendations about the objectivity and robustness of the procedures used to earmark the women entrepreneurs in Amanimakoro village were recapitulated by the Village Executive Officer (VEO). On the contrary, the VEO noted that Amanimakoro village was not among the best producers of edible wild mushrooms due to inadequate forest cover. To this effect, he suggested that FORVAC should have considered working with more remote villages which are still having abundant mushrooms and large forest tracts such as Luhagala, Litumbandyosi, Mabani and Kingole villages; and noted that modern mushroom cultivation

project could have been more appropriate for Amanimakoro village. The quotes from the words of Amanimakoro's VEO confirm this proposition (VEO-Amanimakoro village, 25th January 2021):

A quote on objective and robust process to earmark the entrepreneurs:

> "…The whole community is aware of the process used to identify the women mushroom entrepreneurs; it was done through the village general assembly meetings where FORVAC officers were invited …"

A quote on inappropriateness of Amanimakoro village for edible wild mushroom value chain:

> …The process to obtain mushroom entrepreneurs to be supported with FORVAC was well designed and executed; I did not see any problem. But they left out some very potential villages with a lot of mushrooms such as Litumbandyosi, Luhagala, Mabuni and Kingole…I I would advise FORVAC to visit these mentioned villages…"

3.2 Discussion of the findings

3.2.1 Poverty profiles

The general literature on utilization and trading in wild edible mushrooms and other non-wood forest products (NWFPs) are highly associated with the level of household capability exemplified by levels of physical, social and financial assets (e.g. Shackleton and Shackleton, 2006; Belcher and Schreckenberg, 2007; Christensen et al., 2008; Vyamana, 2009). In addition, given the increasing realization that communities are highly differentiated (Ellis and Allison, 2004) it was necessary to ensure that ideas and realities from all wealth groups were equally represented. These facts necessitated exploration of household assets dynamics through wealth ranking based on people's own view on poverty in line with the widely accepted multidimensional nature of poverty (Narayan et al., 2000; Ravnborg, 2003; Vyamana, 2009).

Regarding access to and use of livelihood assets, two things are relevant with respect to poverty and rural livelihoods (Ellis and Mdoe, 2003; Ellis and Allison, 2004). First, ownership or access to assets and their efficient productive uses are the fundamental bases by which the poor can construct their own routes out of poverty (Narayan et al., 2000). Moving out of poverty normally follows a sequence of asset accumulation that involves stepwise trading-up assets such as chickens to goats to cattle to land; or, cash from non-farm income to farm inputs to higher farm income to land or to livestock (Ellis and Mdoe, 2003). Findings from the wealth ranking exercise clearly showed that one of the valuable livelihood or income generating activities for the poor and poorest was collection and trading in wild edible mushrooms. This implies that interventions to address constraints that hinder the poor and poorest from undertaking efficient collection and trading of wild edible mushrooms can help them climb out of poverty.

The proportions of household in each wealth category observed in different study villages provide baseline for subsequent evaluation of the extent FORVAC and other development interventions attain livelihood improvements objectives. As noted by URT (2008) and Angelsen et al. (2011), in order to attribute dynamics observed in wealth categories of particular households such assessments need to be combined with a well-designed in-depth interviews to those households that show either movement into or out of poverty. This is because several factors other than those controlled by a particular program/project may be equally important in determining the dynamics of wealth categories.

Furthermore, the high proportion of the poor and poorest (91%) found in this study is typical for forest adjacent communities in Tanzania as reported in previous studies (e.g. URT, 2008; Vyamana et al., 2015). Given that most of the poor and poorest are the ones that rely on collection and trading in wild edible mushrooms than their counterpart non-poor, investment in improvements in production efficiencies, and/or commercialization of edible wild mushrooms has the potential to contribute to significant impacts on poverty alleviation in the studied villages and other similar rural areas**.**

3.2.2 Traditional knowledge about edible wild mushrooms

There are at least two points of generalizations that can be derived from the observed majority who expressed their confidence in their ability to differentiate edible from inedible mushrooms species; and congruency of their responses on macroscopic features to those that were

documented through FGDs. First, the folk taxonomy system of training had been effective in reaching the majority of mushroom collectors and imparting knowledge that is consistent and coherent. Second, the features reported to be used for differentiating edible from inedible mushroom species can be considered valid since they were confirmed to be consistent from different set of people using different sets of data acquisition techniques.

The mushroom features used by local communities to characterize mushroom species corroborate findings from other ethnomycological studies conducted in Tanzania (e.g. Härkönen et al., 2003, Tibuhwa, 2012) and elsewhere (e.g. Haro-Luna et al., 2019); which have consistently reported local communities across cultures applying the same macro-morphological features for differentiation of mushroom species. Similarly, there are overlaps between the macro-morphological features applied under folk taxonomy and scientific approach especially at the family and genus levels. For example, one of the key distinguishing features of the genus *Lactaruius* under the folk taxonomy in the studied communities was exudation of milky latex that exactly matches scientific system as described by Härkönen et al. (2003).

It is interesting to note that most studies in Tanzania and elsewhere have described transmission of folk mycological knowledge from parents and grandparents to their children and grandchildren as being solely through oral tradition (e.g. Tibuhwa, 2012, 2013; De Kesel et al., 2002 cited by Kamalebo et al., 2018; Härkönen et al., 2015 cited by Kamalebo et al., 2018;). However, in line with other studies elsewhere (e.g. Haro-Luna et al., 2019), this study has revealed a strong, yet often overlooked, component of practical oriented approach that characterizes folk taxonomic knowledge transmission system. The approach amalgamates with the basic features of competence-based training approach rather than conventional oral tradition per se. Despite the widely cited inherent weaknesses of the mode of transmission of folk taxonomic knowledge, in that it lacks written documentation, it seems to be integrating an overlooked strong element due to its particular emphasis on impartation of practical skills rather than theoretical constructs; a practice that shares many qualities with the widely promulgated competence based training approach. In accordance with the principles of competence-based training approach, under folk mycological knowledge transmission system the trainees are trained through practical orientation based on the principles of experiential learning, and/or learning by doing. As noted by several authors (e.g. Uçar and Sungur, 2017), this kind of training approach is known to be effective in ensuring competence development as opposed to traditional theory and content based training that overemphasizes memorization at the expense of competency[13] development. Thus, efforts to document and analyze folk mycological taxonomic knowledge should also pay particular attention on appreciation of the effectiveness of the inherent training methodologies adopted besides contents thereof. As Tibuhwa (2013) rightly puts it, wild mushroom collection is a professional job that requires specialized local knowledge acquired from long traditional training through experiential learning process, which is independent of the formal education level.

The foregoing discussion calls for the need to revisit some of the previous widely accepted views or rather claims that folk taxonomic mycology knowledge is limited to specific surroundings where people live, and that once such people move to new areas their knowledge is lost

[13]Operationally, competency can be defined as an inherent ability of an individual to perform a particular task in a real-world to acceptable standards (Gonczi, 2013).

completely or becomes redundant (e.g. Härkönen et al., 1995 cited by Tibuhwa, 2012). Given the practical training approach that characterizes folk taxonomic knowledge transmission, where mushrooms are identified using a holistic approach that integrate their macro-morphological features and habitat characteristics such soils, topography and dominant tree species (i.e. vegetation types); it is unlikely that moving to a new place should always lead to a complete loss of or redundancy of the folk taxonomic knowledge gained. However, it is true that moving in a vegetation type different from the ones where a given person was trained can lead to redundancy or misapplication of the folk knowledge since mushroom species vary with ecological zones. Thus, precise discussion of redundancy and applicability of folk taxonomic mycology knowledge is better discussed with reference to vegetation types or agro-ecological zones rather than mere spatial movements of people. This requires multidisciplinary approach to ethnomycological studies where mycologists and ecologists are supported to work together as a team.

A corollary situation is when a new vegetation type such as plantation forests associated with alien mushrooms is introduced in area where people have already acquired and applying folk mycological taxonomic knowledge. In this case, the knowledge becomes redundant due to a new kind of vegetation type that supports mushrooms species that differ from the ones studied in through folk taxonomy training systems. Such scenarios have been reported as key instances of failures of folk taxonomic knowledge sometimes with fetal records of mushroom poisoning due to poisonous mushrooms growing in plantations (e.g. Härkönen, 2002; Härkönen et al., 1994, 2003). Therefore, as suggested by Härkönen (2002), the current expansion of plantation forests in the studied villages calls for the need to invest in development scientific guide for identification of poisonous mushrooms as a long-term measure to ensure safety. Meanwhile, as a short-term measure, awareness should be created to the studied villages and other villages engaged in wild mushroom collection and trading in Tanzania ensure that they avoid collecting mushrooms from forest plantations as much as possible.

The pattern of mushroom species and ethnotaxa recognized in this study is in agreement with the pattern previously reported from other ethnomycological studies in Tanzania (e.g. Tibuhwa, 2012) and elsewhere (Haro-Luna et al., 2019). The dominance of ectomycorrhizal mushrooms is in agreement with other studies in Tanzania (Härkönen et al., 2003; Tibuhwa 2012, 2013). This is expected since miombo woodlands with characteristic mycorrhizal association with mushroom forming fungi covers about 90% of Tanzania's forestland (URT, 2006). Another feature of interest was polytyic nature of ethnotaxa where one name was used to refer to more than one species; that was pertinent for mushrooms from *Rusula, Cantharellus and Lactarius genera; and a small extent Amanitas* other than *Amanita losii,* which were named as 'Uhanga' in Hinga village. This phenomenon is common with other ethnomycological studies both in Tanzania (Tibuhwa, 2013) and elsewhere (Haro-Luna et al., 2019).

3.2.3 Importance of mushroom collection and trading

In all the study villages, mushroom collection for food was recognized as one of important livelihood activities and valued in the same way as other common livelihood activities such as farming and livestock keeping. This proposition is equally supported by qualitative and quantitative data for this study. The most plausible explanation for the observed variation in importance of mushroom trading could be existing opportunities to access market.

Indeed, triangulation of the data confirmed that Kindimbachini and Amanimakoro villages, which valued mushroom trading in the same way as farming and livestock; were also having historic accounts of unique opportunities to market linkages. The market linkage for Amanimakoro village is obvious; it is strategically located along the Lituhi-Kitai road (that also connects to Songea and Mbinga towns) with regular daily buses. However, the market linkage for Kindimbachini is surprising given the difficult terrain and poor road condition that characterizes the village. It was clearly noted that the access to market in Kindimbachini involved participants enduring the hardship of walking long distances on foot to the neighbouring villages of Lituhi, Ndumbi and Mbaha. However, that opportunity was only taped by a few households notably non-poor and poor at the expense of the poorest who lack connection in the neighbouring villages.

The ability of the non-poor and poor households to initiate linkage to markets in the neighbouring villages than the poorest is explained by the degree of social capital. Studies have demonstrated that wealth status affect the networking of an individual and households within and across villages. Influenced by access to livelihood assets, the non-poor and poor are more likely to establish and nurture networks within and between villages than their poorest counterparts (e.g. URT, 2008; Vyamana, 2009; Zorrilla-Miras et al., 2018). Of paramount importance is the fact that membership in social groups leads to increased networking. Thus, one way to help the poor, such as those in Kindimbachini and similar villages, is to mobilize them together with the non-poor and poor fellows, and then support them to establish an association such as co-operative through which market networking can be initiated and nurture. Similarly, supporting creation of such co-operatives in Hinga and Litolomero villages would help them access market network, which most community members are lacking.

3.2.4 Phenology, participation in mushroom utilization and trading

Across the four villages the majority of households (>77%) collected and used mushrooms as food regardless of wealth categories. Apparently, mushroom collection is among the most important component of livelihoods in the studied villages especially for the poor and poorest. The implication is that, interventions that focus on addressing constraints that hinder the poor and poorest from undertaking efficient mushroom collection, processing and trading can help them climb out of poverty. As noted by Ellis and Mdoe (2003), supporting mushroom entrepreneurs for the poor and poorest is likely to have multiplier effects on other important livelihood activities particularly farming and livestock keeping.

The appreciated importance of edible wild mushrooms for food security and income generation especially for the poor is in line with previous studies in various African countries regarding mushrooms and other NWFP (Shackleton and Shackleton, 2006; Marshall et al., 2006; Belcher and Schreckenberg, 2007; Chelela et al., 2014). An important issue is the timing of their phenology, which coincides with the peak of food shortages in most farming communities. Thus, although mushrooms may be less important for incomes of some better-off households its use as an alternative to meat or fish stew can be of importance across wealth categories. Indeed, subsistence importance was highly appreciated across study villages than trading. The historical recount of how reserves of dried mushrooms rescued people from severe famine in Kindimbachini village is very touchy and relevant to most rural areas of Tanzania where edible

wild mushrooms grow naturally; a follow-up in-depth documentation as both textual and audio visual can serve as both training material to encourage communities to begin mushroom processing enterprises, and advocacy tool to influence the government at local and national levels to increase budget allocations for forestry related interventions.

The edible wild mushrooms genera of *Cantharellus, Russula, Amanita, Lactarius* and *Termitomyces* commonly harvested in the studied villages are widely reported from other parts of Tanzania miombo woodlands (e.g. Chelela et al., 2014; Tibuhwa, 2013). Similarly, the phenology recorded in this study corroborates other similar studies in Tanzania (e.g. Tibuhwa, 2011, 2013). This suggests an overlap of species that are ubiquitous in miombo woodlands in Tanzania. From management point of view, this provides an opportunity for resource sharing to enhance cost effectiveness; for example, training and learning materials can be shared over most parts of rural areas of Tanzania where mushrooms grow. On the other hand, this is an advantageous for advancing the value chain for export market where uniformity of the product can be ensured by combining similar mushroom species from different regions.

It is interesting to note that selling fresh mushrooms was an activity for the poor and poorest but not the non-poor in Kindimbachini and Hinga villages. To the contrary, there was no selling of fresh mushrooms at all at Litolomero village. The reason for completely not selling fresh mushrooms observed in Litoromero village was explained, in the perspective of the local communities, to be lack of demand for mushrooms as everybody has access to mushrooms that grow everywhere and close to homestead since the village is endowed with healthy forest in every part (See Figure 9). The most plausible explanation for the pattern observed at Kindimbachini and Hinga villages could be limited demand for fresh mushrooms that makes the venture not lucrative at all. This proportion is in agreement with other studies that assessed livelihoods in relation to natural resource utilization in Tanzania and elsewhere. Studying incomes generated from trading in different forest products in the Eastern Arc Mountains area of Tanzania, which includes some parts of Southern Highlands, Vyamana (2009) found that despite of the obvious opportunities the non-poor did not get involved in commercial wood harvesting since they were engaging in relatively more lucrative non-farm business, leaving the less paying opportunities to the poor and poorest community members. The same proposition has been suggested by other rural livelihood studies in Africa (Barret et al., 2001, Ellis and Allison, 2004; Ellis and Freeman, 2007). By the same token, the majority of non-poor were involved in trading of dried mushrooms than their poor and poorest counterparts since the business is more lucrative.

3.2.5 Mushroom harvesting practices

Harvesting practices were assessed with respect to mushrooms picking practices, proportions of mushrooms of different growth stages in each harvesting occasion and utensils used to carry mushrooms from harvesting sites.

Findings clearly indicated that none of the respondents was covering back soil on spots where mushrooms are uprooted. The common practices for picking mushrooms by cutting stems with fingers and complete uprooting using hands were the only popular practices used. Studies have demonstrated that picking of mushrooms by cutting ensures sustainability of mushroom productivity than uprooting or plucking (e.g. Luoma et al., 2006). Similarly, as noted by Bloesch

(2009), cutting mushrooms near the ground is hygienic practice since it ensures cleanness hence acceptance by buyers. In this regard, communities in Hinga village were performing better whereas those in Kindimachini were performing worse.

Regarding, proportions of mushrooms of different growth stages, the most critical is the proportion of young mushrooms having closed caps. This is because harvesting of immature mushrooms (or unopened/juvenile fruiting bodies) can be detrimental in two possible ways. First, since the fruiting bodies are removed before releasing spores (equivalent to seeds), it can affect subsequent reproduction cycle by inhibiting spore germination stage. However, minimum proportions can be harvested without causing any harm. Nevertheless, the actual threshold has not been quantitatively determined for different mushroom species and ecosystems around the world (e.g. Venturella, 2016). Second, deliberate targeting of immature mushrooms may instigate raking the mineral soil and litter layers; practices that have been reported to cause significant decline in subsequent mushroom yields due to damage of the mycelium or interruption of microenvironment required to support subsequent development of mushrooms (e.g. Pilz and Molina, 2002; Luoma et al., 2006). The median value of ≤ 50% for the proportions of immature mushrooms recorded in this study is still within acceptable ranges.

For utensils used to carry mushrooms, woven baskets made of organic material are recommended as opposed to closed containers like plastic bags or buckets. The latter is discouraged because it speeds up deterioration of the mushrooms (Bloesch, 2009). Qualitative information in across study villages indicated that traditionally people in the study villages had been using bamboo baskets to carry mushrooms. They are now moving to plastic buckets and basins out of desire for prestige as they perceive those to be modern utensils than bamboo baskets. Indeed, quantitative data showed a pattern moving from bamboo baskets towards plastic buckets. Though the frequencies of use of buckets did not exceed 54%, it is important that communities are made aware of the effects of plastic utensils on quality of mushrooms harvested.

3.2.6 Quantities of mushrooms produced, consumed, processed and traded

Regarding the quantities of mushrooms harvested and traded, Kindimbachini showed an exceptional pattern that was completely different from Litolomero and Hinga village[14]. Inherent differences in livelihood opportunities within and between villages could be offer the most plausible explanation for the observed pattern. A cursory review of findings related to wealth ranking criteria (Table 2 and Appendix 11) and relative importance of different livelihood activities (Table 9 & Figure 8), clearly indicate that Kindimbachini is a typical farming community whereas Hinga and Litolomero villages are fishing communities; with Hinga being more biased to fishing than Litolomero.

The large quantities of mushrooms harvested by the non-poor and poor households than the poorest in Kindimbachini village could be explained by differences in social network that exist among the wealth categories. As the findings clearly indicated, the village is characterized by high opportunities for selling dried mushrooms in the neighbouring villages of Lituhi, Ndumbi

[14]It should be noted that quantitative data could not be collected from Amanimakoro village due to non-response as the timing of the study coincided with the peak of farming season.

and Mbaha along the coast of Lake Nyasa. Another opportunity, also revealed in the findings, is the younger man originating from the village but currently residing in Dar es Salaam, who comes annually to purchase dried mushrooms; the young man belongs to a religion whose members are compelled to be vegetarian i.e. allowed to eat vegetables and mushrooms but never eat meat. However, it is worth noting that the inherent connection to the market for Kindimbachini is likely to be more pronounced among the non-poor and poor than poorest. This is because of the fact that social ties and relationships tend to be more prominent and strong among the non-poor and poor households but extremely weak or completely lacking among the poorest (e.g. Ellis and Mdoe, 2003); especially when the connections are mediated through informal arrangements (Schnegg, 2018). This implies that the non-poor and poor are relatively connected to the market than the poorest. Secondly, the poorest are also constrained in terms of labour availability for harvesting and subsequent processing mushrooms. Mushroom season coincides with a period when the poorest are busy working both in their own farms and the farms of non-poor and poor to earn their living (Ellis and Allison, 2004; Table 2 and Appendix 11). Thirdly, the poor have no access to assets such as drying sheds, spacious kitchen huts where mushrooms can be dried, and mats needed to dry large amount of mushrooms during the rainy season (Ellis and Mdoe, 2003). This situation leaves the poorest with limited time and labour, and/or assets needed to collect and process large quantities of mushrooms.

On the other hand, the non-poor and poor households of Hinga and Litolomero village are not harvesting large quantities of mushrooms probably due to presence of fishing and related business opportunities as relatively more lucrative ventures. For most of the non-poor and poor households in Litolomero and Hinga villages, mushrooms are mostly harvested for subsistence only. As noted earlier, seeing that there are more paying ventures through fishing and fisheries related businesses such as trading in sardines and fishes, the non-poor and most of the poor have little or no interest to trade in mushrooms; leaving it for the poorest (e.g. Ellis and Freeman, 2007; Vyamana, 2009). As just note above, although the poor and poorest have no alternatives better than mushrooms, they are constrained by inadequate access to required assets for drying of mushrooms. Thus, taken in totality, provision of mushroom drying technology accessible to the poor and poorest in the study villages and similar areas can greatly improve their livelihoods through increased productivity of dried mushrooms.

3.2.7 Incomes generated from trading of edible wild mushrooms

The values for total and cash incomes observed from this study are comparable to values reported by other mushroom trading studies in Tanzania. For Kindimbachini village, the highest maximum was USD 869 (or 2,000,000 TZS) and lowest was USD 94 (or 216,000). This compares very well with the value of USD 400–900 reported by Tibuhwa (2013) and USD 500 – 650 by Chelela et al. (2014). However, the value appears to be extremely higher than the maximum value of USD 171 recently reported specifically for mushroom trading in Malawi (Mahonya et al., 2019). The differences between this study and Malawian study are expected, given the differences in biophysical characteristics. The highest cash incomes generated in Kindimbachini than Litolomero and Hinga relates to the levels of harvesting and processing as determined by market opportunities and availability of alternative income generating opportunities.

3.2.8 Abundance of marketable mushrooms and drivers of change

There are at least two immediate generalizations that are applicable to observed trend in abundance of marketable mushroom species. First, the studied communities have ample knowledge on the co-existence of edible wild mushrooms with healthy miombo forests. This is implied in the widely acknowledged linkage between the perceived declining abundance of edible wild mushrooms and the on-going deforestation and forest degradation. Second, the majority of the studied communities have clearly indicated perceived decline in edible wild mushroom species; and have acknowledged that the decline has happened as a result of their own actions of clearing forests for farms or charcoal making, and/or practicing overgrazing.

The general literature on common pool resource management suggests that knowledge on resource dynamics is among the key factors that enhance adoption of resource conservation measures in a given community (e.g. Berkes and Turner, 2006 cited by Brooks, 2010). Similarly, studies have continually confirmed that communities that perceive resource scarcity are likely to adopt resource conservation strategies than those that do not perceive scarcity of the resource (Brooks, 2010; Nie et al., 2020). Furthermore, the likelihood of adoption of conservation measures is further increased when communities perceive that such scarcity emanate from their own actions (e.g. Campos et al., 2018). On the other hand, as noted by Nie (2018), cooperation among all categories of community members is among the important crosscutting factors that enhance adoption of conservation strategies for a common pool resource. Also, appropriate institutions[15] help to enhance and maintain cooperation by reducing free-riding behavior (e.g. Ostrom 1990 cited by Nie, 2018). However, such institutions should be designed in ways that match people's preferences. This suggests the need to foster participatory approaches when developing institutions to deal with common pool resource management. This proposition conforms to the current forest policies and legislation in Tanzania that promote participatory forest management approaches (URT, 1998; URT, 2002).

Based on this analysis, strategies to support sustainability of edible wild mushroom value chain in the study villages and similar areas have to take into account at least three key issues:

1) Building on existing folk taxonomy knowledge regarding the biological co-existence of mushrooms and healthy miombo forests while at the same time paying particular focus on the underlying causes of decline in the abundances of edible wild mushrooms;
2) Building on communities' own perceptions on scarcity of edible wild mushrooms, and/or creating awareness on edible wild mushroom scarcity based on verifiable evidences on mushroom abundance dynamics over time; and
3) Integrating the edible wild mushroom production in the overarching participatory forest management (PFM) framework as stipulated in existing policies, legislation and guidelines. This should also take into account lessons learned from previous implementation of PFM in Tanzania and other similar countries. This is important as it fosters local institutions that promote cooperation among resource users, which in turn fosters trust and willingness of participating individuals to respect agreed resource utilization norms.

[15]Institutions can be defined as humanly devised norms to constrain or construct political, economic and social interactions (North, 1991 cited by Nie, 2018).

3.2.9 Potential yields of edible wild mushrooms

The scenarios analysis reveals potential increase in quantities of mushrooms harvested and processed as a result of promotion of improved processing technologies capable of avoiding the frequently reported losses of mushrooms rotting due to failure of local drying technology whenever there is continuous heavy raining of three to four consecutive days. Based on the analysis, the magnitude of increase are estimated at 1 to 3 folds for Kindimbachini, compared to 9 and 10 folds for Hinga and Litolomero villages, respectively. The difference suggests that Kindimbachini is harvesting and processing mushrooms close to the maximum potential despite the challenges of inadequate technology. This proposition is supported by the difference in quantities of mushrooms harvested and processed as recorded in Table 12 and Table 13 where Kindimbachini recorded overall median production quantity that are high by 3 and 2 folds of total quantity of fresh mushrooms compared to the values for Litolomero and Hinga villages, respectively. The corresponding values for total dried mushrooms were 12 and 6 folds in that order. The uniqueness of Kindimbachini regarding quantities of mushrooms harvested and processed is also of historical reasons as already discussed under sub-section 3.2.4 of this report.

There are different scenarios that can signal increase in production in response to expected gain in incomes. The gain can be achieved through either increase in price or decrease in losses resulting from improvement in technologies. For example, Martínez-Carrera et al. (2002) recorded an increase in amount of mushrooms harvested signaled by increase in selling prices. However, as further noted by the same author and Belcher and Schreckenberg (2007) such promoted increase in quantities harvested of mushrooms (or any other NWFPs) harvested may culminate in subsequent decline in potential harvestable quantities if not integrated with sustainable management practices. This is issue is discussed in detail under sub-section 3.3 of this report.

Under the current situation, production levels at Kindimbachini village are 37.5 litres for opportunistic collectors represented by 60% of all 458 households; and 165 litres for specialized collectors represented by 40% of the total households. The increase is expected to be gains from motivation to harvest more during rainy season since there will be no fear of any loss to due to drying failure; and avoided loss due to accidental rotting of mushrooms that in some cases is reported to account for 70% of the total production that would be produced in case there were no drying failures. Based on these scenarios Kindimbachini is expected to attain a total annual production of about 133,000 litres compared to 22,059 and 71,040 litres for Litolomero and Hinga villages, respectively. The highest projected quantities observed in Kindimbachini reflects the differences in the current production levels as already presented in Table 12 and Table 13. These scenarios signify increases in production by 1 to 3 folds for Kindimbachini; 9 and 10 folds for Hinga and Litolomero villages respectively. This is an indication that despite the current challenges of lack of drying technology, community in Kindimbachini villages are striving to process mushrooms close to the projected potential; as opposed to Litolomero and Hinga villages. This proposition reflects the pattern presented in Table 12 and table 13; which shows that despite high potential for mushroom production reflected in qualitative assessment in Litolomero and Hinga villages, the actual production recorded at the household level was very meager.

3.2.10 Edible wild mushroom value chain

The value chain was characterized by typical functions including collection, transport, processing, direct sales, and sales through intermediaries. Under normal circumstance, the value chain operations hardly went beyond the district or region. The case of a young man who regularly buys dried mushrooms from Kindimbachini village is an exception rather than a norm. The fact that the young man buys mushrooms on the ground of religious requirements provides an avenue establishing and nurturing specialized niche market. However, this will require further in-depth follow up study to understand details of the religion and the extent is spread in Tanzania and outsize Tanzania.

The short and simple mushroom value chain observed in this study is typical of other studies that assessed value chains for wild mushrooms and other NWFPs in Africa and other developing countries (e.g. Marshall et al., 2006; Mahonya et al., 2019). As observed by Mahonya et al. (2019), the simple chain in this study was also associated with limited differentiation between actors where the same person engages in most or all of the functions. This phenomenon was observed in all villages surveyed and Mbinga town market. At the village level, the same person operated as a collector, retailer and processor; and finally also retailer of the dried mushrooms. Similarly, at the Mbinga town the wholesalers where also engaged in retailing together with all other retailers.

Of paramount importance is the fact that with exception of harvesting in the forest where men are involved, most of the value chain functions at production, grading and processing levels were performed by women. Application of folk taxonomic knowledge is highly required during harvesting to ensure proper and correct identification of edible wild mushrooms. Thus, as argued by Marshall et al. (2006), involvement of men at harvesting stage of edible wild mushrooms provide is an important component to make the value chain more viable at the household level through sharing of skills and time.

On the other hand, at the Mbinga town market level all the functions (i.e. wholesale and retailing) were all performed by women. This signifies the potential for the value chain to be used as an entry points for both poverty alleviation and women empowerment in both rural and urban areas. This is the only value chain for which proper programming could lead to wide spread impacts to rural and urban women in a short period of time. The dominance of women in the wild mushroom value chain studied is similar to other studies in Tanzania (**Chelela** et al., 2014), other African countries (Mahonya et al., 2019) and Mexico (Pérez-Moreno et al., 2008). However, Mahonya et al. (2019) found that men tended to dominate the value chain when distances to harvesting sites were excessively long.

Also, the spontaneously developed mushroom value chain through friendly trust between urban and rural mushroom collectors is of unique nature, which should be properly documented and adapted widely. Findings demonstrated clearly that the spontaneous development of the value chain was instigated by the recent road construction, something that adds to our understanding as to how rural road development can make the difference. This raises concern over villages such as Kindimbachini that are having poor road condition, although the government has began

construction of the road it is still in bad condition unless further improved. The findings from this study provide an opportunity to compile and advocacy bulletin that can be used to persuade the government to quickly complete the road to Kindimbachini.

As highlighted almost throughout the report, the major challenge for the edible wild mushroom value chain was lack of appropriate drying technology, which reportedly caused losses of up to 90,000 TZS (or USD 39) to 720000 TZS (or USD 313) per season in actual terms; which happens when rains come continuously unexpectedly causing rotting of mushrooms being dried. The real loss seems to be thrice of the observed values since there are foregone quantities that are deliberately left to rot in the forest as the harvesters are instilled with fear of incurring losses during times of obvious frequent and continuous rains. Thus, investment in appropriate drying technology is likely to increase the household's incomes from mushroom trading by at least three folds. Also, there is high potential for multiplier effects to town based mushroom retailers through regular supply of dried quality mushrooms. As noted by Marshall et al. (2006), appropriate drying technology can also provide a breakthrough for accessing national and international markets as a result of assurance in high production of high quality products.

There is also a problem of value chain governance as revealed from unbalance gross profit between the wholesalers making 317% as their profit margin compared to 60% to 80% accruing to retailers. Though not capture adequately in our data, this imbalance is likely to be worse for the rural women who are producers. This issue needs to be tackled with caution since it is delicate component of any business; the best way to address this would be develop a market information system capable of providing symmetrical information to all actors; such information is powerful tool to enhance bargaining power of mushroom collectors (e.g. Marshall et al., 2006; Belcher and Schreckenberg, 2007).

On the other hand, though not quantified perishability of fresh mushrooms is another challenge for both town based retailers; and village retailers/collectors. They are forced to set lower prices in fear that if not bought quickly mushrooms would be rotten within a day. Another challenge, as already discussed under sub-section 3.2.8, was declining mushroom availability due to deforestation and forest degradation emanating from clearing of forestland for farming due to unsustainable farming practices, and/or overgrazing that cause compaction due to repeated trumping of livestock. This implies that successful commercialization of edible wild mushrooms needs to integrated strategies to address these challenges adequately.

3.2.11 Capacity of the previously identified local mushroom entrepreneurs

As noted by other previous studies on mushroom value chains (e.g. Shackleton and Shackleton, 2006; Marshall et al., 2006; Belcher and Schreckenberg, 2007; Mahonya et al., 2019), one of the overall pertinent findings from this study was that the poor and poorest were more dependent on utilization and trading in edible wild mushrooms for their livelihoods than their non-poor counterparts. This presents an opportunity to use edible wild mushroom value chain enhancement as one of the entry points for poverty alleviation.

It is clearly understood that, in short-term, working with the few earmarked women entrepreneurs trading in wild mushrooms provides an opportunity for quick achievement of

activities as stipulated in the FORVAC's work plan. However, empirically verified lessons from previous similar interventions suggest potential risks of failure associated with the approach. The failure emanate from the likelihood of cultivating free-riding behavior among the majority community members having been excluded from being direct beneficiaries (Brooks, 2010; Nie, 2018). This in turn would culminate in common pool resource (forest) degradation thereby rendering the enterprise redundant; this happens because availability of edible wild mushrooms is correlated with the presence of healthy forests. Given that all traded mushrooms recognized in Kindimbachini and Amanimakoro are mycorrhizal fungi associated with miombo tree species, common pool resource degradation would jeopardize the productivity of edible wild mushrooms in the long-term.

On the other hand, one of the conditions for successful interventions to promote effective conservation of common pool resources, including edible wild mushrooms, requires that adequate efforts be directed to enhancing formulation and strengthening of community level institutions. The usefulness of local institutions in enhancing sustainability of common pool resources is premised on the fact that appropriate institutions can help to reduce free-riding behaviuor which in turn improves and maintains cooperation (Ostrom, 1990 cited by Nie, 2018). However, such institutions must be formulated to foster preferences of the targeted local people. Thus, based on the assessment of mushroom women entrepreneurs, it is advised that FORVAC adopt a more holistic and participatory approach for enhancing commercialization of edible wild mushrooms in the Southern Highlands. This should go hand in hand with formulation of new or strengthening existing appropriate institutions for management of common pool resources rather than working through individual entrepreneurs per se. However, as also reiterated by village leaders form Kindimbachini, this requires adequate community mobilization preferably engaging communities through their respective sub-village meetings/events prior village level meetings/events.

3.3 Analysis of the potential for commercialization of wild edible mushrooms

3.3.1 Awareness creation to local experts, and decision- and policy- makers

Based on the perspectives of local communities, wild edible mushrooms are considered to be among the valuable resources for their livelihoods, in some cases even acting as stepping stone surviving otherwise deadly famines. However, the local government at district and regional levels may not be having such perspective; to them there are indication that wild mushrooms are considered to be less valued. During the field data collection several local government civil servants both at the district and regional levels were almost perplexed when they heard that a qualified researcher had been hired and team with a master's student, and together traveled all the way from Morogoro to Ruvuma/Songe and Mbinga, only to study about wild mushrooms. The first civil servant was encountered commented (January, 2021):

> "…I hear that you want to research about wild mushrooms, then what next after that?...they are freely growing in the forest…worse enough they very seasonal…why don't you talk about mushroom farming that can be more reliable and much paying business?..."

Yet, another high ranked civil servant commented (January, 2021):

> "…I can see this is a completely new task we are getting from FORVAC; regarding the student research, it is important that the motive is not to score an 'A' but addressing the real practical problems, including making sure that the findings come back to us in a form that is implementable and relevant to the context of end users…I mean we need to come up with practical recommendations…perhaps we should now begin to consider structuring university theses to be practical oriented…In other words one may even wish to research on how 'research' helps to solve real problems of our local communities…I will ask you, especially the elder, to bring back the findings in an implementable manner…we need to bridge the gap between research and development…But if I may ask a question: what is the real interest for the wild mushrooms sub-sector…?...especially…and potential to improve livelihoods of the people… I used to hear about mushroom farming but not the ones growing in the natural forests…So, do you mean you really want to promote natural mushrooms or grown mushrooms…?

Given the above quotes it is obvious that most of civil servants, even high rank ones, have negative attitude about wild mushrooms. As noted by Boa (2004), this not surprising since it has been a common phenomenon especially in sub-Saharan Africa. In order to earn their support it is important that they are provided with appropriate information and data that will enlighten their understanding about wild mushrooms, especially their livelihood importance to both rural and urban population, in particular the women in Mbinga town and villages like Litumbadyosi, Amanimakoro and Kindimbachini. The case of the spontaneously developed wild mushroom value chain in Mbinga District and associated livelihoods and women empowerment impacts; and the historical role played by wild mushrooms in Kindimbachini village need to be further enriched and documented both as textual and audio-visual for training and advocacy to local decision- and policy- makers; who tend to underrate the livelihood roles of wild mushrooms and other NWFPs at large.

Also, it is worth noting that existing national and local natural resources management initiatives give less or negligible priority on quantification, monitoring, and planning for sustainable utilization of edible wild mushrooms (MNRT, 2015; Amin et al., 2017). Thus, local forestry and agriculture experts should be technically supported to ensure that wild mushrooms become part and parcel of both land use planning and forest management planning. In this case, experts from Sokoine University of Agriculture (SUA) could be consulted to support review and updating of the guidelines for forest inventories, and/or land use planning in order to ensure adequate integration of wild mushrooms and other NWFPs.

3.3.2 Integrating with national policy

As noted by Marshall et al. (2006) and Belcher and Schreckenberg (2007), successful commercialization of wild mushrooms and other NWFPs requires that relevant policies are analyzed to identify and take advantage of existing opportunities. For example, Land Use Planning Policy and guideline provide an opportunity that can be utilized to promote sustainability of wild mushrooms; during zoning of land pieces an expert with good facilitation skills can manage to chip-in and facilitate participatory identification of wild mushrooms hotspots that can be set aside as mosaics of wild mushrooms reverves apart from tree-biased land

use planning. To the contrary, this opportunity has not been utilized; for example, Village Land Use Plans for Kindimbachini, Hinga and Litolomero villages never even mention about mushrooms even though the mushrooms have been part of culture and overall livelihoods in these village. Although all the plans are reportedly prepared through participatory process, they seem to be limited in terms of how the processes are really participatory to facilitate people talk about their real lives. One of the challenge of participatory processes, is that, the outcome depends very much on the facilitation skills of the facilitators; that is why you can have two teams of facilitators all going to the same village yet each coming back with different information in terms of both width and depth. Given this reality, it is important that when land use planning is being conducted the so called multidisciplinary team be formulate in a flexible ways such that all relevant experts are drawn in to ensure that nothing is omitted or overlooked. For example, since it is clearly known that Southern Highlands are endowed with abundant mushrooms it would be good idea to bring in a mycologist in the land use planning g team so that mycological issue are neither forgotten nor overlooked. University of Dar es Salaam is renowned for having seasoned mycologists that can be utilized to ensure that relevant multidisciplinary land use plans are developed.

Another relevant policy to consider is the National Forest Policy of 1998[16] in conjunction with the Forest Act of 2002. Based on these policy documents, it is clear that Participatory Forest Management (PFM) is the key strategy for fostering effective forest management in Tanzania. In Tanzania, PFM objective is three folds: 1) secure sustainable forest management, 2) improve forest governance, and 3) improve livelihoods of the people living adjacent to a given forest. The forest policy and act are all relevant and provides opportunity to integration of sustainable for sustainable forest management that integrate sustainable wild mushroom production. However, this requires that a good mix of the multidisciplinary team is formed during the planning and implementation phase including subsequent trainings to the Village Natural Resource Committees (VNRCs). Since the PFM process begin with Participatory Forest Resource Assessment (PFRA), as suggested for guidelines for forest inventories, it is advised that an expert from SUA be engaged to review, and/or advocate for such review so that the guidelines captures dynamics of wild mushrooms, among others. This implies that, besides routine project activities, FORVAC should also consider undertaking analysis of relevant policies and guidelines o take adequate advantage of existing opportunities and develop the basis for subsequent advocacy work for persuading the government to effect relevant policy changes for the betterment of the

3.3.3 Integrating measures to address drivers of deforestation and forest degradation

As already noted in sub-section 3.1.9 and Appendix 15, qualitative assessments across all study villages have reiterated the concern over unsustainable farming practices as the key drivers behind the observed decline in wild mushrooms availability. It is necessary that strategies to address the identified drivers of declining wild mushrooms availability are properly validated and integrated in the wild mushrooms commercialization strategy. Having acknowledged that their own actions have caused the observed decline in mushroom availability is, according to Campos et al. (2018), an indication of their willingness to support any relevant remedial

[16]The policy has been under review since 2010; but the new one is yet to be officially released. There is a risk that it might be released when it is already outdated!

measures within the limits of their capacity in terms of knowledge and other assets. Thus, what is needed is to put together the required interdisciplinary and engage the community in detailed analysis of the problem and come up with action plans for addressing the drivers of declining wild mushrooms availability. Given the fact that the drivers identified cut across several sectors, such problem analysis should be conducted in the context of involving more than one sector with an objective to foster long-term commitments from each of the relevant sectors.

4.2.4 Creating community level institution to enhance equitability and cooperation

As rightly argued by, Ostrom (1990) as cited by Nie (2018), in order to enhance equitability and cooperation it will be better to facilitate establishment of community level institution to bring together all mushroom collectors and traders within each targeted village. The best model of such institution would be the one that allows for open membership for any one in perpetuity provided certain requirements are met. The cooperative model is proposed due to its suitability to foster both production and marketing. The process to facilitate establishment such cooperatives need to be extremely participatory with adequate mobilization of all social groups and spatial coverage of the environment in each targeted village. Successful roles played by cooperatives as successful entry points for commercialization of wild mushrooms and other NWFPs are provided by Marshall et al. (2006) for Mexico and Bolivia.

4.2.4 Introducing appropriate mushroom drying technology

Losses due to lack of appropriate mushroom drying technology has been frequently cited during the field data collection. Given the magnitudes of the money lost directly and indirectly through the foregone harvestable mushrooms, it is clear than appropriate mushroom drying technology represents a breakthrough for revolution of the wild mushrooms value chain in the study villages and others within the Southern Highlands. To ensure adequate quality control the dryer should be owned by the village level cooperative. Members would be granted the right of use with appropriate user fee charged to ensure financial sustainability.

The best dryer for maintaining quality of mushrooms is the one made of sieved shelves heated from the bottom (Härkönen, 2002; Boa, 2004; Bloesch and Mbago, 2009). Use of ordinary solar dryers, though cheap, may take excessively longer drying time (3-5 days) especially during the rainy season which could lead to losses just as it happens without any dryer. The best model of solar dryer is the one linked to a standby external power supply (e.g. generator, connection to grid electricity) fitted with a heating element, and integrated with thermostat for effective temperature control that helps to maintain quality of dried mushrooms. This model insures that drying is not stopped even when the rain continues concurrently as the external power continues to dry the mushrooms.

The design and assembling of the machineries and equipments can be done through Gama Metal Works based in Morogoro. The company is among the national SIDO-certified assemblers of solar driers and other machineries. There are two alternative models of the solar dryers fitted with generator power supply:

i. Medium size measuring 8 × 6 m; at a total cost of 10,000,000 TZS
ii. Medium size measuring 15 × 8 m; at a total cost of 12,500,000 TZS

Given the fact that drying characteristics for all species in Tanzania are not known, it is advised that each of the dryers to be installed should be fitted with automated temperature and humidity sensors, and integrated with a set of CCTV cameras all of which will utilize low-cost Arduino microcontrollers capable of transmitting real time data accessible through the web or predetermined mobile phone number that FORVAC will choose. This would require a separate budget of about USD 2,500.

4. CONCLUSIONS AND RECOMMANDATIONS

4.1 Conclusions

1) The poor and poorest constituted 91% of the households in the study villages, and they were more reliant on collection and trading of edible wild mushrooms than their counterpart non-poor households. This suggests that interventions to improve production efficiencies and commercialization of edible wild mushrooms have the high potential to significantly contribute to poverty alleviation.

2) Despite potential weaknesses, this study has demonstrated effectiveness and validity of folk taxonomic knowledge transmission system based on a consistence and coherence over a wide range of geographical coverage and age differences. The study has further re-confirmed the widely acknowledged congruency between folk taxonomic knowledge and scientific knowledge.

3) Establishment of exotic tree plantations such as pines and eucalypts may lead to introduction of some poisonous mushrooms leading to risks of mushroom poisoning as a result of failure of folk taxonomic mycology knowledge whenever there is a spontaneous introduction of new mushroom species not covered during the folk trainings.

4) The value of wild mushrooms as food is widely acknowledged but the relevancy of mushroom trading is only valued under the context of well established market linkage. However, unprompted opportunities for spontaneous linkages to mushroom markets tend to be hijacked by the non-poor and the poor at the expense of their poorest counterparts.

5) Besides the widely accepted livelihood importance of mushrooms, the findings has discovered the unique historical record of the role played by reserves of dried mushrooms to rescue people from severe famine in Kindimbachini. This is among pertinent issues that need to be widely communicated to both the general public and various levels of the government.

6) This study has confirmed widely reported mushroom genera of *Cantharellus, Russula, Amanita, Lactarius* and *Termitomyces* as common genera of edible wild mushrooms in different regions of Tanzania where miombo woodlands grow. This provides the potential for supporting cross fertilization of folk taxonomic knowledge, and developing training and learning materials that can be used over a wide geographical area within the country thereby enhancing cost effectiveness.

7) The non-poor and poor are more likely to engage in mushroom processing and trading when there are known market opportunities and limited access to other more lucrative business opportunities such as fishing and fisheries related businesses.

8) Edible wild mushrooms represent a potential opportunity for most of the poor and majority of the poorest to build pathways out of poverty. However, this potential is completely constrained by lack of appropriate mushroom drying technology; and inadequate access to assets such as spacious kitchen huts and large racks with mats that are needed to successfully utilize traditional mushroom drying methods.

9) The study villages have identified unsustainable farming and livestock keeping as the key drivers for the observed decline in mushrooms abundance. Since the communities have acknowledged contribution of their own actions to decline in wild mushroom this is an assurance that they can positively support interventions for conservation of mushrooms habitats.

10) The case of the young man who regularly purchase mushrooms from Kindimbachini on reportedly religious grounds reveals one of unrealized pathways that can be adapted to enhance commercialization of wild mushrooms through niche markets. However, this requires further analysis and follow up to validate the information and determine the extent the religion is established in Tanzania and outside Tanzania. Parallel this gives an idea of exploring the possibility to develop mushrooms market linkages Diasporas residing in big cities including Dodoma, Dar es Saalam, Mwanza and Arusha.

11) The existing spontaneously initiated fresh mushrooms value chain built under friendship and trust observed in Mbinga district represents a good case as a point of departure for promoting commercialization of wild mushrooms in the targeted villages.

12) This study has revealed a serious negative attitude about wild mushrooms enterprises exhibited by VEO from Amanimakoro and some civil servants from the local government in Ruvuma region. These attitude if not addressed may lead to subsequent failures of the planned wild mushrooms value chains/enterprise planned to be supported.

13) Due to their number, capacity and negligible connection to the markets, the women mushroom entrepreneurs earmarked for support through FORVAC do not provide an appropriate intervention entry point that can guarantee wide and far reaching impacts.

4.2 Recommendations

1) In order to ensure effective participation of all social groups in the targeted villages, each intervention should be designed with default mechanisms to enhance equitable access to benefits of the project/program.

2) It is advised that any investment/intervention that alters forest cover should be appraised against its contribution or negative impacts on wild mushrooms and

livelihoods benefits. This should be approached through advocacy and awareness creation for civil servants and other relevant actors.

3) The current expansion of forest plantations and woodlots of exotic tree species observed in the studied villages should go hand in hand with development of scientific guide for identification of poisonous mushrooms as a long-term measure to ensure safety. As a short-term measure, awareness should be created to the studied villages and other villages engaged in wild mushroom collection and trading in Tanzania ensure that they avoid collecting mushrooms from forest plantations of exotic tree species as much as possible.

4) In order to enhance and ensure equitable access to wild mushrooms markets for the poorest and non-poor community members alike, communities should be mobilized and facilitated to form associations particularly in the form of co-operatives as a vehicle to connect with the different levels of markets at local, regional, national and ultimately international level.

5) Given the overlap of commonly utilized mushroom species in most regions where miombo woodland occurs within the country such as Iringa region, Tabora and Kigoma; it is advised that, when developing training or learning materials to insure that they are prepared in a way that enhances applicability over a wide geographical range. However, this could require some few complementary studies to help document vernacular names for the common mushrooms to ensure effective communication across different cultures.

6) To ensure effective and wider impacts from the wild mushrooms value chain, improved solar dryers should be introduced in the study villages. This should be done as pilot interventions and used to document lessons learned. To this effect, a reasonable investment in robust monitoring system to ensure capturing of quality data (both qualitative and quantitative) is required.

7) Establishment of sustainable wild mushroom value chain should be integrated with strategies to address the drivers of declining wild mushrooms especially unsustainable farming practices and wild fires. To ensure success, such strategies should be designed and implemented under multisectoral approach.

8) FORVAC should plan follow-up validation and documentation of the case of the wild mushroom niche market through religious avenues identified in Kindimbachini to determine the actual potential within and outside the country.

9) FORVAC should consider documentation, through both textual and audio-visual, of the functioning of the spontaneously emerged wild mushrooms value chain involving urban and rural women in Mbinga District; and in the same vein, the historical role played by wild mushrooms during famine as identified in Kindimbachini village. This kind of documentation can be of value for training and advocacy; including training and awareness creation to local government staff who exhibit negative attitude towards wild mushroom value chain.

10) In order to enhance multiplier effects for urban based women retailers and rural based mushroom collectors, the planned wild mushroom commercialization interventions should aim at supporting both ends of the value chain. In this case, it should be noted that promotion of appropriate mushroom drying technology is more practical and appropriate to rural women; whereas the urban women could be supported with other mushroom processing technologies such as pickling and cold room facilities.

11) In order to avoid potential subsequent failure of the planned wild mushroom value chain establishment, the process of establishment and subsequent support provision should be integrated with appropriate training and advocacy components to address the negative attitude revealed from the VEO for Amanimakoro and some civil servants at the local government.

12) In order to enhance sustainability and far reaching impacts, it is advised that FORVAC should consider supporting the wild mushroom value chain through village level cooperatives as entry points instead of previously identified women entrepreneurs.

REFERENCES

Aday, L .A. and Cornelius, L. J. (2006). Designing and conducting health surveys: a comprehensive guide. John Wiley & Sons.

Albuquerque, U. P., de Lucena, R. F. P. and Neto, E. M. F. L. (2014a). Selection of Research Participants. In: Albuquerque, U.P., Cunha, L.V.F.C., Lucena, R.F.P., Alves, R.R.N. (Eds.), Methods and Techniques in Ethnobiology and Ethnoecology. Springer, New York, pp. 1 - 14.

Albuquerque, U. P., Ramos, M. A., Lucena, R. F. P., Alencar, N. L. (2014b). Methods and Techniques Used to Collect Ethnobiological Data. In: Albuquerque, U. P., Cunha, L. V. F. C., Lucena, R. F. P., Alves, R. R. N. (Eds.), Methods and Techniques in Ethnobiology and Ethnoecology. Springer, New York, pp. 15–38.

Angelsen , A., Larsen, H. O., Lund, J. F., Smith-Hall, C. and Wunder, S. (Editors) (2011). Measuring livelihoods and environmental dependence: methods for research and fieldwork. CIFOR Bogor, Indonesia. 263 pp

Barrett, C. B., Reardon, T. and Webb, P. (2001). Nonfarm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications. Food Policy 26(4): 315 – 331.

Belcher, B. and Schreckenberg, K. (2007). Commercialisation of Non-timber Forest Products: A Reality Check. Development Policy Review 25(3): 355 – 377.

Bloesch, U. (2009). Wild edible mushrooms from the Selous-Niassa Wildlife Corridor in Ruvuma Region, Tanzania. Flyer. https://www.researchgate.net/publication/301214327_Wild_edible_mushrooms_from_the_Selous-Niassa_Wildlife_Corridor_in_Ruvuma_Region_Tanzania_Flyer

Bloesch, U. and Mbago, F. (2009). Wild edible mushrooms and their marketing potential in the Selous-Niassa Wildlife Corridor, Tanzania. Second study (28/2 – 21/3/09). Wildlife Division, Ministry of Natural Resources and Tourism, Dar es Salaam. https://www.researchgate.net/publication/301206592_Wild_edible_mushrooms_and_their_marketing_potential_in_the_Selous-Niassa_Wildlife_Corridor_Tanzania

Boa, E. R. (2004). Wild edible fungi: A global overview of their use and importance to people. Non-wood forest products (No. 17). Food and Agriculture Organization of the United Nations (FAO), Rome. http://www.fao.org/3/a-y5489e.pdf

Brooks, J. S. (2010). The Buddha mushroom: Conservation behavior and the development of institutions in Bhutan. Ecological Economics 69: 779 – 795.

Campos, J. L. A.., Araújo, E. L., Gaoue, O. G. and Albuquerque, U. P. (2018). How can local representations of changes of the availability in natural resources assist in targeting conservation? Science of the Total Environment 628-629: 642-649.

Caporale, F., Mateo-Martín, J., Usman, M. F. and Smith-Hall, C. (2020). Plant-Based Sustainable Development - The Expansion and Anatomy of the Medicinal Plant Secondary Processing Sector in Nepal. Sustainability12(14):5575. https://www.mdpi.com/2071-1050/12/14/5575

Chelela, B. L., Chacha, M. and Matemu, A. (2014d). Wild edible mushroom value chain for improved livelihoods in Southern Highlands of Tanzania. American Journal of Research Communication, 2(8):1-14

Christensen, M., Bhattarai, S., Devkota, S. and Larsen, H. O. (2008). Collection and use of wild edible fungi in Nepal. Economic Botany 62:12 - 23. doi: 10.1007/s12231-007-9000-9

Egli, S., Peter, M., Buser, C., Stahel, W. and Ayer, F. (2006). Mushroom picking does not impair future harvests – results of a long-term study in Switzerland. Biological Conservation 129: 271 – 276. doi:10.1016/ j.biocon.2005.10.042

Ellis, F. and Allison, E. (2004). Livelihood Diversification and Natural Resource Access. FAO, LSP WP 9, Access to Natural Resources Sub-Programme,Livelihood Diversification and Enterprise Development Sub-Programme. 40pp. http://www.fao.org/3/ad689e/ad689e.pdf Page visited on 29/03/2008

Ellis, F. and Freeman, H.A. (2007). Rural Livelihoods and Poverty Reduction Strategies in Four African Countries. *Journal of Development Studies* 40(4): 1-30.

Ellis, F. and Mdoe, N. (2003). Rural livelihoods and Poverty Reduction in Tanzania. World Development 31(8): 1367 - 1384.

Härkönen, M. (2002). Mushroom Collecting in Tanzania and Hunan (Southern China): Inherited Wisdom and Folklore of Two Different Cultures. Tropical Mycology 1: 149 – 165.

Härkönen, M., Niemelä, T. and Mwasumbi, L. (2003). Tanzanian mushrooms: Edible, harmful and other fungi. Norrlinia 10:1–200

Härkönen, M., Saarimaki, T. and Mwasumbi, L. (1994). Tanzanian mushrooms and their uses 4. Some reddish edible and poisonous Amanita species. Karstenia 34: 47 - 60

Haro-Luna, M. X., Ruan-Soto, F. and Guzmán-Dávalos, L. (2019). Traditional knowledge, uses, and perceptions of mushrooms among the Wixaritari and mestizos of Villa Guerrero, Jalisco, Mexico. IMA Fungus 10:1 – 14. https://doi.org/10.1186/s43008-019-0014-6

He, J., Zhou, Z., Yang, H., Xu, J. (2011). Integrative management of commercialized wild mushroom: A case study of Thelephora ganbajun in Yunnan, Southwest China. Environmental management 48: 98 – 108.

Hosford; D., Pilz; D., Molina; R. and Amaranthus, M. (1997). Ecology and management of commercially harvested American Matsutake. General Technical Report (GTR)-412. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 68 p.

Kamalebo, M. H., Hippolyte, N. S. W. M., Ndabaga, C. M., Degreef, J. and André, D. K. (2018). Uses and importance of wild fungi: traditional knowledge from the Tshopo province in the Democratic Republic of the Congo. Journal of Ethnobiology and Ethnomedicine 14, 13. https://doi.org/10.1186/s13002-017-0203-6.

Luoma, D. L., Eberhart, J. L., Abbott, R., Moore, A., Amaranthus, M. P. and Pilz, D. (2006). Effects of mushroom harvest technique on subsequent American matsutake production. Forest Ecology and Management236: 65 - 75. https://doi.org/10.1016/j.foreco.2006.08.342.

Mahonya, S, Shackleton, C. M. and Schreckenberg, K. (2019). Non-timber Forest Product Use and Market Chains Along a Deforestation Gradient in Southwest Malawi. Frontiers in Forests and Global Change 2:71.doi: 10.3389/ffgc.2019.00071

Marshall, E., Schreckenberg, K. and Newton, A. C. (eds) (2006) Commercialization of Non-timber Forest Products: Factors Influencing Success: Lessons Learned from Mexico and Bolivia and Policy Implications for Decision-makers. Cambridge: UNEP World Conservation Monitoring Centre.

Martínez-Carrera, D., Morales, P., Pellicer-González, E., León, H., Aguilar, A., Ramírez, P., Ortega, P., Largo, A., Bonilla, M. and Gómez, M. (2002). Studies on the traditional management, and processing of Matsutake mushrooms in Oaxaca, Mexico. Micologia Aplicada International 14(2): 25 - 43.

Narayan, D., Patel, R., Schafft, K., Rademacher, A. and Koch-Schulte, S. (2000). Can anyone hear us? Voices of the poor. Oxford University Press, Oxford.

Nie, Z. (2018). Cooperation, Institutions and Sustainable Development: empirical evidence from China. PhD thesis, Wageningen University, Wageningen, the Netherlands. 162pp. ISBN 978-94-6343-784-4. DOI https://doi.org/10.18174/451360

Nie, Z., Yang, X. and Tu, Q. (2020). Resource scarcity and cooperation: Evidence from a gravity irrigation system in China. World Development 135:105035. ISSN 0305-750X.

Onduso, F. N., Stephenson, S. L. and Devil, T. (2018). A preliminary study of the ecological distribution and diversity of mushrooms in the Standing Rock Indian Reservation, USA. Current Research in Environmental and Applied Mycology 8(3): 306 - 312.

Pérez-Moreno, J., Martínez-Reyes, M., Yescas-Pérez, A., Delgado-Alvarado, A. and Xoconostle-Cázares, B. (2008). Wild Mushroom Markets in Central Mexico and a Case Study at Ozumba. Economic Botany 62: 425 – 436.

Pilz, D. and Molina, R. (2002). Commercial harvests of edible mushrooms from the forests of the Pacific Northwest United States: issues, management and monitoring for sustainability. Forest Ecology and Management 155(1-3): 3 - 16.

Ravnborg, H. M. (2003). Poverty and Environmental Degradation in the Nicaraguan Hillsides.World Development 31(11): 1933 – 1946.

Schnegg, M. (2018). Institutional multiplexity: social networks and community-based natural resource management. Sustainability Science 13(4): 1017 – 1030. https://doi.org/10.1007/s11625-018-0549-2

Shackleton, C. M. and Shackleton, S. (2006). Household wealth status and natural resources use in the Kat River Valley, South Africa. Ecological Economics 57:306 - 317. doi: 10.1016/j.ecolecon.2005.04.011

Sharma, B. P., Lawry, S., Paudel, N. S., McLain, R., Adhikary, A. and Banjade, M. R. (2020). Operationalizing a Framework for Assessing the Enabling Environment for Community Forest Enterprises: A Case Study from Nepal. Small-Scale Forestry19: 83 - 106.

Tibuhwa, D. D. (2011). Substrate specificity and phenology of macrofungi community at the university of Dar es Salaam main campus, Tanzania. Journal of Applied Biosciences 46: 3173 – 3184

Tibuhwa, D. D. (2012). Folk taxonomy and use of mushrooms in communities around Ngorongoro and Serengeti National Park, Tanzania. Journal of Ethnobiology and Ethnomedicine 8: 36 – 44.

Tibuhwa, D. D. (2013). Wild mushroom-an underutilized healthy food resource and income generator: experience from Tanzania rural areas. Journal of Ethnobiology and Ethnomedicine 9: 49 - 62.

Tibuhwa, D. D. (2018). Edible and Medicinal Mushrooms Sold at Traditional Markets in Tanzania. Research Journal of Forestry 12: 1-14. http://docsdrive.com/pdfs/academicjournals/rjf/2018/1-14.pdf

Tibuhwa, D. D., Buyck, B., Kivaisi, A. K. and Tibell, L. (2008). Cantharellus fistulosus sp. nov. from Tanzania. Journal of mycology 2: 129 - 135.

Tibuhwa, D.D., Buyck, B., Kivaisi, A.K. and Tibell, L. (2008). Cantharellus fistulosus sp. nov. from Tanzania. Journal of mycology 2: 129 - 135.

Tibuhwa, D.D., Kivaisi, A.K. and Magingo, F.S.S. (2010). Utility of the macro-micromorphological characteristics used in classifying the species of Termitomyces. Tanzania Journal of Science 36: 31 - 45.

Uçar, F. M. and Sungur, S. (2017). The role of perceived classroom goal structures, self-efficacy, and engagement in student science achievement. *Research in Science &Technological Education 35*(2): 149 - 168.

United Republic of Tanzania (URT) (1998). National Forest Policy. The United Republic of Tanzania. Dar es Salaam, Tanzania. 59pp.

United Republic of Tanzania (URT) (2008). Action Research into Poverty Impacts of Participatory Forest Management (ARPIP): Case Studies from the Eastern Arc Mountains area of Tanzania. Ministry of Natural Resources and Tourism, Forestry and Beekeeping Division, Dar es Salaam. 124pp.

URT (2002). The New Forest Act, no. 7 of 7th June 2002, Ministry of Natural Resources and Tourism, The United Republic of Tanzania. Government Printer, Dar es Salaam, Tanzania, 174pp.

URT (2006). Participatory Forest Management: Facts and Figures. Forestry and Beekeeping Division, Ministry of Natural Resources and Tourism, Dar es Salaam, Tanzania.

Venturella, G. (2016). Pleurotus nebrodensis ssp. nebrodensis. The IUCN Red List of Threatened Species 2016: e.T61597A102952148. https://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T61597A102952148.en.

Vyamana, V. G., Amuri, N., Mugasha, W. A., Hieronimo, P. and Mourice, S. (2015). Climate Smart Agricultural Options for Small-scale Farmers in the South Nguru Mountain Landscape, Mvomero District, Morogoro. TFCG Technical Report 46.

Vyamana, V.G. (2009). Participatory Forest management in the Eastern Arc Mountains of Tanzania: who benefits? *International Forestry Review* 2(2): 239-253.

Zorrilla-Miras, P., Mahamane, M., Metzger, M. J., Baumert, S., Vollmer, F., Luz, A. C., Woollen, E., Sitoe, A. A., Patenaude, G., Nhantumbo, I., Ryan, C. M., Paterson, J., Matediane, M. J., Ribeiro, N. S. and Grundy, I. M. (2018). Environmental Conservation and Social Benefits of Charcoal Production in Mozambique. Ecological Economics 144: 100 – 111.

Zotti, M., Persiani, A. M., Ambrosio, E. Vizzini, A., Venturella, G., Donnini, D., Angelini, P., Di Piazza, S., Pavarino, M., Lunghini, D., Venanzoni, R., Polemis, E., Granito, V. M., Maggi, O., Gargano, M. L. and Zervakis, G. I. (2013). Macrofungi as ecosystem resources: Conservation versus exploitation, Plant Biosystems - An International Journal Dealing with all Aspects of Plant Biology: Official Journal of the Societa Botanica Italiana. DOI:10.1080/11263504.2012.753133

APPENDICES

Appendix 1: Terms of reference for the study

Project number and title	P34809P001 / Forestry and Value Chains Development Programme (FORVAC)
1. Area of operations	• Kindimba Chini, Ndongosi and Amani Makoro villages in Mbinga District • Hinga and Litolomero villages (Nyasa District) • Mbinga Town / Songea Town markets
2. Duration	31 December 2020 – 19 February 2021 (21 effective consultancy days within this time period)
3. Background	The Forestry and Value Chains Development Programme (FORVAC) is a 4-year (7/2018-6/2022) Programme funded by the Governments of Tanzania and Finland. The implementing agency of the programme is the Forest and Beekeeping Division (FBD) of the Ministry for Natural Resources and Tourism (MNRT), in close cooperation with Tanzania Forest Service (TFS) and the President's Office Regional Administration and Local Government (PO-RALG). FORVAC is working in three different cluster areas; Tanga, Ruvuma and Lindi. Forestry and Value Chains Development (FORVAC) aims to contribute in increasing economic, social and environmental benefits from forests and woodlands while reducing deforestation. The expected outcome of FORVAC is *"Improved forest-based income, livelihoods and environmental benefits"*. The outcome will be achieved through the following outputs: **Output 1: Improved Value Chains and increased Private Sector Involvement in the forest sector.** **Output 2: Stakeholder capacity to implement and promote forestry value chain development enhanced.** **Output 3. Functional extension, communication, monitoring systems; and Management Information System (MIS) in place.** **Output 4. Supportive legal and policy frameworks to forest value chain and sustainable forest management developed.** FORVAC is a value chain development programme, and in the Community Based Forest Management context it promotes sustainable forest businesses around timber, charcoal, and non-wood forest products. The core idea of FORVAC is to ensure the existence of forests now and in the future and to contribute to increased income at the community level by promoting forest-based businesses. Businesses in this context can be e.g. community as a whole selling wood from a Village Land Forest Reserve (VLFR) or e.g. giving licenses for beekeepers, individuals or community groups building businesses around the raw material from VLFR (e.g. honey processors, carpenters, mushroom processors, bamboo product makers). It can also be individuals or groups building a business around community forestry operations (e.g. logistics inside or outside the forest, forest management planning / inventory service providers, mobile sawmill owners providing servicea to forest communities). CBFM has been launched in above mentioned villages in early 2000s. The villages are part of the 14 villages who own a large joint VLFR Namswea-Lilengalenga, in total of about 23,000 ha. The VLFR has first been established for watershed protection purposes, but also provides an important base for individual businesses, e.g. mushroom production. FORVAC identified the mushroom production as a potential value chain during interviews which were made in Mbinga district to assist programme to select rural businesses for further development through mentoring and micro grants. The entrepreneurs engaging in mushroom business are mainly female and they sell mainly fresh mushrooms both in the surrounding villages and near-by town centres during the season. A few interviewed individuals also engage in drying and selling dried mushroom outside the season and as far as in Dar es Salaam. This assessment is to further find out the details related to the mushroom value chain in above mentioned villages in Mbinga and Nyasa Districts, and to recommend a way forward for FORVAC in terms of boosting the value chain.

4. Objectives	Contribute to development of the mushroom value chain in Mbinga and Nyasa districts and improved livelihoods in the area.
5. Scope	This assessment is to find out the details related to existing situation in mushroom business in above mentioned villages / market: • Production: mushroom species, seasons (including fluctuation in the availability of mushrooms between seasons – "good" years / "bad" years), production area/sites, current harvesting techniques/practices and their sustainability, perceived threats/conservation status of mushroom habitats, potential volumes. • Estimation of number of people involved in the mushroom business in above mentioned villages, and estimation of percentage of women among the producers, list of individuals identified, description and contact information. • Quick assessment of the capacity of the four mushroom businesses (2 in Kindimba Chini, 2 in Amani Makoro) that FORVAC is supporting through community level business support & mentoring (also includes grant support), possibility of growing one of these businesses into processing & branding & marketing (-> market for others). • Processing: methods for storing, and processing including possible drying or other appropriate processing and packing methods. • Market: where are mushrooms currently sold, which species are preferred in the market and the respective prices, market for fresh /dried goods, are there larger bulk buyers or are mushrooms sold to individuals. • Bottle necks related to the business. Basing on the data collected, the consultant is expected to draw conclusions and give practical recommendations on how FORVAC could contribute to increased value and sustainability for the mushroom value chain. Consultant is requested to communicate and cooperate with the SUA MSc student, who is currently doing an MSc thesis on the same. It is required that these two studies would contribute to each other and data collected by either party would be shared and used by the both.
6. Deliverables	• Report of the assessment of the mushroom value chain, business feasibility, and business potential in Mbinga and Nyasa Districts. • PowerPoint presentation
7. Timing	31 December – 19 Feb. 2021, fieldwork during January – early February 2021. Presentation of the results at FORVAC PMU in Dodoma in mid-February 2021.
8. Payment	Exact terms of payment will be negotiated with the Consultant during contracting.
9. Consultant	Proposed Consultant: Dr. Vincent Vyamana, Miombo Ecologist/NRM/Mushroom Specialist
Annexes	• FORVAC Programme Document (PD), https://forvac.or.tz/wp-content/uploads/2019/12/FORVAC-Programme-Document_FINAL.pdf • Annual Workplan and Budget 2020 – 2021, https://forvac.or.tz/wp-content/uploads/2020/03/FORVAC-Annual-Workplan-and-Budget-2020-2021-1.pdf • FORVAC Market Systems Analysis (2018): https://forvac.or.tz/wp-content/uploads/2019/11/20181218_Market-Systems-Analysis.pdf • Training Needs Assessment (2019): https://forvac.or.tz/wp-content/uploads/2019/11/20190714_Training-Needs-Assessment.pdf • FCG Code of Conduct: https://forvac.or.tz/wp-content/uploads/2020/01/FCG-Code-of-conduct.pdf

Appendix 2: Scheme for abundance trend analysis for the most marketable wild edible mushroom species

Identified most marketable edible mushroom species	Scores on abundances (1 = least marketable; 5 highly marketable)					Reasons for declining or increasing trends observed	Impacts due to observed trend
	1980	1990	2000	2010	2020		

Appendix 3: Structured questionnaire for personal interviews with mushroom harvesters/collectors

SECTION A: INYTRODUCTION

My name is _____, a researcher representing FORVAC project.
We are doing research to understand mushroom collection, use and trade; and how it relates to the overall livelihoods of the people in this area. The aim of this research is to document actual experiences of mushrooms collectors as they engage in collection, processing and marketing of fresh and processed mushrooms; and their interaction with other actors involved in marketing of fresh and processed mushrooms. Findings from this research will be made available to decision- and policy- makers at the village, district, regional and national levels to help them come up policies or interventions that are relevant to the real needs and priorities of mushroom collectors and traders. The information that you provide will be kept with high level of confidentiality in such a way that your name (or any kind of identity) will not be associated with any report or recommendations resulting from this research. We assure you that there will be no any trouble or damage to you or your properties as a result of this research. We have obtained permit to conduct this research in this village from national, regional, district and village authorities. You are free to stop the interview at any point in time without being required to provide and explanation. Also, you are not obliged to respond to each of the questions that will be asked; and it is okay if you decide not to provide responses to any of the questions as you may feel during the course of interview.

This interview will take approximately one hour.
If you are ready we can start the interview, now. Otherwise, you are free to decline from participating in this research. In case you still have any question regarding this research you are free to ask; I am willing and ready to provide further clarification.

Respondent's consent to participate in the interview has been obtained?		Yes/No_____
Name of the respondent:	**Signature:**	**Date:**

SECTION B: GNERAL INFORMATION

District:	Ward:	Village:	Interviewer's name:	Date of interview:

SECTION C: INTERVIEWEE BACKGROUND INFORMATION

1. Name of the head of the household: 2. Sex of the head of household o Male o Female 3. What is the tribe of the head of household?_____	4. Wealth category of the household: o Non-poor o Poor o Poorest 5. What is the age of the head of household?	6. What is the highest education level of the head of the household? o No formal education o Some primary (left school prior standard 7) o Primary education o Secondary education o College o University o Others_____
7. Respondent's name (if not head of household):	8. Age of respondent (Years):	9. Sex of respondent (if not head of household): o Male o Female 10. What is the tribe of the respondents (if different from the head of household)?
11. What is respondent's tribe (if different from that of the head of household)?	12. Education level of the respondent (if not head of household) o No formal education o Some primary (left school prior standard 7) o Primary education o Secondary education o College o University o Others_____	

13. How many adults (18 years and above) live in this household? Males_____ Females____

14. How many children (below 18 years) live in this household? Males_____ Females____

15. Which are livelihood activities for this household among the following??

o Farming____ o Business____ o Livestock keeping__ o Mushroom collection	o Casual labour____ o Charcoal production___ o Timber production____ o Others: _

16. For each of the livelihood activities you have mentioned (including mushroom collection), use the table below to distribute 50 beans amongst the activities such that the most important activity receives many beans while the least important receives fewer beans

Livelihood activity	Scores (# beans)	Livelihood activity	Scores (# beans)
Farming		Casual labour	
Business		Charcoal production	
Livestock keeping		Timber production	
Mushroom collection		Others: _	

17. On average, what was total annual cash income in 2019/20 season (Include remittances, income from sell of mushrooms and other forest products, crop income, livestock income, business, wage labour, pension et cetera)?_____

SECTION D: MUSHROOM COLLECTION

18. How did you become a mushroom collector?

19. How many years of experience in mushroom collection do you have?_____

20. How many other members of your household are involved in mushroom collection [both adults (18 years and above) and children (below 18 years)]?

Adults above 18 years				Children below 18 years			
Number present		Number involved in mushroom harvesting during 2019/2020 season		Number present		Number involved in mushroom harvesting during 2019/2020 season	
Males	Females	Males	Females	Males	Females	Males	Females

21. For this household, is mushroom collection activity undertaken as [tick one (s [t
    a) a regular and specific main activity (dedicated mushroom collector)_____
    b) an add-on activity along with other activities considered to be of more importance (Opportunistic mushroom collector)_____

22. Are you satisfied with your work as a mushroom collector? (Why?/Why not?)

23. Will this household continue to collect mushrooms in the future? (Why?/Why not?)

24. Is there any need for a permit to collect mushrooms from the wild?

25. a) Is any member of this household in possession of a mushroom collection permit?

b) If the permit is required and no one in this household has one, why not?

26. How do you decide, when and how much mushroom to collect (availability, need for cash, off-season, etc.)?

27. Mushroom collected and sold at different times during the 2019/20 season

Months of the year when available	Number of days of collection in a month	Total months of collection in a year	Average daily collection (indicate unit of measure)	Average daily hours used for mushroom collection including time used to walk to and from harvesting sites times	Average daily fresh mushroom consumed and sold			Average daily fresh mushroom quantity processed for future use and sale
					Quantity consumed	Quantity sold	Unit price (TZS)	

28. Where do members of this household collect mushrooms? What means of transport are use to reach each of the mushroom harvesting sites

Harvesting sites	Land tenure for the harvesting site[17]	Distance from home to harvesting site (or walking/driving time)	Means of transport to reach the harvesting site

29. In your view, how has availability of mushrooms in the wild changed now compared to the past 10 years

a) Perceived change in mushroom availability in the wild	b) Reasons for increased or decreased availability	c) If there is a decrease what should be done to address the problem?
o No change o Increased o Decreased		

SECTION F: TECHNIQUES AND KNOWLEDGE

30. a) Are you able to locate sites with abundant mushrooms when you go out for mushroom harvesting? Yes/No____?
    b) How do you locate sites with abundant mushrooms?
    c) How did you learn the skills for locating sites with abundant mushrooms?
    d) To what extent are you able to locate sites with abundant mushrooms during collection?
        o 1 2 3 4 5
    e) Why have you assigned that particular scale on your ability to locate sites with abundant mushrooms?

31. a) Are you able to differentiate edible from inedible mushrooms? Yes/No____

    b) How do you differentiate edible from inedible mushroom species?

    c) How did you learn the skills for differentiating edible from inedible mushrooms?

    d) On a scale of 0 to 5 points, indicate the extent you are able to differentiate edible from inedible mushroom species?

[17]Private land; Community/village land; Government land

o 1 2 3 4 5

e) Why have you assigned that particular scale on your ability to differentiate edible from inedible mushrooms?

SECTION G: MUSHROOM HARVESTING AND HANDLING PRACTICES

32. Once you are in a mushroom harvesting site how do you harvest mushrooms (tools, equipments and the process of harvesting used)?

33. Has your technique changed over the years? (How? Why?/Why not?)

34. Do you use any particular techniques to ensure sustainability of mushroom productivity in sites where you harvest? Yes/No

35. a) How many techniques do you use to ensure sustainability of edible wild mushrooms?
    b) Which techniques are you using? Why are you using each of the techniques mentioned?

36. Do other mushroom collectors in the village use different technique(s)? (Why / Why not?)

37. If other collectors are using different techniques, what do you think about the techniques that other mushroom collectors use?

38. On a scale of 0 to 10 points, indicate average composition of mushrooms of different maturity stages that you harvest in a typical harvesting batch?

Stage of mushroom maturity	Proportion (# out of 10)
Young mushrooms having closed caps	
Mushrooms at intermediate maturity stage having caps half opened	
Complete mature mushrooms having completely opened caps	

39. Is there any price differentiation for mushrooms of different maturity stage? Yes/No?

40. If there is price differentiation for mushrooms of different maturity stage, indicate average price for each maturity category?

Stage of mushroom maturity	Unit of measure	Unit price
Young mushrooms having closed caps		
Mushrooms at intermediate maturity stage having caps half opened		
Mature mushrooms having completely opened caps		

41. What utensils do you use for harvesting and transporting mushrooms from harvesting site to home or market places?

42. Are there any agreed mushrooms harvesting practices for this community/village in order to ensure mushroom availability in the future? Yes/No___

43. If yes: a) what are the agreed mushroom harvesting practices in this community/village? _____

    b) If yes, are the agreed practices formal (accepted and there are written bylaws or laws to enforce them) or informal (accepted but there are no written bylaws to enforce them)?

44. Are you willing to change the way you harvest mushrooms if it is required as a measure to ensure its availability in the future or for the future generation? Yes/No_____

SECTION H: PROCESSING AND STORAGE OF PROCESSED MUSHROOMS

45. Do any member of this household process harvested mushrooms? Yes/No_____

46. How many mushroom processing techniques are being used in this household?

47. For each mushroom processing technique used in this household, provide the following information in the table

Processing methods	What share of the fresh mushroom you process comes out as processed mushroom that can be stored or sold?	Average annual quantity of fresh mushrooms processed by the method		Shelf-life of mushrooms processed by different methods and storage technique		For 2019/20 season, proportion of processed mushroom that is....		
		Unit of measure	Quantity	Shelf- life	Storage technique used	Consumed at the family	Sold	Given to neighbours or friends free of charge

48. If processed mushrooms are being sold from this household, what is the average price?

SECTION H: MARKETING AND MARKET INFORMATION SYSTEM

49. Did any household member sell fresh mushroom during 2019/20 season?

50. To whom were the fresh mushrooms sold during 2019/20?

Type of buyers	Description of the buyer category	Tick (√) all that apply
Direct customers	Residence of the same village who buy and use mushrooms at their homes	
Itinerant sub-local traders	Traders who move from village to village beyond the road network; usually cover many districts. Often focus on selected high-value products. Always actively contact harvesters. These are normally rare.	
Permanent sub-local traders	Traders who have a permanent presence. May or may not receive or distribute advances; harvesters may be contacted actively or passively. May act as broker or commission agent. These could be common.	
Specialist local traders	Traders who are located in or near the district of origin; average catchment area of 1-3 districts. Trading exclusively in mushrooms. These are rare.	
Generalist local traders	Traders who are located in or near districts of origin; average catchment area of 1-3 districts. Trading a number of items besides mushrooms. These could be common.	
Processors	Traders who buy mushrooms and process them into advanced products such as medicine, dietary supplements, et cetera	
Multi-purpose cooperatives	Cooperatives that buy mushrooms from harvesters acting and transporters	

51. a) In 2019/2020 season, which of the following general locations did this household sell fresh mushroom?
    - o Within the village
    - o Outside village but within the district
    - o Outside the district
    - o Other (specify)

    b) If the household sold fresh mushrooms outside your residence, where did the household sell fresh mushrooms in 2019/20?
        (i). Selling location name: _____
        (ii). Distance to selling location (in walking hours from residence)_____

52. Quantity of fresh mushrooms sold at within the village for 2019/20 season (specify unit)_____
53. Quantity of fresh mushrooms sold outside the for 2019/20 season (specify unit)_____

54. What means of transportation did the household use to deliver fresh mushrooms to different selling locations in 2019/20 (multiple responses)?
    a) Bicycle d) Tricycle (Bajaji) g) Truck

b) Bull cart
c) Bus
e) Motorcycle
f) Tractor
h) Walk
i) Others (specify)_____

55. Did any member of this household encounter any rent-seeking event during transportation or marketing of fresh mushrooms for the 2019/20 season? Yes/No____

56. What types of rent-seeking did you encounter during transportation of fresh mushrooms to the main selling market place in 2019/20? On average, how much did each rent-seeking event cost in 2020?

Types of rent-seeking encountered	**Costs incurred due to each rent-seeking encountered (TShs)**
No rent-seeking encountered	
Rent-seeking from forest staff	
Rent-seeking from police officers	
Rent-seeking from village leaders	
Other rent-seeking:	

57. Are the customers for processed mushrooms different from those for fresh mushrooms? Yes/No____ (If no, jump to question 76)

58. If there are different customers for fresh and processed mushrooms, to whom did members of this household sell processed mushrooms in 2019/20 season?

Type of buyer	Description of the buyer category	Tick (ic all that apply
Direct customers	Residence of the same village who buy and use mushrooms at their homes	
Itinerant sub-local traders	Traders who move from village to village beyond the road network; usually cover many districts. Often focus on selected high-value products. Always actively contact harvesters. These are normally rare.	
Permanent sub-local traders	Traders who have a permanent presence. May or may not receive or distribute advances; harvesters may be contacted actively or passively. May act as broker or commission agent. These could be common.	
Specialist local traders	Traders who are located in or near the district of origin; average catchment area of 1-3 districts. Trading exclusively in mushrooms. These are rare.	
Generalist local traders	Traders who are located in or near districts of origin; average catchment area of 1-3 districts. Trading a number of items besides mushrooms. These could be common.	
Processors	Traders who buy mushrooms and process them into advanced products such as medicine, dietary supplements, et cetera	
Multi-purpose cooperatives	Cooperatives that buy mushrooms from harvesters acting and transporters	

59. In 2019/20 season, where did members of this household sell processed mushrooms? Yes/No____

60. If processed mushrooms from this household were sold outside this village, where were the processed mushrooms sold in 2019/20?
    a) Selling location name:_____
    b) Distance to selling location (in hours from residence)_____

61. In this household, do the means of transportation for processed mushrooms different from those for fresh mushrooms? Yes/No____ (If no, jump to question 78)

62. What means of transportation to members of this household use to deliver processed mushrooms to the main selling site in 2019/20 season (multiple responses)?
    a) Bicycle
    b) Bull cart
    c) Bus
    d) Tricycle (Bajaji)
    e) Motorcycle
    f) Tractor
    g) Truck
    h) Walk
    i) Others (specify)_____

63. a) What types of rent-seeking did any member of the household encounter during transportation of processed mushrooms to the main selling market place in 2019/20?
    b) On average, how much did each rent-seeking event cost in 2019/20?

Types of rent-seeking encountered	**Costs incurred due to each rent-seeking encountered (TShs)**
No rent-seeking encountered	
Rent-seeking from forest staff	
Rent-seeking from police officers	
Rent-seeking from village leaders	
Other rent-seeking:	

64. a) On a scale of 1 to 5, indicate the extent members of this household are able to find customer for the mushrooms prior harvesting or processing?

    o 1 2 3 4 5

65. Why have you assigned that particular scale on the ability of members of this household to link with customers?What are the means of accessing mushroom price information for members of this household [***Do not read answers; circle all that apply***]?
    1) Contacting friends/neighbors
    2) Decided by buyers
    3) From radio/magazine
    4) You decide yourself
    5) Mobile phones
    6) Others (specify) _____

66. Use a scale of 0 to 5 to indicate the extent you can trust each of the means of accessing mushroom price information you have just mentioned?

- Contacting friends/neighbors
- Decided by buyers
- From radio/magazine
- Sellers decide themselves
- Mobile phones
- Others (specify) ……

67. What factor doe the members of this household use to decide on selling price for the mushrooms collected or processed [***Do not read answers; circle all that apply***]?
    - Production in that particular year
    - Other farmers selling at comparably lower prices
    - Buyers coming with their prices
    - You decide yourself
    - Others (specify) ……...

68. What are the uses of the money from mushroom trade for this household?

SECTION I: CHALLENGES

69. a) Has any member of this household encountered any challenge regarding collection and marketing of mushrooms? Yes/No___
    b) How many categories of challenges have members of this household faced?
    c) What challenges have you encounter as mushroom collector?
    d) How serious is each of the challenges?
    e) How do you cope with each of the challenges?

Perceived challenges	Coping strategies (if any)

Thank you for your cooperation

Appendix 4: Semi-structured interview guide for FORVAC Business Mentor from Social and Economic Development Initiatives of Tanzania (SEDIT) based in Mbinga district

1. What is the overall key purpose of your interventions/program/sub-program?

2. a) What are specific interventions that you are implementing in Mbinga district?
   b) Villages covered by different interventions?

3. a) What process did you use to identify village-based entrepreneurs for support through SEDIT of behalf of FORVAC?
   b) What were the specific criteria used to identify/select the entrepreneurs to be supported by FORVAC?
   c) How were village governments involved?

4. a) What plan do you have for the earmarked village-based entrepreneurs?
   b) What progress on the plan have you made so far?

5. What challenges are mushroom entrepreneurs facing at present?

6. a) What dream/vision for the overall mushroom collectors in the villages where you work over the next five years?
   b) What are the strategies for reaching the dream?

7. Do you have any additional comments/views?

Appendix 5: Semi-structured interview guide for leaders for Mbinga town market

1. What are your general views on the business of edible wild mushrooms in this market/town?

2. On average, how many mushroom traders are operating in this market premises/town?

3. a) Where do the traders source their mushrooms and what are the arrangements?
   b) Types of mushrooms sold?
   c) Proportion of sellers of fresh and dried mushrooms

4. a) What are your general views on availability of edible wild mushrooms now compared to the past ten or more years?
   b) What are the reasons on the trend you have just described?

5. What are your general views on profitability of the edible wild mushrooms business?

6. What are the challenges faced by mushroom traders in this market premises/town and what are the possible means to address each of the challenges?

7. Do you have any additional comments/views?

Appendix 6: Semi-structured interview guide for mushroom traders selling mushrooms at different town centres

1. a) Ownership of the mushroom business (private, consortium, etc)?
   b) What other businesses are you doing apart from selling mushrooms?
   c) Rank all the business in order of their importance based on your own perspective?

2. What types of mushrooms are you selling?

3. a) Where do you source the mushrooms you sell?
   b) What are the arrangements for sourcing mushrooms that you sell?
   c) What are the seasons for selling fresh and dried mushrooms?
   d) Buying and selling prices?
   e) Estimates of annual quantities of mushrooms traded?
   f) Who are your customers?
   g) What is your perception on availability of customers?

4. Are there any specific conditions from the government that mushroom traders need to comply with?

5. a) How do you perceive availability of mushrooms now compared to the past ten years?
   b) What are the reasons for the trend in mushroom availability that you have just described?

6. What are the uses of money to earn from the mushroom trading?

7. Do you have any additional comments/views?

Appendix 7: Semi-structured interview guide for a representative from Mamaland Mushroom Farms based in Morogoro

1. a) Business name?
   b) Location of the business?
   c) Legal status (Formal, informal, etc)
   d) When did you start the mushroom business?
   e) Number of employees (Male, Female)? Are you paying any social security fund for the employee (evidence, if any)?
   f) Highest education level of the CEO
   g) How did you start your business?
   h) Mode of operation (seasonal/continuous)?

2. Type of ownership (private, consortium, etc)
3. a) What products do you normally sell?
   b) Estimates of annual production levels for each product

4. a) Where do you source your raw materials or commodities (if applicable)?
   b) Mushroom species you are dealing with?

5. a) Do you process mushrooms?
   b) What processing technologies are you using?
   c) Where and how did you get the technology?

6. a) What products are you selling at present?
   b) What are the end markets for different products you are selling?

7. Average annual financial turnover (capital, running costs, gross revenues, etc)
8. What is your perception about the market/demand?
9. a) What are the future plans for your company/enterprise?
   b) What are the motives behind each component of the future plan?

10. a) Do you have any plan to share your knowledge with wild edible mushroom collectors?
    b) What is the motive behind your plan to share knowledge?
    c) What knowledge/skills do you wish to share with the mushroom collectors?

11. Do you have any additional comments/views?

Appendix 8: Semi-structured interview guide for village leaders

1. a) What are the livelihood activities for this village?
   b) Rank each of the livelihood activities on its importance as you perceive it?

2. a) What proportion of households is involved in mushroom collection for subsistence only?
   b) What proportion of households is involved in mushroom collection for subsistence and trading?

3. What have interventions have you accomplished with FORVAC so far?

4. a) What are the neighbouring villages that have abundant mushroom supply?
   b) Provide an indication of the relative abundances of mushrooms in each of the villages in comparison to yours?

5. a) How many mushrooms entrepreneurs that have been earmarked for support from FORVAC?
   b) How were you involved in identification of the mushroom entrepreneurs?
   c) What criteria or process did you/FORVAC use to identify the mushroom entrepreneurs?

6. What are the key challenges regarding mushroom collection and trading in this village?

7. a) What future do you wish/dream for the mushroom traders in this village?
   b) In your views, what are the most appropriate means to reach each of the desired future for the mushroom traders?

8. Do you have any additional comments/views?

Appendix 9: Checklist for interview with wild mushroom entrepreneurs previously earmarked for support from FORVAC

1. Name and particulars of the entrepreneur
2. Date of interview
3. Experience in mushroom trading
4. Formalization of the business (Formal/Informal)
5. What support received so far and from whom?
6. What products do you sell and what are the end markets?
7. Prices for fresh and dried mushrooms?
8. Ownership of the business (Private, Consortium, etc)
9. Costs incurred
10. Quantities of fresh and dried mushrooms produced, consumed and sold
11. Selling prices for fresh and dried mushrooms
12. Incomes from mushroom trade of the last three years
13. In your view, how profitable is the mushroom trading?
14. Perception on access to financial services for capital
15. Do you have any additional comments/views?

Appendix 10: Summary of responses from individual and group interviews of key informants

I. Interview with the Business Mentor from SEDIT Tanzania

S/N	Theme	Responses
1	Interviewee(s) and positions	Jackson George Sweveta, Business Mentor for Social and Economic Development Initiatives of Tanzania (SEDIT) based in Mbinga district
2	Key purpose of your interventions/program/sub-program	In line with overall FORVAC goal and objectives, SEDIT is managing the business mentoring component with the aim of supporting target communities to add value to different forest products. Thus, we are focusing on promoting forest based income generating activities through which to incentivize communities to effectively participate in forest protection. This component of the program is to be implemented over six months timeframe, ending by April 2021
3	Key interventions implemented trough SEDIT	1) As SEDIT, we are promoting three categories of forest-based income generating activities: beekeeping, handcrafts and wild mushrooms 2) We are working in seven (7) villages within Mbinga district: mushroom enterprises are being supported in Amanimakoro and Kindimbachini where we are supporting three and two women respectively; beekeeping enterprises are being supported in Kiwombi, Kindimbajuu, Kindimbachini, Amanimakoro, Ndongosi and Barabara villages; besides we also support bamboo-based handcrafts in Ukata and Amanimakoro villages
4	Process to used to identify entrepreneurs for support through SEDIT	1) A multidisciplinary team was formed combining professionals with a wide range of specialization from Mbinga District Council and FORVAC 2) The team developed criteria for business selection and invited entrepreneurs from the target villages to prepare and submit relevant business proposal with respect to forest-based income generating businesses. 3) The team reviewed the submitted proposals jointly to assess genuineness and feasibility of each them; besides applicants were also assessed by oral interviews conducted by the team in each village 4) The team conducted physical assessment of the proposed enterprises to verify genuineness and overall suitability of the business; through this process some enterprises were dropped and some new ones were identified and added; for example, one business (individual) from Barabara village was dropped. 5) The team conducted training needs assessment (TNA) to identify kind of trainings that were needed to make the indentified entrepreneurs perform good and successful business ventures. Through the TNA the following key gaps in skills were identified: lack of entrepreneur skills, lack of business management, lack of record keeping, lack of marketing strategies and preparation of business plan. Also the enterprises lack beekeeping skills, honey processing and packaging skills; and mushroom preparation/processing and preservation skills. 6) An overarching training program was then developed based on the findings from TNA 7) One general entrepreneur training was conducted for all entrepreneurs across targeted sub-sectors; thereafter there has been an on-going on entrepreneurship trainings across all targeted villages

S/N	Theme	Responses
5	How were the respective village governments involved in identification of the entrepreneurs earmarked to receive support from FORVAC	1) Advertisements/calls for business proposals were posted via village notice boards 2) Oral interviews for the entrepreneurs that submitted proposals were conducted in respective village government offices 3) Physical validation was done through the village government offices; village leaders organized the assessments and final reports were first shared with the village leaders, and then respective applicants (entrepreneurs) were inform.
6	Specific criteria used to select the entrepreneurs to be supported by FORVAC	I am not sure of the whole process since I took this role SEDIT had already begun the process well before October 2020. We did analysis and business selection in October 2020 when I had just arrived in Mbinga to take my position as Business Mentor; entrepreneurs who had submitted their plans and who scored higher in the follow-up oral interviews were selected. So in summary, high scores on the quality and genuineness of the business plan and oral interviews were the two main criteria; nevertheless I know that women and disabled were given special priority.
7	Kind of support planned to be given to the earmarked entrepreneurs	Besides the conventional TNA, we also provided an opportunity to respond to specific requests from different entrepreneurs/groups of entrepreneurs as a complimentary process to build their capacity; this was done purposely to enable them to become functional businesses. For mushroom entrepreneurs which is the focus of this discussion, as you told me, they identified the following specific needs: 1) Over lolls and gumboots for protection during mushroom collection in the forest 2) Baskets (vikapu) and buckets for collecting mushrooms, and cargo tricycle motorcycle (Guta) for transportation of mushrooms from collection sites to processing centres 3) Construction of mushroom storage house/workshop/office 4) Big cooking pot (sufuria) and knives (visu) 5) Construction of drying beds and plastic sheeting for drying mushrooms 6) Microwave drying oven 7) Solar drying machine 8) Different sorts of furniture 9) Packaging and labeling materials (airtight plastic bags) SEDIT also noted that none of the mushroom entrepreneurs has land where the office and drying/processing facilities can be installed; we will also act on this issue of land for installation of processing facilities
8	Progress made so far	Besides trainings, each of the enterprises has developed a business plan; SEDIT is now reviewing the business plans in collaboration with FORVAC, staff from the district council and other actors; the next step will be to support implementation of the plans; SEDIT want to keep things going using common practices to begin start with.
9	Challenges that mushroom entrepreneurs face	1) Lack of appropriate storage technologies, most mushroom collectors in the target villages are selling fresh mushrooms due to lack of appropriate drying technology; the buyers are within each respective village for the time being 2) The few who dry their mushrooms produce dried mushrooms of poor quality due inadequate hygiene (e.g. flies contaminating mushrooms during drying); that why we are planning to support them with plastic sheeting and wire mesh to ensure hygienic drying 3) Lack of entrepreneurship skills

S/N	Theme	Responses
		4) Lack of linkage to regional, national and international markets 5) Declining mushroom availability in the forest due to frequent droughts as a result of climate change
10	Dream/vision for the success to be seen via the mushroom collectors over the next five years	To see functional processing and storage centres that are clustered across all villages supported by the program; value added products that meet national and international standards including appropriate packaging and branding
11	Means/strategies proposed to reach the dream	SEDIT to work jointly, as team, with all development actors in Mbinga district with a shared purpose of leaving a permanent/sustainable mark regarding forest-based enterprises across all program villages
12	How was the village governments involved in identification of the entrepreneurs identified to receive support from FORVAC	1) Advertisements/calls for business proposals were posted via village notice boards 2) Oral interviews for the entrepreneurs that submitted proposals were conducted in respective village government offices 3) Physical validation was done through the village government offices; village leaders organized the assessments and final reports were discussed with the village leaders, prior informing respective applicants (entrepreneurs).

II. Entrepreneurs from Amanimakoro village

a) Interview with Hilda Joseph Komba

S/N	Theme	Responses
1	Name and particulars	Hilda Joseph Komba (Female) residing in Amanimakoro village
2	Date of interview	Date , 26th January, 2021
3	Highest education of the trader	Primary school
4	Experience in mushroom trading	Since 2000, I have been collecting mushrooms together with my husband and other colleagues for home consumption and trading
5	Support received so far	I was enrolled by FORVAC after stringent testing and evaluation of my business proposal/idea We then had a seminar with FORVAC on entrepreneurship and mushroom business in 2020; and we were also trained on moderns way of processing mushrooms using wooden drying boxes, wire-mesh and plastic sheets (turubai); it was a theoretical training mostly through pictures or drawings.
6	Products sold	I sell both fresh and dried mushrooms
7	End markets	We sell mushrooms mostly locally here in the village; the market is adequate; we do not get loss because when we fail to sell fresh mushrooms we dry the remainder for off-season selling
8	Prices for fresh and dried mushrooms	We sell fresh mushrooms in a bowl each at 500 TZS, there are 5 such bowls in one dumla/sado ***[Researcher's note: There are 4 liters in one dumla]***
9	Formalization of the business	I have not registered the business with the government, except that FORVAC did register me
10	Ownership of the business	We are doing as a family business; but have now invited three supported to help us. We are not paying them money; in fact we are working together as a group and then everyone is given a share of the mushrooms collected; and a portion is set aside to generate a group fund. We have a bank account for the group; and our group have been registered at Mbinga District Council ***[Researcher's note: But this claim could not be verified]***
11	Things that FORVAC could have done did not do	We wish that FORVAC could support us to construct a building for our business; help us to create actual linkages with better markets like in Dar es salaam.
12	Costs incurred	No records at present; we will start keeping records next season
13	Quantities of fresh and dried mushrooms produced, consumed and sold	
14	Incomes from mushroom trade of the last three years	

S/N	Theme	Responses
15	Perception on access to financial services for capital	No reliable sources of capital

b) Interview with Germana Clemence Mapunda

S/N	Theme	Responses
1	Name and particulars	Germana Clemence Mapunda (Female) residing in Amanimakoro village
2	Date of interview	Date , 26th January, 2021
3	Highest education of the trader	Primary school
4	Experience in mushroom trading	I started mushroom trading since 2011
5	Support received so far	I have not received any support, so far
6	Products sold	I sell mostly fresh
7	End markets	I sell fresh mushrooms within the village, moving from house to house
8	Mode of operation	This is a seasonal business since mushrooms harvested cannot last over the whole year
9	Prices for fresh and dried mushrooms	We sell fresh mushrooms in a bowl each at 500 TZS, there are 5 such bowls in one dumla/sado. ***Researcher's note: There are 4 liters in one dumla. Price per liter can be calculated as 500 TZS/Bowl * 5 Bowl/Dumla *1 Dumla/4 Liters; this gives 625 TZS/Liter***
10	Formalization of the business	Yes, my business is registered
11	Ownership of the business	We are doing as a family business; but have now employed three people (all females) to help us on a permanent basis.
12	Things that FORVAC could have done did not do	A building for our business and actual linkage to better markets like in Dar es salaam.
13	Costs incurred	No records at present; we have just learnt how to keep records but have not yet began to practice
14	Quantities of fresh and dried mushrooms produced, consumed and sold	Last year I collected 12 baskets in total, one basket equals to 1 plastic bucket of 20 liters
15	Selling prices for fresh and dried mushrooms	We sell fresh mushrooms using a small bowl, each bowl of mushrooms is sold at 500/= TZS. There are 5 such bowls in a dumla/sado.
16	Perception of profitability of the mushroom trading	Yes, I get profit but it is decreasing year after year due to decrease in mushroom availability

S/N	Theme	Responses
17	Incomes from mushroom trade over the last three years	I do not have written records at present. **Researcher's note:** ***Calculations annual income for mushrooms collected in 2019:*** ***a)12 baskets * 20 liters/basket = 240 liters of mushrooms;*** ***b) 240 liters * 625 TZS/Liter = 150,000 TZS*** ***c) Therefore, annual income from mushroom business for the 2019 equals 150,000/= TZS***
18	Perception on access to financial services for capital	No reliable sources of capitalC

III. Entrepreneurs from Kindimbachini village

a) Interview with Altemia Kayombo

S/N	Theme	Responses
1	Name and particulars	Altemia Kayombo (Female) residing in Kindimbachini village
2	Date of interview	28th January, 2021
3	Highest education of the trader	Primary education
4	Experience in mushroom trading	Yes, I do mushroom trading and have 10 years of experience
5	Support received so far	Received business training
6	Products sold	I sell both fresh and dried mushrooms
7	End markets	I sell mushrooms mostly here in my village Occasionally I sell mushrooms in the nearby villages such as Lituhi; but this is limited due to poor roads so we have to walk on foot to reach the village. There is one young man, named Sigi who is from this village but lives in Dar es Salaam; he comes every year to buy dried mushrooms. Apart from this young man who comes occasionally, I have no connection to markets in towns or cities; poor road is the main contributing factor.

S/N	Theme	Responses
8	Prices for fresh and dried mushrooms	We sell fresh mushrooms in a bowl each at 500 TZS, there are 5 such bowls in one dumla/sado ***[Researcher's notes: a dumla is equivalent to 4 litres].*** We sell a *dumla*/*sado* of dried mushrooms at 12,000/= TZS
9	Reasons for not organizing hired transport to take mushrooms to town markets	Yes, some crop sellers do organize transport to take their bananas and yams to town. But we have not utilized that opportunity for our mushrooms; I am not sure of the reasons
10	Formalization of the business	I have not registered the business with the government, except that FORVAC link me with the district council and have been registered as an entrepreneur with an identification card from the government
11	Ownership of the business	This is a family business
12	Costs incurred	The major cost in input is the family labour: walking around in the forest for picking mushrooms; and cleaning, boiling and drying at home. Sometimes I provide cash incentives to my children that help me in the business Another cost is on purchasing baskets we use for carrying mushrooms
13	Quantities of fresh and dried mushrooms produced, consumed and sold	We collect a total 10 baskets for each mushroom picking day, we are a group of 5 people and set aside a whole day for mushroom picking from 7am to 5pm. One basket is to 5 – 6 dumla/sado per basket (or 20-24 liters). On each collection day, half of the basket of fresh mushrooms is consumed at home; 1 basket is sold and 8.5 baskets are dried to produce dry mushrooms that we sell-off-season After boiling, 5 baskets (5*20 = 100 liters) we get 1 sado (or 4 liters). Each year we consume 5 dumla/sado (5*4 = 20 liters) of dried mushrooms at home
14	Selling prices for fresh and dried mushrooms	Fresh mushrooms are sold using a bowl, each at 500 TZS; 1 dumla/sado (of 4 liters) yields 5 such bowls
15	Perception of profitability of the mushroom trading	Yes I am making some profit, but not that much because of unreliable market; it basically gives me home basic needs.

S/N	Theme	Responses
16	Incomes from mushroom trade of the last three years	2018: Do not remember 2019: 30,000 TZS 2020: 25,000 TZS 2021: 15,000 TZS (just for the month of January)
17	Perception on access to financial services for capital	I any realiable access to financial services and other requirements
18	Any additional comment	I would like to request FORVAC that they provide us with working gears; look the mushroom season is now ending but we have received nothing from FORVAC despite their promise since last year.

b) Interview with Imagladis John Kayombo

S/N	Theme	Responses
1	Name and particulars	Imagladis John Kayombo (Female) residing in Kindimbachini village
2	Date of interview	28th January, 2021
3	Highest education of the trader	Secondary education
4	Experience in mushroom trading	Yes, have been doing mushroom trading since 2010
5	Support received so far	Received trainings on entrepreneurship skills, record keeping and marketing skills
6	Products sold	I sell both fresh and dried mushrooms
7	End markets	I sell dried mushrooms in the nearby villages of Lituhi, Ndumbi and Mbaha, and here in the village; the price is the same across all market places.
8	Prices for fresh and dried mushrooms	We sell fresh mushrooms in a bowl each at 500 TZS, and on average I generate 60,000 TZS annually We sell dried mushrooms at 12,000 TZS per dumla
9	Reasons for not organizing hired transport to take mushrooms to town markets	No response
10	Formalization of the business	I have not registered the business with the government, but have been registered as an entrepreneur with an identification card from the government
11	Ownership of the business	This is my own private business
12	Costs incurred	The major cost input is the family labour and utensils used for carrying and processing mushrooms I have not employed anyone but have invited one of my neighbours to help me with collection; I did this following a call from FORVAC that we should start collecting as much mushrooms as possible to continually have stock to supply over the whole year
13	Quantities of fresh and dried mushrooms produced, consumed and sold	I have been producing an annual average of 30 dumla of dried mushroom over the last three years [***Researcher's note: each dumla is equivalent to 4 litres***]

S/N	Theme	Responses
14	Perception of profitability of the mushroom trading	The business is very profitable; it helps me to get money for running my life; buying seeds and fertilizers for use in farming, and other household needs
15	Incomes from mushroom trade of the last three years	Between 2018 and 2020, I have been generating annual incomes of 360,000 TZS and 60,000 TZS from selling dried and fresh mushrooms respectively
16	Savings	I never save cash money; all the money is invested back in farming and sardine business, and basic household needs
17	Perception on demand	Buyers are available here in the village and nearby villages; but have never accessed town markets, I need support for linkages with such markets
18	Perception on cooperation with other mushroom correctors	We do not have regular ways of sharing knowledge and information, I often discuss with my fellow entrepreneur who is also under FORVAC; but have no connection to other mushrooms collectors
19	Perception on access to financial services for capital	I am a widow and have limited financial opportunities; I am earnestly praying to God that mushrooms continue to be available for me to generate regular incomes every year. I know there are many widows in this village, most of them have their sons and daughters to help them, but for me have non to help me
20	Potential harvestable yield	When everything is going on well; each of the mushroom collectors would be able to produce 1 to 3 bags of dried mushrooms; there are large healthy forests around this village that we have not seriously harvested so far.
21	Any additional comment	When FORVAC selected me for support I thought that was my immediate breakthrough; however days and months are passing without receiving equipments that we were promised; it is very hard to collect large quantities of mushrooms without gumboots for protection against injuries, aluminum pots for boiling mushrooms for drying and wire mesh for dying the mushrooms. At present we are drying mushrooms on traditional racks made of poles and bamboo mats; I have seen the efficiency of wire mesh for drying through our fellow coffee growers who use it to dry their coffee and seems to be working very well

IV. Village leaders

a) Interview with Village Executive Officer from Amanimakoro village

S/N	Theme	Responses
1	Interviewee and position	Leonard Antony Hanjewele, Village Executive Officer for Amanimakoro village
2	Date of interview	25th January, 2021
3	Livelihood activities for this village	Agriculture, gardening mining, livestock keeping, mushroom collection for family consumption, mushroom collection for trading, charcoal making and timber
4	Importance of each livelihood activity	Agriculture: 5 out of 5 points Gardening: 4 out of 5 points Mining: 2 out of 5 points Livestock keeping: 3 out of 5 points Mushroom collection for family consumption: 2 out of 5 points Mushroom collection for trading: 1 out of 5 points Charcoal making: 1 out of 5 points Timber: 1 out of 5 points
5	Proportion of households involved in mushroom collection for consumption	About 10% of the households Mushrooms are less important for the livelihood in this village as we do not have adequate forests to collect mushrooms; many people depend during agriculture, gardening livestock keeping
6	Proportion of households involved in mushroom collection for both consumption for trading	About 20%
7	Projects/activities accomplished with FORVAC support	In this village, FORVAC supported sustainable forest management and land use planning We are anticipating that FORVAC will help us to design and draw a plan for turning our village into a small town, we hope to grown into a small town in the near future
8	Neighbouring villages that have abundant mushroom supply	Luhagala, Litumbandyosi, Mabani and Kingole villages
9	Number of mushroom businesses registered through FORVAC	I think we two groups that are registered with FORVAC, but not quite sure One group has 10 members and the other has 7 or 8 people if not mistaken

S/N	Theme	Responses
10	The process used to identify the entrepreneurs	1) The groups were existing as conventional women groups prior coming of FORVAC, when the opportunity came we encouraged the groups to switch to mushrooms trading since they had already been registered and had members well connected to each other 2) The criteria used to get the beneficiaries for mushroom entrepreneurs to be supported by FORVAC were: women that were already in groups, some few men that were convinced by the founders of the women groups to join the groups just before FORVAC enterprise evaluation process. 3) In this process 4 out of 9 sub-villages (or 44% the sub-villages) did not participate at all because had no members in the women groups that were existing. The sub-villages that did not participate were Ostabei, Voda, Njombe and Lukali. I think leaving these sub-villages behind is a problem administratively; but there was nothing we could do since participation was completely on a free will basis; also the membership to the groups is still open to anyone, once awareness creation is done. 4) The whole community should know of the process followed to identify the two mushroom groups since we communicated everything in the village general assembly meetings. Also FORVAC organized several other community meetings subsequently; the identified groups have been registered too.
11	Current production of dried mushrooms	No response
12	Perceived challenges for mushroom collectors and strategies they use to cope with the challenges	1) Edible wild mushrooms are too seasonal to make a viable business; also productivity is very low in our case. 2) The best option could have been to promote cultivated mushrooms that can be produced in large quantities and throughout the year.
13	Recovery percent of dried mushroom	No response
14	Production levels of dried mushrooms for a scenario of a reliable market and drying technology	No response
15	Dream/vision for the success to be seen via the mushroom collectors over the next five years	To see women mushroom groups growing their capital up to ten millions; and facilitated to grow mushrooms instead of relying on mushrooms that are seasonally collected from the wild.
16	Means/strategies proposed to reach the dream	1) I believe they will take their own initiatives ('*...watajiongeza wenyewe...', the emphatic Kiswahili phrase that was translated*) to engage in a diversified enterprises that will enable them to grow and accumulate capital. 2) Requesting FORVAC and other actors to facilitate trainings on large scale/commercial mushroom farming

S/N	Theme	Responses
17	Possibility to achieve the dream through the two entrepreneurs currently earmarked for support from FORVAC	As on point # 16 above
18	Advise/recommendations to FORVAC in case they expand to other villages	1) The process to get the entrepreneurs went very well so I have nothing to suggest or comment on that. However, regarding the choice of program villages, I think FORVAC was wrong; there are villages with abundant wild mushrooms such as Luhagala, Litumbandyosi, Mabani and Kingole that were erroneously skipped; I really do not know why FORVAC did not go to these villages if at all they wanted to support enterprise on wild mushrooms. To this effect, I would like to advise FORVAC to consult these villages if they seriously want to venture in edible wild mushrooms. 2) I would like to thank FORVAC that forest protection is now improved following the program

b) Interview with village leaders from Kindimbachini village

S/N	Theme	Responses
1	Interviewee(s) and positions	Kasmiri Matei Ngonyani, Village Chairperson for Kindimbachini village Denis Yonasi Kawonga, Village Executive Officer for Kindimbachini village
2	Date of interview	26th January, 2021
3	Livelihood activities for this village	Agriculture, livestock keeping, charcoal making, timber, mushroom collection, beekeeping Their relative importance:
4	Importance of each livelihood activity	Agriculture: 5 out of 5 points Livestock keeping: 5 out of 5 points Charcoal making: 3 out of 5 points Timber: 3 out of 5 points Mushroom collection: 5 out of 5 points Beekeeping: 5 out of 5 points
5	Proportion of households involved in mushroom collection for consumption	About 90% of the households Mushrooms are very important for the livelihood in this village. I still remember the famine of 2010, we had experienced drought in the previous season for the entire village; many people could not harvest enough grains…the few grains harvested could not take us over the whole season. Just before rains season of the year 2010 famine became fiercer; many families used their dried mushroom serves to survive, we were carrying dried mushrooms to the nearby villages of Lituhi, Ndumbi and Mbaha villages along the coast of Lake Nyasa. There we exchanged our dried mushrooms with maize grains and cassava that took us through

S/N	Theme	Responses
		the famine. Because of this historical experience, mushrooms are highly respected; every family collects mushrooms during the fruiting season; and keeping reserves of dried mushrooms has become an important aspect of not only livelihoods but also the overall culture of our society.
6	Proportion of households involved in mushroom collection for both consumption and trading	About 40% of the households
7	Projects/activities accomplished with FORVAC support	In this village, FORVAC supported, land use planning, sustainable forest management, beekeeping training and entrepreneurship training
8	Neighbouring villages that have abundant mushroom supply	Yes, we are bordering four other villages with abundant mushrooms: Kimara, Kizota and Kindimbajuu
9	Number of mushroom businesses registered through FORVAC	We have registered only two people
10	The process used to identify the entrepreneurs	The chairperson responded, the process started since July or August 2020, I do not remember well the exact dates. It involved the following steps: 1) We were invited to a villager leaders seminar in Mbinga; there we were told about the opportunity for community members to write their business proposal under wild edible mushrooms, beekeeping and crafts for funding; the ceiling for the funding was set between 1 million and 15 million Tanzania shillings per each successful entrepreneur. We were given seven days to come back to our village and inform our people to write and submit their proposals within the seven days after which FORVAC would come to collect any proposals that would be submitted. 2) We came back to our village and informed the community through sub-village chairpersons; it was impossible to call a village general meeting because time was so limited 3) Some community members did submit their proposal within the deadline; we received a total of 217 applications/proposals. FORVAC came and collected the applications and took them back to their office for further assessment. 4) After about a month, FORVAC came back with a list of 90 proposals submitted by individual entrepreneurs, and 7 proposals by groups that had passed stage one of the assessment processes. 5) These names were posted on notice board here at the village office; and we called a general meeting where people were asked to check their names and also we told them about the personal interview that was to follow after that. 6) At an appointed day, FORVAC came and conducted the personal interviews with each individual or group that had been shortlisted. I am not sure as to what questions they were asked since I was not part of the interview panel. 7) Finally, three (3) beekeeping groups and 2 individual mushroom entrepreneurs qualified for anticipated funding from FORVAC. This was followed by another physical verification where one beekeeping group was dropped because they were found not have the beehives they had reported to own in

S/N	Theme	Responses
		their proposal. To this effect, there remained 2 beekeeping groups and 2 mushroom entrepreneurs that are illegible for FORVAC entrepreneur funding; this final stage was reached in November 2020. Some came complaining as to why many proposals were rejected, but I continually explained that the basis was the strength of the proposals and how the applicant performed during the interview session. 8)Since November 2020, the qualified groups and individuals have been recruited in 6 months training program where we are receiving one training session per each month, so this is expected to end by April 2021. Until now all trainings have been theoretical, but expect some practical training in the future.
11	Current production of dried mushrooms	In this village the majority of households (about 60%) collect and dry mushrooms for family consumption [opportunistic mushroom collectors]; and the rest 40% collect and dry mushrooms for both household consumption and trading [specialized collectors]. For opportunistic collectors, they are producing an average of 1 to 1.5 bags of dried mushrooms, whereas the specialized collectors are producing 5 to 6 bags of dried mushrooms. A bag of dried mushrooms is equivalent to 30 '*dumla*' of 4 litres each [i.e. 1 bag is equivalent to 120 litres] Under normal circumstances, each household needs an average of half a sack (i.e. 15 *dumla*) for own consumption; the rest can be sold in various markets or remitted to friends and relatives.
12	Perceived challenges for mushroom collectors and strategies they use to cope with the challenges	1) Luck of investment capital for running business: No copping strategy so far 2) Poor road infrastructure that limits transporting fresh mushrooms to town markets: we are copping by drying and selling dried mushrooms that can be stored over a long period and transported long distances without perishing 3) Accidents that cause injuries in the forests due to snakes and other animals: we are copping by being careful and doing mushroom picking in groups 4) Lack of appropriate technology for drying mushrooms: we are using traditional boiling and sun drying method where drying is done during sunny days using traditional racks made of wood and bamboo sticks or mats. However, there are losses due to rotting of mushrooms since drying of mushrooms coincides with heavy rain days [**Researchers notes:** *This is tricky since rainy days are the same days when mushrooms are prolific in the forest*]. Non-poor households and a few poor households are able to use plastic sheeting to protect their drying mushrooms; the majority of the poor and all of the poorest household cannot afford to buy the sheeting; thus they either have to forego their potential incomes

S/N	Theme	Responses
		by avoiding getting involved in mushroom drying in fear of the likelihood of mushroom being rotten due to rains or they often times end-up getting losses. 4) We have not yet quantified the physical loss of mushrooms due to rotting caused by heavy rains; but there is also foregone incomes as people especially the poor and poorest tend to avoid drying mushrooms during the peaks of rains in fear of losing their mushrooms due to rains. At minimum, this is causing an annual losses of 0.25 bags (or 7.5 dumla of 4 liters each) to 0.5 (15 dumla of 4 liters each) for opportunistic collectors; and 1 sack (or 30 dumla of 4 liters each) to 2 sacks (or 60 dumla of 4 liters each). ***[Researchers notes: This is equivalent to loss of about 90,000/ TZS to 180,000 TZS for the opportunistic mushroom collectors who are the poor and poorest; and 360,000/ TZS to 720,000 TZS for the specialized mushroom collectors who are mostly non-poor and a few of the transitioning poor households]***
13	Recovery percent of dried mushroom	The recovery rate based on experience in this community is 10 fresh portions to 1 dried portion of mushrooms (10:1)
14	Production levels of dried mushrooms for a scenario of a reliable market and drying technology	1) The opportunistic collectors who constitute 60% of all collectors would increase their production from the current production of 1 to 1.5 bags of dried mushrooms to about 3 to 5 bags of dried mushrooms. 2) The specialized mushroom collectors would increase their production from the current production of 5 to 6 bags up to as high as 10 to 15 bags of dried mushrooms [Researcher's note: 1 bag equals 30 dumlas or 120 liters]. 3) This would be possible because we have many parts with healthy forests that produce mushrooms; for example mushrooms growing in the reserved forests are not harvested to its optimal level; there are also several other large forest tracts along the way to Lituhi and Matili that are not utilized to their optimal levels. In fact, most of mushrooms are left to rot in the forest since people are not motivate to harvest in fear of losses due to unreliable market and trying technology.
15	Dream/vision for the success to be seen via the mushroom collectors over the next five years	To see mushroom collectors growing their business from the current annual profit of below 100,000/= TZS per household to at least 1 million
16	Means/strategies proposed to reach the dream	1) Requesting the government, FORVAC and other actors to help to create business linkages to town markets 2) Awareness creation to the whole community on benefits and market potentials for wild edible mushrooms 3) Requesting the government to finalize construction of our access road so that is passable all the year round

S/N	Theme	Responses
17	Possibility to achieve the dream through the two entrepreneurs currently earmarked for support from FORVAC	It is impossible to reach the dream by relying only on the two entrepreneurs earmarked for support through FORVAC; we request that more community members be considered for FORVAC support to ensure large and long-lasting impacts on people's livelihoods. This is difficult; they must be more than just two women.
18	Advise/recommendations to FORVAC in case they expand to other villages	In order to ensure sizeable impacts, the process to get the entrepreneurs should be modified so that the whole village is adequately mobilized to form desired interest groups rather than asking individuals to compete on the basis of business proposals and interviews; more emphasis should be put on creating awareness among community members across all sub-villages prior group formation, and/or call for proposals or application letters. On our side as leaders, we also have a responsibility to continue creating awareness among our people on the emerging market for mushrooms especially dried mushrooms. Other interventions such as land use planning went very well; so in the future the processes should be repeated without any changes.
	Opinions on the research process	Everything went well, people have understood how our livelihoods are linked to mushrooms and the environment in general; I am happy that they have also shown positive participation so far.

c) Interview with village leaders from Litolomero village

S/N	Theme	Responses
1	Interviewee(s) and positions	Petro Rowlance Haule, Village Chairperson for Litolomero village Oscar Oswald Gwamaka, Acting Village Executive Officer for Litolomero village Exervery Chiwangu, Village Council Member for Litolomero village
2	Livelihood activities for this village	Agriculture, fishing, livestock keeping, small business (e.g. street vending of vegetables and sardines), mushroom collection for consumption, Mushroom trading Their importance
3	Importance of each livelihood activity	Agriculture: 5 out of 5 points Livestock keeping: 5 out of 5 points Fishing: 3 out of 5 points Small business: 4 out of 5 points Mushroom collection for consumption: 3 out of 5 points Mushroom trading: 2 out of 5 points

S/N	Theme	Responses
4	Proportion of households involved in mushroom collection for consumption	About 95% of the households are involved in collection of mushrooms; the rest 5% represents civil servants within the village who are new to this village so not familiar with collection of mushrooms Mushrooms are very important for the livelihood in this village; however, its potential is limited due to seasonal availability, being available only from December to March each year
5	Proportion of households involved in mushroom collection for both consumption and trading	About 40% of the households Mushroom trading is also limited by seasonality but also there is no assurance of market
6	Projects/activities accomplished with FORVAC support	In this village, FORVAC supported land use planning, setting aside and demarcating village forest, beekeeping training
7	Neighbouring villages that are involved in collection of mushrooms	We are bordering Hinga, Mbuli, Litoho, Kilindi, Barabara and Ngumbo villages
8	Perceived relative abundance of mushrooms with respect to the study village	Litolomero: 5 out of 5 points Hinga: 4 out of 5 points Mbuli: 2 out of 5 points Litoho: 1 out of 5 points Kilindi: 3 out of 5 points Barabara: 3 out of 5 points Ngumbo: 2 out of 5 points
9	Reasons for the perceived relative abundances	Litolomero is ranked highest in abundance of mushrooms than the neighbouring village because we have healthy forests everywhere, around our houses besides the reserved forest at Nahinga Mountain that we share with Hinga village; In fact we have not even touched forests at Nahinga for mushroom harvesting, large quantities of mushrooms are left to rot in the forest since we have no assurance of the buyers; Hinga village comes next of us because they only depend on forests at Nahinga Mountain for mushrooms, they do not have healthy forests that produces mushrooms within the village ***[Researcher's observation: during the field tour it took a few minutes to reach sites with mushrooms for Litolometro village, whereas for Hinga village it took us more than one hour to walk to a place where we could find mushrooms]***.
10	Number of mushroom businesses registered through FORVAC	
11	The process used to identify the entrepreneurs	

S/N	Theme	Responses
12	Current production of dried mushrooms	Currently, each household produces about 3 to 5 dumla of dried mushrooms
13	Markets for mushrooms	We are selling both fresh and dried mushrooms to Hinga, Mbuli, Ngumbo, Litoho and Lundumatu villages; selling is done during special market days (mnada) for each village
14	Perceived challenges for mushroom collectors and strategies they use to cope with the challenges	Lack of market for mushrooms, so trading in mushrooms is despised being linked to backwardness; we have no any copping mechanism excepting hoping for support from the government at the higher levels
15	Recovery percent of dried mushroom	The recovery rate based on experience in this community: a) For Upoho (*Lactarius* species) and similar species that are not succulent, recover is 60 liters (two baskets of 30 liters each) of fresh mushrooms to 4 liters (or one dumla of 4 liters) of dried mushrooms b) For Ulelema (*Amanita losii*) and similar species that are excessively succulent the recovery is 120 liters (four baskets of 30 liters each) of fresh mushrooms to 4 liters (or one dumla of 4 liters) of dried mushrooms
16	Production levels of dried mushrooms for a scenario of a reliable market	With assurance of markets, production levels of would be increased from the current 3 - 5 dumla to 45 or more dumla per each of the 95% of the total households
17	Dream/vision for the success to be seen via the mushroom collectors over the next five years	We do think we can have any dream for our traders of mushrooms for the time being due to the current challenge of markets
18	Means/strategies proposed to reach the dream	Not applicable
19	Possibility to achieve the dream through the two entrepreneurs currently earmarked for support from FORVAC	
20	Advise/recommendations to FORVAC in case they expand to other villages	We pleading to the government at all levels to help us connect to good markets for mushrooms
21	Opinions on the research process	

d) Interview with village leaders from Hinga village

S/N	Theme	Responses
1	Interviewee(s) and positions	Filbert Damian Mapunda, Village Chairperson for Hinga village Modestus Joseph Chiwango, Village Executive Officer for Hinga village Joseph Joseph Chiwangu, Village Council Member Thomas Filbert Mapunda, Village member with recognized as an experienced mushroom collector
2	Livelihood activities for this village	Agriculture, fishing, livestock keeping, charcoal making, timber, mushroom collection for consumption, Mushroom trading Their importance
3	Importance of each livelihood activity	Agriculture: 5 out of 5 points Fishing: 5 out of 5 points Livestock keeping: 4 out of 5 points Charcoal making: 1 out of 5 points Timber: 2 out of 5 points Mushroom collection for consumption: 5 out of 5 points Mushroom trading: 3 out of 5 points
4	Proportion of households involved in mushroom collection for consumption	About 80% of the households are involved in collection of mushrooms mostly for consumption
5	Proportion of households involved in mushroom collection for both consumption and trading	Only about 30% of households are involved in mushroom trading, selling both fresh and dried mushrooms; there is no attractive market that is why only a few are involved in mushroom trading
6	Projects/activities accomplished with FORVAC support	In this village, FORVAC supported land use planning, setting aside and demarcating village forest
7	Neighbouring villages that are involved in collection of mushrooms	We are bordering Lundu, Litolomero, Barabara and Mbuli
8	Perceived relative abundance of mushrooms with respect to the study village	Hinga: 5 out of 5 points Lundu: 4 out of 5 points Litolomero: 5 out of 5 points Barabara: 3 out of 5 points Mbuli: 3 out of 5 points
9	Reasons for the perceived relative abundances	Litolomero is ranked highest in abundance of mushrooms than the neighbouring village because we have healthy forests everywhere, around our houses besides the reserved forest at Nahinga Mountain that we share with Hinga village; In fact we have not even touched forests at Nahinga for mushroom harvesting, large quantities of mushrooms are left to rot in the forest since we have no assurance of the buyers; Hinga village comes next of us because they only depend on forests at Nahinga Mountain for mushrooms, they do not have healthy forests that produces mushrooms within the village ***[Researcher's observation: during the field tour it took a few minutes to reach sites with mushrooms for Litolometro village, whereas for Hinga village it took us more than one hour to walk to a place where we could find mushrooms]***.

S/N	Theme	Responses
10	Number of mushroom businesses registered through FORVAC	
11	The process used to identify the entrepreneurs	
12	Current production of dried mushrooms	Currently, each of the households produces about 5 dumla of dried mushrooms
13	Markets for mushrooms	We are selling both fresh and dried mushrooms to Lundu, Mbuli and Ngumbo
14	Perceived challenges for mushroom collectors and strategies they use to cope with the challenges	Harvesting sites are far away from homesteads so there are high risks for accidents such as snake bites and physical injuries in the forest Lack of appropriate technology for drying mushrooms, in most cases mushrooms get rotten due to continuous rains during the peak of mushroom season. We have no any copping mechanism excepting hoping for support from the government at the higher levels
15	Recovery percent of dried mushroom	The recovery rate based on experience in this community is 10 portions of fresh mushrooms to 1 portion of dried mushrooms.
16	Production levels of dried mushrooms for a scenario of a reliable market and access to dying facilities	With assurance of markets and access drying facilities, production levels of would be increased from the current 5 dumla to 50 or more dumla per each of the 80% of the total households This is possible as most of mushrooms are left to rot at Nahinga hills
17	Dream/vision for the success to be seen via the mushroom collectors over the next five years	To see our people improving lives through mushroom business, being able to buy good furniture and construct improved houses
18	Means/strategies proposed to reach the dream	Asking the government at higher levels to provide training to the community members, and support us to link with markets in big cities. Government helping us to access appropriate mushroom drying technology to minimize losses due to mushroom rotting during drying We ask that findings from the research to be used to inform the government about our concerns
19	Possibility to achieve the dream through the two entrepreneurs currently earmarked for support from FORVAC	
20	Advise/recommendations to FORVAC in case they expand to other villages	We pleading to the government at all levels to help us connect to good markets for mushrooms
21	Opinions on the research process	

V. Mushroom traders in Mbinga town

a) Leaders of the Mbinga town market

S/N	Theme	Responses
1	Interviewee(s) and positions	Enhihart V. Nyoni (Male), Chairperson for Mbinga Town Market Frank Kalage (Male), Vice Chairperson for Mbinga Town Market
2	Date of interview	03rd February, 2021
3	History of mushroom commercialization in Mbinga town	In the past, mushrooms were considered to be wild commodity; growing and dying on its own in every rain season; rural populations such as those in ***Litumbandyosi, Lipambalamba and Mpepai*** to mention a few, have been consuming mushrooms from time in memorial but the quantities were too large that tons and tons of mushrooms used to rot in the natural forests as there was no access to town markets due to poor roads by then; rural markets were impractical as everyone virtually collected mushrooms from the forest so there was no need to buy from neighbors. Nowadays, as a result of construction of good roads, mushrooms are transported to our market here in Mbinga town; rural people have taken advantage of good roads and they have gradually started to bring mushrooms in the town market; nowadays, baskets and baskets are being brought in this town market, those who have experience of eating mushrooms continue to eat even when they are in town, so becoming key buyers; I am among the consumers of mushrooms here in town, I originate from rural areas with abundant mushrooms in Masasi division, Luwilo ward in Ludewa district of Njombe Region.
4	Presence of mushroom traders	We have mushrooms traders in this town that fall under two categories: those who sell within the Mbinga town market premises ranging from 5-7, and those who are street vendors for whom we do not have records.

S/N	Theme	Responses
5	Actors for mushroom trading and profit distribution along the value chain	I think the traders are making money, otherwise they would not continue with the business; most probable the mushroom collectors in the village are the ones who make the most profit, for them their investment is only time and skills for identifying edible from inedible and locating sites with mushrooms. The value chain is ***somehow organized***; there are women who are sales agents, they have a network of linkages with the mushroom collectors in several villages with abundant mushrooms and that are accessible with daily bus services such as ***Litumbandyosi***, Lipambalamba and Mpepai villages; the sales agents are the ones who invest money to keep the value chain functioning; the mushroom collectors package their mushrooms in bamboo baskets and send them as parcels addressed to specific sales agent via daily buses either from their villages or passing by their villages but without paying any transportation charges upfront, each respective sales agent receives particular mushrooms parcels at the bus stand and pays the due transport charges for each parcel; thereafter the sales agents distribute mushrooms to mushroom retailers (both those selling within the town market premises and the street vendors) and collect the money that she send back to respective mushroom collectors via the same buses.
6	Perception on edible wild mushrooms as a commodity	I think we need to reach a place where we should advise the government to recognize edible wild mushrooms as important commodity for livelihoods of people both in town and rural areas, and so should invest to improve and sustain it; we know that mushrooms are found in areas with healthy natural forests, when the forests are cleared or trees thereof cut haphazardly production of mushrooms goes down and may eventually disappear completely; we urge the government to support effective forest management in order to ensure sustainable supply of the mushrooms; I call upon the government to think of mushrooms' habitats in the same way as they think about Mikumi and other National Parks; therefore forests that produce the mushrooms should be put under stringent and effective management arrangements similar to what is done for National Parks.
7	Proportion of fresh and dried mushrooms sold in the market	In this town, about 90% of mushrooms sold are fresh and only 10% is sold as dried mushrooms; dried mushrooms are regularly available in the villages; but they do not reach in this town market, if supplied I am sure buyers will be available especially the same people who are used to eating mushrooms in their culture
8	Storability	I have never tried to store fresh mushrooms in a refrigerator, so I am not sure how effective refrigeration could be; we probably need to research on applicability of refrigerators for storage of fresh mushrooms

S/N	Theme	Responses
9	Challenges and proposals on how they can be addressed	1) Mushrooms are seasonal and do not grow in every forest, we are just wondering if there could be ways to make it available over the whole year 2) Mushrooms are perishable commodity, it get rotten in a day or just a few days; for example, Ulelema get rotten just within 24 hours; we ask the government to help the traders here with appropriate processing and storage technologies. 3) Edible wild mushrooms are nutritious food but only few people know about this fact, many do not buy mushrooms just because of lack of knowledge about nutrition benefits of mushrooms, if awareness creation could be done then many will begin to buy and eat mushrooms; we are just beginning to hear about mushrooms being rich vitamin 'C' but this is not well known to many people.
10	Perceptions on future demand for wild edible mushrooms	I think if the supply of edible wild mushrooms could be increased many people will be excited to try and eat it; I remember when we first arrived in this town cattle meat used to be a rare commodity, only few people used to eat the meat but nowadays everybody wants to eat the meat; so in the same way, once mushroom supply is increased and sustained many will be convinced to start eating it especially when they are educated about the benefits of eating mushrooms
11	Advise/recommendations to the government	Since mushrooms are just like any other commodity such as maize crops and fish, we request the government to take serious steps to improve the commodity so that participants could benefit and improve their livelihoods; we further request that the government provide more education on how we can participate in improving wild mushrooms as a commodity. We have heard about processed mushrooms, some have talked about canned mushrooms; we believe, with real determination the government can invest in improvement of mushrooms; if possible we are requesting that efforts for processing mushrooms be channeled through the current traders of mushrooms who can be organized through the Mbinga Town Market leadership.

b) Mushroom traders selling mushrooms within Mbinga town market premise

S/N	Theme	Responses
1	Interviewees and positions	Mwajibu Abdallah (Female), mushrooms sales agent and trader in Mbinga town Market Fatuma Ally (Female), mushrooms sales agent and trader in Mbinga town Market Aisha Ally (Female), mushrooms trader in Mbinga town Market Fatuma Ismail (Female), mushrooms trader in Mbinga town Market
2	Date of interview	22nd February, 2021
3	Ownership of the business	Each of us is operating her own personal/private business

S/N	Theme	Responses
4	Experience in business	One had one year experience, two had one year and one had just began the business
5	Mushrooms trading actors and their relationships	Although we all sell mushrooms in this market, in this group of four people we are performing two distinct roles in the mushroom trading. The first role is performed by two of us who are mushrooms sales agents (Mawakala-plural/Wakala-singular, in Kiswahili), we operate as wholesalers on behalf of the mushrooms collectors based in rural areas; the role is performed by the rest two people who are ordinary traders of mushrooms, also known as 'Mawinga' [Researcher's notes: a colloquial Kiswahili word translated as football prayers on the side lines of the ground who have to pass a ball to those at the centre in order to score a goal] who buy mushrooms on wholesale price and sell to consumers as retailers. As Mawakala, we have established direct business connection with mushroom collectors based in **Litumbandyosi and Luhagala** villages, and we work on their behalf; the collectors send us mushrooms as parcels via daily buses coming from or passing by their villages; the collectors notify us once they load mushrooms in a particular bus; upon receiving the mushrooms we pay transport charges to the bus operators on behalf of the collectors, and send money back for the previous day's consignment deducting money paid for transport charges, so ultimately the collectors bear the all costs for transporting mushrooms to town; we then sell the mushrooms received to 'Mawinga' on a wholesale price as set by the collectors; at the same time keep a portion of the mushrooms that we trade as retailer at Mbinga town market just in the same way as 'Mawinga'. So, after distributing the mushrooms received from collectors, we join our fellow 'Mawinga' at the Mbinga town market where we all sell the mushrooms direct to consumers with no visible differences among us. There are several other Mawakala who works in the same way with different mushroom collectors from other villages with regular daily bus services, but we do not have their information.
6	All business done by the mushroom traders and relative importance	We sell several other commodities including mushrooms, tomatoes, onions, cassava, yams, cabbage, sweet pepper and pumpkins. These commodities complement each other; since they are available in different seasons; so none is important than the other, they almost have equal importance.
7	Nature of mushrooms sold	We are selling fresh mushrooms only; dried mushrooms are not supplied for the time being
8	Nature of relationship between mushrooms sales agents (Mawakala) and mushroom collectors	We have informal relationship based on friendship; for example, the collectors who send mushrooms to us are those that who used to live with us in town but shifted the village when his husband died; since we were friends he approached us and agreed to establish this kind of informal mushroom business relationship. So for collectors to send mushrooms to town they should have someone they know and trust

S/N	Theme	Responses
9	Wholesale and retail prices	Wholesale price: 1 dumla is sold at 5000 TZS ***[Researcher's note: a dumla is equivalent to 4 liters]*** Retailers sell mushrooms by small portions (*mafungu, in Kiswahili*) sold at 500 TZS each, and get between 8000 and 9000 TZS for each dumla sold ***[Researcher's note: this makes a gross profit margin of 3000 to 4000 TZS per dumla]***
10	Extent the current demand is satisfied	The supply of mushrooms is fluctuating over time within the season, in most cases the demand is satisfied but there are cases where the demand is not satisfied during dry spells when mushrooms become temporary scarce.
11	Species of mushrooms traded	We are selling Ulelema, Unguyugu, Kalungeya, Upoho and Kambalakata
12	Species that used to be available but now disappeared	Upoho and Kambalakata are becoming scarce since 2020 though not completely disappeared
13	Mushroom season	January to March
14	Months of making good profit from mushroom trade	We make good profit in January just at the beginning of the mushrooms season
15	Average annual mushrooms sales for each trader	On average, one trader sell about 120 dumla annually ***[Researcher's note: This is equivalent to a profit margin of 360,000/= to 480,000/= TZS of the three months of mushroom season]***.
16	Places for selling mushrooms	We are selling within Mbinga Town Market
17	Uses of money generated from mushrooms trade	We use the money earned from mushrooms trading for basic household needs such as school uniforms for our children; and buying soap and food items; we also use the money for savings in VICCOBA.
18	Perceived challenges	There is other category of mushrooms traders who receive mushrooms through the same arrangement of rural collectors but they are moving around selling mushrooms in the streets; probably they could be making money more than we do.

c) **A trader selling mushrooms as a street vendor**

S/N	Theme	Responses
1	Interviewee and positions	Shukuru Ngonyani (Female), street mushrooms trader in Mbinga town
2	Date of interview	23rd February, 2021
3	Ownership of the business	Personal/private business
4	Experience in business	Every year I sell mushrooms during the rainy season, have been doing this over the last five years

S/N	Theme	Responses
5	Mushrooms trading actors and their relationships	I sell mushrooms that originate **from Litumbandosyi village**; collectors have their sales agents who stay in here in town. Collectors send mushrooms via daily buses, the sales agents (bosses) receives mushrooms at the bus stand, me and other retailers go to the bus stand every morning at around 9:00 am; we buy mushrooms from agents at a wholesale price and then we go out sell to consumers. I neither have personal relationship with the mushrooms sales agent nor mushroom collectors who supply the mushroom from **Litumbandyosi village**. There are about 5 to 7 mushrooms sales agents who are all females, and we are about 15 to 20 retailers who are all females too; me and some other retailers sell mushrooms in the streets; there is another group of retailers who are permanently stationed within Mbinga town market; each trader from either of the groups of mushrooms retailers is registered as small entrepreneur and give the 20,000 TZS identification card. Whether one sell in streets or in stationed within the Mbinga town market is just a division of marketing niches; but we all have equal rights as registered small business entrepreneurs.
6	All business done by the mushroom traders and relative importance	I sell several commodities including mushrooms, vegetables such as tomatoes and fruits; I sell mushrooms walking around the streets but sell the rest of commodities at a kiosk within my homestead. These commodities complement each other; since they are available in different seasons; so none is important than the other, they almost have equal importance.
7	Nature of mushrooms sold	I sell fresh mushrooms most of the time; dried mushrooms are rarely supplied but although the market seems to be lucrative than fresh mushrooms. Sometimes I dry leftovers of fresh mushrooms, produced half a dumla last year
8	Nature of relationship between mushrooms sales agents (Mawakala) and retailers	I have no permanent connection to any mushrooms sales agent, can buy from any of them

S/N	Theme	Responses
9	Wholesale and retail prices	For fresh mushrooms, 1 dumla is sold at 5000 TZS for wholesale price ***[Researcher's note: a dumla is equivalent to 4 liters]*** I sell by small portions (*mafungu, in Kiswahili*) each sold at 500 TZS , and earn between 8000 and 9000 TZS per each dumla sold For dried mushrooms, when available, a dumla is sold at 6000 to 7000 TZS for wholesale price. Retail price is 1000 TZS per one tea cup that gives 10000 TZS to 11000 TZS for each dumla retailed; the gross profit is 3000 TZS to 5000 TZS for each dumla bought and sold.
10	Extent the current demand is satisfied	There is high demand for both fresh and dried mushrooms, only that there are no suppliers of dried mushrooms
11	Species of mushrooms traded	I sell Ulelema, Unguyugu and Maua (flower) mushrooms
12	Species that used to be available but now disappeared	No any species that has disappeared
13	Mushroom season	January to April
14	Months of making good profit from mushroom trade	No response
15	Average annual mushrooms sales	On average, I sell 200 to 300 dumla of fresh mushrooms annually ***[Researcher's note: This is equivalent to a profit margin of 600,000/= to 1,200,000/= TZS over the four months of mushroom season i.e. from January to April]***.
16	Places for selling mushrooms	I sell mushrooms in streets
17	Uses of money generated from mushrooms trade	I use the money from mushrooms trading for school requirements of my son; and other basic household needs such as buying food and paying for health services for members of my family.
18	Perceived challenges	No response

VI. A representative from Mamaland Mushroom Farms based in Morogoro

S/N	Question	Response
1	a) Business name?	Mamaland Mushroom Company
	b) Location of your business	Morogoro, Kingorwila and Muungano village
	c) Legal status	Formal registered by Brela
	d) When did you start your business?	Started in 2016
	e) Number of employees	Males – 5, Females – 4; none of them is employed; they are all casual labourers
	f) Mode of operation	Continuous, all the year round
2	Type of ownership	Private company
3	a) What are the products from your business	a) Exotic grown mushrooms ✓ Oyster Mushroom ✓ Button Mushroom ✓ Mushroom spawn b) Indigenous wild edible mushrooms: ✓ *Lactarius* ✓ *Cantharellus* c) We also offer consultation services on how to establish mushroom business
	b) Product levels of for each product	✓ Oyster mushrooms: 5t/year ✓ Button mushroom: 1t/year ✓ Mushroom spawn: 1200 bottles (300 mls)/year ✓ Wild mushrooms: 1.5t/year ✓ Service of consultation: about 5 occasions per year over the past 3 years
4	a) Where do you source your raw materials (if any)?	**a) Exotic mushroom** Agricultural west products such as rice straw, maize cobs, sugarcane bagasse and maize stalks are obtained from farmers in Kihonda and Mafiga Saw dust and woodchips are obtained from carpenters in Mazimbu and Mkundi Packaging materials: bottles from SIDO and TIRDO, bags and PP bags from Omary Packaging company **b)** Wild mushrooms Informally contracted mushroom collectors based in Tabora and Iringa
5	a) Do you process mushrooms?	Yes, we process exotic mushrooms to produce mushroom powder, snacks and pickles
	b) Where did you get the technology used to process mushrooms?	Self learned and some delivered from Limax Group company from the Netherlands
6	Current market for your products?	Whole sellers in Dar es salaam Retail shops in Morogoro and Dar es salaam Vendors in Morogoro Restaurant in Dar es salaam Individual public servants working at SUA, Mzumbe, Morogoro Municipal Council
7	Average annual financial turn over (cost and gross revenues)	No records at present, could be shared latter through e-mail
8	Your perception on the market demand	The demand is rapidly growing due to increase in health conscious for customers, and the public in general
9	a) What are the future plans for	Increase productivity up to 2t/day for exotic mushrooms; spawn production up

S/N	Question	Response
	the company	to 1000 bottles/month Fetch international market for wild mushrooms
	b) What are the motives for future plan?	The need to capture the emerging business opportunities
10	a) Do you have any plan to share knowledge with wild mushroom collectors	Exactly, by the following means: ✓ Training ✓ Developing mushroom collectors' guide ✓ Launch website for knowledge sharing ✓ Awareness creation to the public through seminars and media tours in Radio and TVs (e.g. SUA and Abood Media in Morogoro) and community radios in Kagera region
11	Is there anything you would like to learn from wild mushroom collectors?	Yes, I would like to learn local ways/methods of preserving mushrooms and also demographic and distribution of mushrooms in different forest sites
12	Challenges	o People are not used to eating wild mushrooms and tend to avoid it; o Lack of public awareness on health benefits of mushrooms; and o Lack of funds to run the company to its maximum potential
13	Additional comments	There are so many untapped mushroom market and value addition opportunities. Mushroom subsector can be a way out of poverty Potential to alleviate malnutrition, youth unemployment and climate change degradation through mushroom trading Mushroom cultivation is a zero-west process, so environmentally friendly

Appendix 11: Community defined wealth indicators, criteria and categories in sample village from Mbinga and Nyasa districts of Ruvuma region, Tanzania

Wealth indicators	Wealth categories								
	Kindimbachini village			Litoromero village			Hinga village		
	Non-poor	Poor	Poorest	Non-poor	Poor	Poorest	Non-poor	Poor	Poorest
1. Kind of house owned									
Roof	Corrugated iron sheets imported from South African	Local corrugated iron	Thatched with grass	Local corrugated iron	Local corrugated iron	Thatched with grass	Local corrugated iron	Local corrugated iron	Thatched with grass
Wall	Burnt brick with plaster	Burnt brick but without plaster	Poles and mud	Burnt brick but without plaster	Burnt brick but without plaster	Poles and mud	Burnt brick but with plaster	Burnt brick but without plaster	Poles and mud
Floor	Cement or tiles	Cement but never use tiles	Dust	Cement but never use tiles	Dust	Dust	Cement but never use tiles	Dust	Dust
2. Number and type of livestock owned									
Cattle	Own 6-50 cattle	May own 1-5 cattle	Never own cattle	Own 5 or more cattle	May own up to 3 cattle	Never own cattle	Own 20 or more cattle	Own 5-9 cattle	May own 0-2 cattle
Goats/Sheep	Own 21-50 goats/sheep	Own 2-5 goats/sheep	May own 1 goat/sheep	Own 5 or more goats	May own up to 5 goats/sheep	May own 0-2 goats/sheep	Own 15 or more goats	Own 1-6 goats/sheep	May own 0-3 goats/sheep
Pig	May own 6-50 pigs	May own 1-3 pigs	May own 1pig	May own more than 3 pigs	May own 0-1 pigs	May own 0-1pig	Own 10 pigs or more	May own 1-3pigs	May own 0-3pigs
Chicken/ducks	May own 21-100 chickens/ducks	May own 5-20 chickens/ducks	May own 1-5 chickens/ducks	Own more than 10 chickens/ducks	May own up to 4chickens/ducks	May own up to 3 chickens/ducks	Own more than 20 chickens/ducks	Own 5-10 chickens/ducks	May own up to 5 chickens/ducks
3. Food security (number of meals a day)	NA	NA	NA	Three meals a day and is able to choose what to eat	Two meals a day and may not choose what to eat	Two meals a day and may not choose what to eat; and may not be starving	NA	NA	NA

Wealth indicators	Wealth categories								
	Kindimbachini village			Litoromero village			Hinga village		
	Non-poor	Poor	Poorest	Non-poor	Poor	Poorest	Non-poor	Poor	Poorest
						most of the time			
4. Size of farm/land owned	Own 26-50 acres	Own 3-25 acres	Own 1-2.5 acres	Own more than 8 acres of farm	Own up to 3 acres of farm	Own less than one acre of farm	Own more than 4 acres of farm	Own 1-2 acres	Own a quarter to one acre of farm
5. Income generating activity undertaken (Off-farm activities)	○ Shops ○ Restaurant ○ Trading in crops and livestock ○ Own motorbikes for hire as known as 'bodaboda'	○ Restaurants ○ Small kiosks (magenge) ○ Selling wild mushrooms	○ Casual labour ○ Selling wild mushrooms	○ Trading in crops and livestock ○ Local brewing	○ Small business (sardines, vegetables, etc) ○ Local brewing ○ Selling wild mushrooms ○ Making and selling timber from the natural forest	○ Small business (sardines, vegetables, etc) in some instances and in relatively small quantities ○ Local brewing once in a while and in small quantities ○ Selling wild mushrooms ○ Casual labour	○ Shops ○ Trading in sardines; bulking and selling to Songea town ○ Operating milling machines	○ Selling sardines and vegetables in the street ○ Selling buns ○ Selling wild mushrooms ○ Casual labour ○ Local brewing ○ Tailoring	○ Selling sardines in the street ○ Selling wild mushrooms ○ Casual labour
6. Ability to access health services	Able to send their sick ones up to referral private hospitals anywhere and without any delay	Able to send their sick ones up to referral private hospitals but with significant delays and may not choose hospitals	Cannot afford costs for health services; depends on village dispensary	NA	NA	NA	NA	NA	NA
7. Fishing gears									
Canoes	NA	NA	NA	NA	NA	NA	Own three (3) or more canoes	May own one canoe	Never own any fishing gear
Oar	NA	NA	NA	NA	NA	NA	Own two	May own one	

Wealth indicators	Wealth categories								
	Kindimbachini village			Litoromero village			Hinga village		
	Non-poor	Poor	Poorest	Non-poor	Poor	Poorest	Non-poor	Poor	Poorest
							(2) or more oars	oar	
Sardine nets	NA	NA	NA	NA	NA	NA	Own two (2) or more sardine nets	May own one sardine nets	
Fish nets	NA	NA	NA	NA	NA	NA	Own two (2) or more fish nets	May own fish nets	
Fish hook	NA	NA	NA	NA	NA	NA	May own more than 200 fish hooks	May own 30 or less fish hooks	

Appendix 12: Colour photos for mushroom species encountered in the field from selected villages within Mbinga and Nyasa districts of Ruvuma region, Tanzania

I. Mbinga district: Amanimakoro village


Reference number: 01

Ethnotaxa: Mbatata (Ngoni) **Scientific name:** *Russula compressa*
Growth stage: Mature
Cap diameter (cm): 11 ***Stipe*** **length (cm):** 7 **Fresh weight (gm):** 56




Reference number: 02

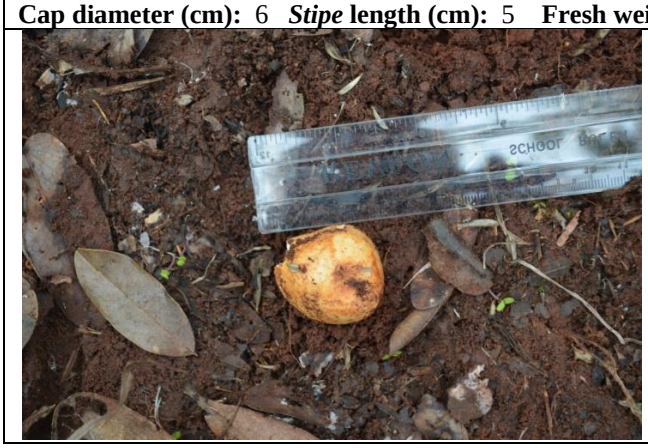
Ethnotaxa: Uhinda (Ngoni) **Scientific name:** *Russula cellulata [Sensu lato]*
Growth stage: Mature
Cap diameter (cm): 9 ***Stipe*** **length (cm):** 7.5 **Fresh weight (gm):** 27


Reference number: 03

Ethnotaxa: Uhinda (Ngoni) **Scientific name:** *Russula cellulata [Sensu lato]*

Growth stage: Medium size

Cap diameter (cm): 6 ***Stipe* length (cm):** 5 **Fresh weight (gm):** 22

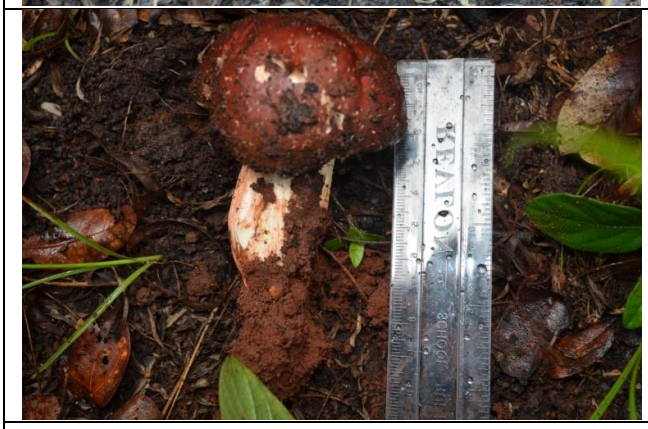
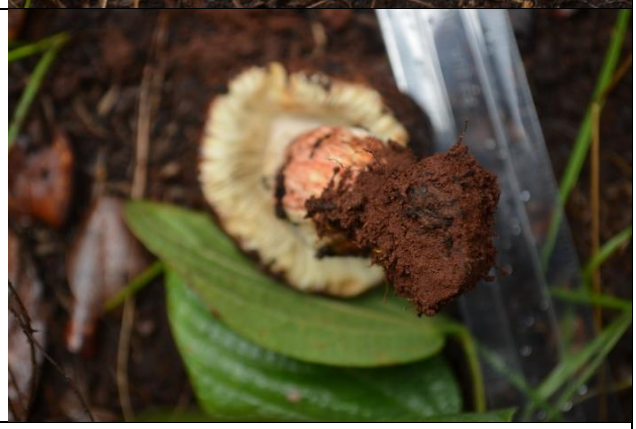




Reference number: 04

Ethnotaxa: Uhinda (Ngoni) **Scientific name:** *Russula cellulata [Sensu lato]*
Growth stage: Small size
Cap diameter (cm): 3 ***Stipe*** **length (cm):** 4 **Fresh weight (gm):** 10



Reference number: 05

Ethnotaxa: Mbatata (Ngoni) **Scientific name:** *Russula compressa*
Growth stage: Small
Cap diameter (cm): 5 ***Stipe*** **length (cm):** 9 **Fresh weight (gm):** 75




Reference number: 06

Ethnotaxa: Uharakata **Scientific name:** *Lactarius sp2 [Sensu lato]*
Growth stage: Mature
Cap diameter (cm): 4.9 ***Stipe*** **length (cm):** 3.3 **Fresh weight (gm):** 6



Reference number: 07

Ethnotaxa: Mbatata (Ngoni) **Scientific name:** *Russula compressa*
Growth stage: Medium
Cap diameter (cm): 8 ***Stipe*** **length (cm):** 10 **Fresh weight (gm):** 58


Reference number: 08

Ethnotaxa: Kalungeya (Ngoni) **Scientific name:** *Cantharellus cf. floridula [Sensu lato]*
Growth stage: Mature
Cap diameter (cm): 1 Stipe **length (cm):** 2 **Fresh weight (gm):** ?



Reference number: 09

Ethnotaxa: Unguyuwu (Ngoni) **Scientific name:** *Cantharellus isabellinus*
Growth stage: Mature
Cap diameter (cm): 6 - 8.5 ***Stipe*** **length (cm):** 3.6 - 4 **Fresh weight (gm):** 30 - 41




Reference number: 10

Ethnotaxa: Uhinda (Ngoni) **Scientific name:** *Russula cellulata [Sensu lato]*
Growth stage: Mature
Cap diameter (cm): 11.5 ***Stipe*** **length (cm):** 11.5 **Fresh weight (gm):** 97


Reference number: 11

Ethnotaxa: Upelepeta **Scientific name:** *Termitomyces* sp
Growth stage: Medium
Cap diameter (cm): 7.5 ***Stipe*** **length (cm):** 6.5 **Fresh weight (gm):** 43


Reference number: 12

Ethnotaxa: Upelepeta **Scientific name:** *Termitomyces* sp1
Growth stage: Young
Cap diameter (cm): 11.5 ***Stipe*** **length (cm):** 6.5 **Fresh weight (gm):** 61




Reference number: 13

Ethnotaxa: Kisanga (Ngoni) Scientific name*: Termitomyces* sp2

Growth stage: Mature; Cap diameter (cm): 18.5 **Stipe length** (cm): 10 **Fresh weight** (gm): 19

[Note: the specimen was highly dehydrated]

Medium; **Cap diameter (cm):** 7 **Stipe length (cm):** 11.3 **Fresh weight (gm):** 24

Young; **Cap diameter (cm):** 3 **Stipe length (cm):** 8 **Fresh weight (gm):** 6

II. Mbinga district: Kindimbachini village



Reference number: 14

Ethnotaxa: Kilembesi **Scientific name:** *Lactarius sp1*
Growth stage: Mature
Cap diameter (cm): 4 ***Stipe*** **length (cm):** 2.5 **Fresh weight (gm):** 1

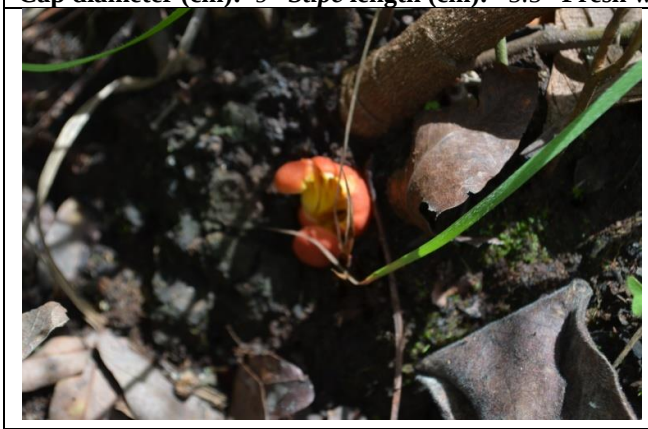



Reference number: 15

Ethnotaxa: Uhinda (Ngoni) **Scientific name:** *Russula cellulata [Sensu lato]*
Growth stage: Mature
Cap diameter (cm): 22 ***Stipe*** **length (cm):** 10 **Fresh weight (gm):** 238


Reference number: 16

Ethnotaxa: Lukolombi **Scientific name:** *Russula sp1*
Growth stage: Medium
Cap diameter (cm): 9 ***Stipe*** **length (cm):** 5.5 **Fresh weight (gm):** 26



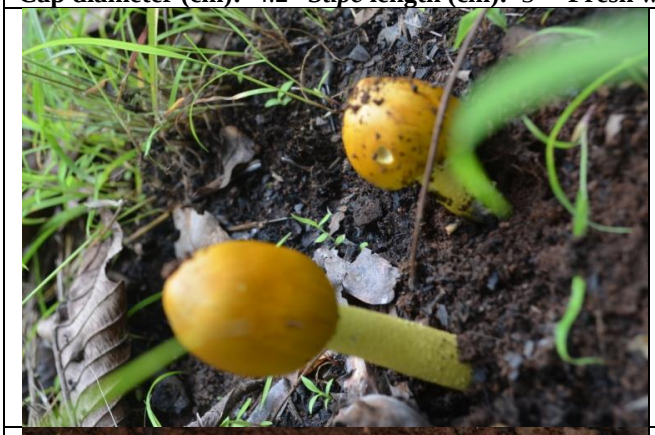

Reference number: 17

Ethnotaxa: Unguyuwu (Ngoni) **Scientific name:** *Cantharellus platyphyllus [Sensu lato]*
Growth stage: Mature
Cap diameter (cm): ? ***Stipe*** **length (cm):** ? **Fresh weight (gm):** 4



Reference number: 18

Ethnotaxa: Unguyuwu (Ngoni) **Scientific name:** *Cantharellus isabellinus*
Growth stage: Mature
Cap diameter (cm): 4.2 ***Stipe*** **length (cm):** 3 **Fresh weight (gm):** 36




Reference number: 19

Ethnotaxa: Magongolo (Ngoni) **Scientific name:** *Amanita masasiensis*
Growth stage: Young
Cap diameter (cm): ? ***Stipe*** **length (cm):** 15 **Fresh weight (gm):** 33



Reference number: 20

Ethnotaxa: Magongolo (Ngoni) **Scientific name:** *Amanita masasiensis* [*Sensu stricto*]
Growth stage: Mature
Cap diameter (cm): 8.5 ***Stipe* length (cm):** 10 **Fresh weight (gm):** 26

III. Nyasa district: Litolomero village



Reference number: 21

Ethnotaxa: Kayunju (Mpoto) [Hairy mushroom] **Scientific name:** *Clavulina wisoli{Sensu lato]*
Growth stage: Mature
Cap diameter (cm): 4 cm [Entire bundle measured] ***Stipe* length (cm):** 5.4 **Fresh weight (gm):** 0.33




Reference number: 22

Ethnotaxa: Upoo (Nyasa)/Ulondi (Matengo) **Scientific name:** *Lactarius volemoides*
Growth stage: Mature
Cap diameter (cm): 5.4 ***Stipe* length (cm):** 7.5 **Fresh weight (gm):** 25



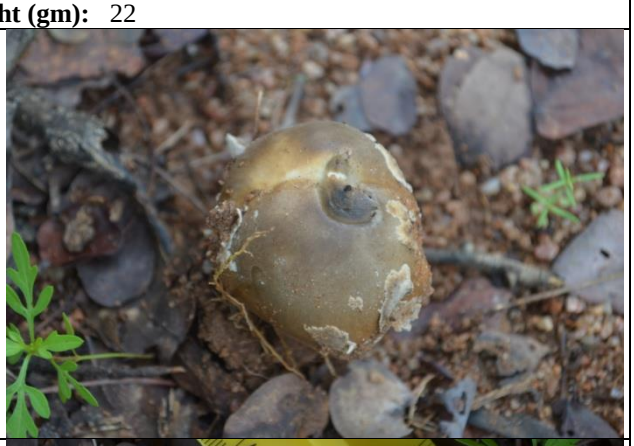
Reference number: 23

Ethnotaxa: Unguyuwu (Ngoni) **Scientific name:** *Cantharellus platyphyllus*
Growth stage: Young
Cap diameter (cm): 2 ***Stipe* length (cm):** 2 **Fresh weight (gm):** 0.67



Reference number: 24

Ethnotaxa: Unguyuwu (Ngoni) **Scientific name:** *Cantharellus isabellinus*
Growth stage: Mature
Cap diameter (cm): 6 ***Stipe*** **length (cm):** ? **Fresh weight (gm):** 22

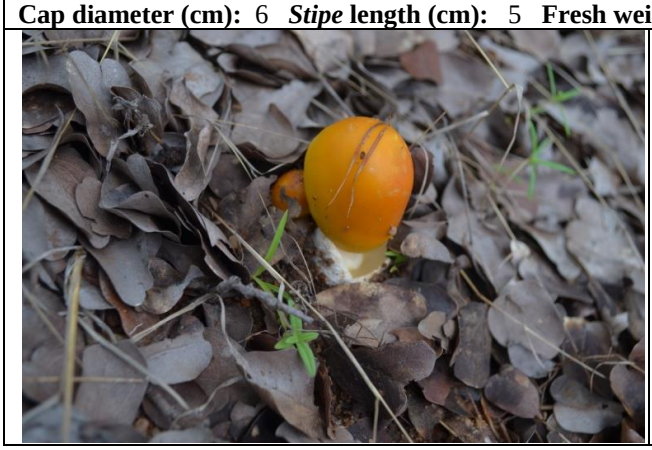
Reference number: 25

Ethnotaxa: Uhanga (Nyasa) **Scientific name:** Unknown 2
Growth stage: Young
Cap diameter (cm): 4 ***Stipe*** **length (cm):** 10 **Fresh weight (gm):** 37




Reference number: 26

Ethnotaxa: Utelesyi (Nyasa) **Scientific name:** *Russula hiemisilvae [Sensu lato]*
Growth stage: Mature
Cap diameter (cm): 6 ***Stipe* length (cm):** 5 **Fresh weight (gm):** 16





Reference number: 27

Ethnotaxa: Magongolo ya ulelema (Nyasa) **Scientific name:** *Amanita masasiensis [Sensu stricto]*
Growth stage: Young
Cap diameter (cm): 2.5 ***Stipe*** **length (cm):** 5.5 **Fresh weight (gm):** 25


Reference number: 28

Ethnotaxa: Unguyuwu (Nyasa) **Scientific name:** *Cantharellus isabellinus*
Growth stage: Mature
Cap diameter (cm): 5 ***Stipe*** **length (cm):** 6 **Fresh weight (gm):** 24

IV. Nyasa district: Hinga village



Reference number: 29

Ethnotaxa: Upohu (Mpoto) **Scientific name:** *Lactarius xerampelinus [Sensu stricto]*
Growth stage: Mature
Cap diameter (cm): 8.75 ***Stipe*** **length (cm):** 5 **Fresh weight (gm):** 45


Reference number: 30

Ethnotaxa: Ulelema (Mpoto) **Scientific name:** *Amanita loosii*
Growth stage: Just protruding
Cap diameter (cm): Not measured ***Stipe*** **length (cm):** Not measured **Fresh weight (gm):** Not measured [The specimens were not uprooted]



Reference number: 31

Ethnotaxa: Ulelema (Mpoto) **Scientific name:** *Amanita loosii*
Growth stage: Young
Cap diameter (cm): 3 ***Stipe* length (cm):** 10 **Fresh weight (gm):** 64




Reference number: 32

Ethnotaxa: Ulelema (Mpoto) **Scientific name:** *Amanita loosii*
Growth stage: Mature
Cap diameter (cm): 24 ***Stipe* length (cm):** 30 **Fresh weight (gm):** 527


Reference number: 33

Ethnotaxa: Ulelema (Mpoto) **Scientific name:** *Amanita loosii*
Growth stage: Medium
Cap diameter (cm): 15 ***Stipe* length (cm):** 21 **Fresh weight (gm):** 218


Reference number: 34

Ethnotaxa: Ulelema (Mpoto) **Scientific name:** *Amanita loosii*
Growth stage: Over-matured
Cap diameter (cm): 21 ***Stipe* length (cm):** 27 **Fresh weight (gm):** 220 ***[The fruit bodies get highly dehydrated when over-matured, hence significant loss of weight]***

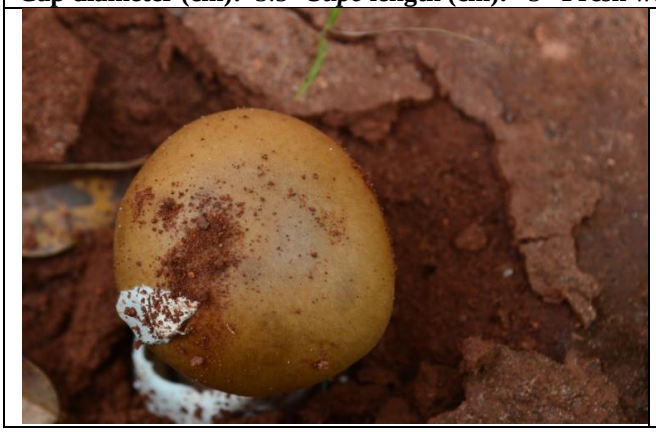

Reference number: 35

Ethnotaxa: Utelesyi (Nyasa) **Scientific name:** *Russula hiemisilvae [Sensu lato]*
Growth stage: Mature
Cap diameter (cm): 5 ***Stipe* length (cm):** 3.5 **Fresh weight (gm):** 19




Reference number: 36

Ethnotaxa: Kamemena (Nyasa) **Scientific name:** *Lactarius kabansus* [*Sensu lato*]
Growth stage: Mature
Cap diameter (cm): 3.5 ***Stipe*** **length (cm):** 3 **Fresh weight (gm):** 4





Reference number: 37

Ethnotaxa: Uhanga-Mwekundu (Mpoto) **Scientific name:** *Amanita sp1*
Growth stage: Young
Cap diameter (cm): 3 ***Stipe* length (cm):** 9 **Fresh weight (gm):** 28




Reference number: 38

Ethnotaxa: Uhanga- Mwekundu (Mpoto) **Scientific name:** *Amanita sp1*
Growth stage: Medium
Cap diameter (cm): 6 ***Stipe* length (cm):** 12 **Fresh weight (gm):** 49




Reference number: 39

Ethnotaxa: Uhanga-Mweusi (Mpoto) **Scientific name:** *Amanita sp2*
Growth stage: Medium
Cap diameter (cm): 2.5 ***Stipe* length (cm):** 10 **Fresh weight (gm):** 17

Appendix 13: Phenology and marketability analysis for edible wild mushrooms species identified in the study villages from Mbinga and Nyasa districts of Ruvuma region, Tanzania

Village	Mushroom species (Scientific names)	Phenology	Ethnotaxa	Scores on marketability (1 = less marketable; 5 = highly marketable) [18]
Amanimakoro	*Cantharellus isabellinus*	Jan-Feb	Unguyuwu (Ngoni)	5
	Russula cellulata [sensu lato]	Jan-March	Uhinda (Ngoni)	5
	Russula sp	Jan-March	Ukolombi (Ngoni)	3
	Amanita loosii	Dec-Jan	Ulelema (Ngoni)	5
	Lactarius spp	Jan-Feb	Upoo (Ngoni)	3
		Jan-Feb	Kilembesi (Ngoni)	5
	Termitomyces letestui	Nov-Dec	Ukufu (Ngoni)	3
	Termitomyces eurrhizus	Dec	Ungala (Ngoni)	5
	Lactarius heimii	Jan-Feb	Uhalakata (Ngoni)	3
	Termitomyces singidensis	Jan-Feb	Upelepeta (Ngoni)	2
	Afroboletus luteolus	Jan-Feb	Mandodo (Ngoni)	2
	Cantharellus symoensii	Jan-Feb	Kalungeya (Ngoni)	3
	Amanita masasiensis	Dec-Jan	Ugongolo (Ngoni)	4
	Termitomyces aurantiacus	Jan-Feb	Luhano (Manda)	2
	Scleroderma sp	Jan-Feb	Matongohuluku (Ngoni)	1
	Russula roseoviolacea	Jan-Feb	Undyelesa (Ngoni)	3
	Cantharellus sp	Jan-Feb	Uyoga-Joni (Ngoni)	3
	Auricularia polyricha	Oct-Jan	Mangaukau (Ngoni)	5
	Lactarius tanzanicus	Dec-Jan	Umbavala (Ngoni)	2
	Clavulina wisoli	Nov-April	Ubihi (Ngoni)	2
	Termitomyces tyleranus	Feb-March	Ulundi (Ngoni)	5
Kindimbachini	*Cantharellus isabellinus*	Feb-March	Unguyuwu (Ngoni)	5
	Russula cellulata	Dec-March	Uhinda (Ngoni)	5
	Amanita loosii	Dec-March	Ulelema (Ngoni)	5
	Lactarius edulis	Jan-May	Upoo (Ngoni)	5
	Termitomyces letestui	Dec	Mkufu (Ngoni)	5
	Termitomyces eurrhizus	Dec-Jan	Mpeta	5
	Lactarius heimii	March	Uhalakati (Ngoni)	5
	Lactarius kabansus	Dec-March	Kilembesi (Ngoni)	5
	Russula sp	Jan-March	Lukolombi (Ngoni)	5

[18]Marketability was found to be equivalent to deliciousness where the most marketable species are those that are delicious and vice versa.

Village	Mushroom species (Scientific names)	Phenology	Ethnotaxa	Scores on marketability (1 = less marketable; 5 = highly marketable) [18]
	Cantharellus symoensii	Feb-March	Kalungeya (Ngoni)	5
	Amanita masasiensis	Dec-March	Magongolo (Ngoni)	Not ranked
	Termitomyces aurantiacus	Dec-Jan	Mandondo (Ngoni)	5
	Auricularia polyricha	Jan-Dec	Mangaukau (Ngoni)	5
	Unknown 1	Jan-April	Uyoga-teleza	5
	Unknown 2	Dec-Feb	Upelepeta (Ngoni)	4
	Termitomyces tyleranus	Jan-March	Ulundi (Ngoni)	3
	Termitomyces microcarpus	Dec-March	Upuli (Ngoni)	5
	Macrolepiota dolichaula	Jan-March	Kibhaya	2
Hinga	*Cantharellus isabellinus*	Dec-April	Unguyuwu (Mpoto)	5
	Russula cellulata	March-April	Uhinda (Mpoto)	4
	Amanita loosii	Dec-April	Ulelema (Mpoto)	5
	Lactarius edulis	Feb-April	Upohu (Mpoto)	3
	Termitomyces letestui	March-April	Nkuhu (Mpoto)	5
	Termitomyces eurrhizus	Dec-April	Uhanga (Mpoto)	3
	Cantharellus symoensii	Dec-April	Unguyuwu-ukulu (Mpoto)	5
	Scleroderma sp	Jan-March	Matongohuruku (Mpoto)	1
	Clavulina wisoli	Jan-April	Kayunju (Mpoto)	5
	Unknown 1	Jan-April	Utelesyi (Mpoto)	3
	Boletus spectabilissimus	Jan-April	Mandodi (Mpoto)	2
	Lactarius kabansus	Jan-April	Chimemena/Kamemena (Mpoto)	2
	Unknown 2	March-April	Upelepetu (Mpoto)	5
	Termitomyces tyleranus	Feb-April	Ulundi (Mpoto)	5
	Unknown 5	Jan-April	Lulimi lwa ng'ombi (Mpoto)	2
	Termitomyces clypeatus	March-April	Mgunda (Mpoto)	5
	Polyporus moluccensis	Dec-May	Mangaukau (Mpoto)	5
Litolomero	*Cantharellus isabellinus*	Feb-April	Unguyuwu (Nyasa)	2
	Russula cellulata	Feb-April	Uhinda (Nyasa)	5
	Amanita loosii	Jan-Feb	Ulelema (Nyasa)	5
	Lactarius spp	Feb-April	Upoo (Nyasa)	5
			Ulondi (Matengo)	
	Termitomyces letestui	Dec-Feb	Nkuhu (Matengo)	3
	Amanita masasiensis	Dec-March	Magongolo ya ulelema (Nyasa)	1
	Clavulina wisoli	March-April	Kayunju (hairy mushroom) (Nyasa)	2

Village	Mushroom species (Scientific names)	Phenology	Ethnotaxa	Scores on marketability (1 = less marketable; 5 = highly marketable) [18]
	Russula hiemisilvae [Sensu lato]	Dec-Jan	Utelesyi (Nyasa)	1
	Amanita mafingensis[Sensu lato]	Dec-Jan	Uhanga (Nyasa)	1
	Boletus spectabilissimus	Dec-March	Mandodi (Nyasa)	2
	Lactarius kabansus	Feb-April	Kamemena (Nyasa)	4
	Unknown 3	Feb-March	Upelepele (Matengo)	2
	Unknown 4	Feb-March	Moyoumu (Matengo)	1

Appendix 14: Trend analysis for marketable edible wild mushrooms species identified in the study villages from Mbinga and Nyasa districts of Ruvuma region, Tanzania

Mushroom species	Ethnotaxa	Scores on historical trends in abundance (1 = least abundant; 5 = most abundant)					Perceived reasons for the observed declining abundance	Perceived impacts of the observed declining abundance
		1980	1990	2000	2010	2020		
a) Amanimakoro village								
Cantharellus isabellinus	Unguyuwu (Ngoni)	5	4	4	4	3	Increased drought incidences due to climate change Forest clearing for charcoal and farming Dust from coal mines inhibit mushroom productivity	Increased incidences of non-communicable diseases such as hypertension and diabetes Decreased income for mushroom sellers Increased scarcity of stew (*kitoweo* or *mboga* in Kiswahili), sometimes leading to increased household spending for food or skipping meals especially for poorest households
Russula cellulata [Sensu lato]	Uhinda (Ngoni)	5	4	4	4	3		
Amanita loosii	Ulelema (Ngoni)	5	4	4	4	3		
Lactarius sp1	Kilembesi (Ngoni)	5	4	4	4	3		
Termitomyces eurrhizus	Ungala (Ngoni)	5	4	4	4	3		
Amanita masasiensis [Sensu stricto]	Ugongolo (Ngoni)	5	4	4	4	3		
Auricularia polyricha [Sensu lato]	Mangaukau (Ngoni)	5	4	4	4	3		
Termitomyces tyleranus	Ulundi (Ngoni)	5	4	4	4	3		

Mushroom species	Ethnotaxa	Scores on historical trends in abundance (1 = least abundant; 5 = most abundant)					Perceived reasons for the observed declining abundance	Perceived impacts of the observed declining abundance
		1980	1990	2000	2010	2020		
b) Kindimbachini village								
Cantharellus isabellinus	Unguyuwu (Ngoni)	5	5	5	5	5	Increased human and livestock population Clearing of 'mpeta' trees (*Vachellia kirkii*) in the lowland areas to meet the increased wood demand and farming areas due to increased human population Overgrazing leading to increased forest soil compaction that inhibit mushroom productivity especially '*mpeta*' mushrooms	No vivid impact for the time being since most types of edible and marketable mushrooms are still abundant
Russula cellulata [Sensu lato]	Uhinda (Ngoni)	5	5	5	5	5		
Amanita loosii	Ulelema (Ngoni)	5	5	5	5	5		
Lactarius spp	Upoo (Ngoni)	5	5	5	5	5		
Termitomyces letestui	Mkufu (Ngoni)	5	5	5	5	5		
Termitomyces eurrhizus	Mpeta	5	3	2	1	1		
Lactarius sp2 [Sensu lato]	Uhalakati (Ngoni)	5	5	5	5	5		
Russula sp1 (Similar to Uhinda but relatively big in size)	Lukolombi (Ngoni)	5	5	5	5	5		
Cantharellus cf. floridula [Sensu lato]	Kalungeya (Ngoni)	5	5	5	5	5		
Termitomyces aurantiacus	Mandondo (Ngoni)	5	5	5	5	5		
Auricularia polyricha [Sensu lato]	Mangaukau (Ngoni)	5	5	5	5	5		
Russula hiemisilvae [Sensu lato]	Uyoga-teleza	5	5	5	5	5		
Lactarius sp1	Kilembesi (Ngoni)	5	5	5	5	5		
Unknown 3	Upelepeta (Ngoni)	5	5	5	5	5		
Termitomyces microcarpus	Upuli (Ngoni)	5	5	5	5	5		
c) Hinga village								

Mushroom species	Ethnotaxa	Scores on historical trends in abundance (1 = least abundant; 5 = most abundant)					Perceived reasons for the observed declining abundance	Perceived impacts of the observed declining abundance
		1980	1990	2000	2010	2020		
Cantharellus isabellinus	Unguyuwu (Mpoto)	5	5	5	5	5	Increase in human and livestock population Forest clearing for settlement and farming Frequent wildfires that kill underground perennial living components of mushrooms. Fires are caused by hunters and cultural habit of setting fire in forests Increased drought incidences	Increased scarcity of food, sometimes causing people to skip lunch and dinner meals especially for the poorest households Inadequate supply of vitamin leading to unhealthy population Inadequate supply of natural foods for wild animals such as monkeys; they are becoming destructive to farms adjacent to forests in search for food
Russula cellulata [Sensu lato]	Uhinda (Mpoto)	5	5	4	4	3		
Amanita loosii	Ulelema (Mpoto)	5	5	4	4	3		
Termitomyces letestui	Nkuhu (Mpoto)	5	5	4	3	2		
Cantharellus symoensii	Unguyuwu-ukulu (Mpoto)	5	4	3	2	1		
Clavulina wisoli	Kayunju (hairy mushroom) (Mpoto)	5	5	4	4	4		
Unknown 3	Upelepetu (Mpoto)	5	5	4	4	3		
Termitomyces tyleranus	Ulundi (Mpoto)	5	5	4	3	3		
Termitomyces clypeatus	Nghunda (Mpoto)	5	5	4	4	3		
Polyporus moluccensis [Sensu lato]	Mangaukau (Mpoto)	5	5	5	5	5		

Mushroom species	Ethnotaxa	Scores on historical trends in abundance (1 = least abundant; 5 = most abundant)					Perceived reasons for the observed declining abundance	Perceived impacts of the observed declining abundance
		1980	1990	2000	2010	2020		
d) Litolomero village								
Russula cellulata [Sensu lato]	Uhinda (Nyasa)	5	5	4	4	3	Increase in human population; and clearing forests for farming Increased drought incidences, and/or unpredictability of rainfall	Food insecurity Decreased opportunities for income generation
Amanita loosii	Ulelema (Nyasa)	5	5	4	4	4		
Lactarius spp	Upoo (Nyasa)/Ulondi (Matengo)	5	5	4	3	2		
Lactarius kabansus [Sensu lato]	Kamemena (Nyasa)/Chimemena (Mpoto)	5	4	3	3	2		

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