Community-based forest management of the Rungwa corridor

Abundance and marketing potential of wild mushrooms

Adansonia-Consulting, Dr. Urs Bloesch, 12 May 2020

Front page photograph (from left to right): Uyungwe (*Russula* sp. 1), Ukikova (*Lactarius xerampelinus*), Ukakungulume (*Cantharellus* cf. *floridula*), Wikese (*Cantharellus isabellinus*), Umpalala (*Lactarius kabansus*), Umpotya (*Russula congoana*), Kansolele (*Termitomyces microcarpus*), Usensuka (*Lactarius tanzanicus*); Mkola mushroom group, 14/3/2020

Content

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Abbreviations

ADAP	Association for the Development of Protected Areas
CBO	Community-based Organisation
DFO	District Forest Officer
FR	Forest Reserve
GEF	Global Environment Facility
GTZ-IS	Deutsche Gesellschaft für Technische Zusammenarbeit, International Services
INHBO	Ilunde Natural Honey Beekeepers Organisation
JUHIWAKU	Jumuiya ya Hifadhi ya Wanyamapori Kululu
SIDO	Small Industries Development Organisation
SME	Small and medium-sized enterprises
TBS	Tanzania Bureau of Standards
TFDA	Tanzania Food and Drugs Authority
TFS	Tanzania Forest Service Agency
UNDP	United Nations Development Programme
VEO	Village Executive Officer
VGS	Village Game Scout
WEO	Ward Executive Officer

Executive summary

This mushroom study was carried out from 9 to 22 March 2020 in the *Community forest management of the Rungwa corridor* project. The survey focussed on the inventory of edible mushrooms and the current use of mushrooms by local communities. Due to the outbreak of the coronavirus we could not conduct a comprehensive market survey with questionnaires in Tabora and in Sikonge.

In addition, the excessive rainfall of this season has led to unusual high water levels in rivers and depressions making the access to certain villages and to the forests of Kululu and Rungwa River Forest Reserve impossible. Finally, the mushroom groups of the villages of Mkola in Kitunda ward and Mwitikio and Majojoro in Kiloli ward of Sikonge district have been met for discussions and interviews.

17 members of mushroom groups, whereof 3 men and 14 women were interviewed and short mushroom forays carried out in nearby forests. All mushrooms mentioned by the locals and/or found in the field were recorded including vernacular names.

In total 60 mushroom species from 19 genera belonging to 12 families were recorded whereof 21 were found in the field. 36 edible mushrooms were recorded. Most preferred species are *Lactarius kabansus*, *L. tanzanicus, L. xerampelinus*, *Cantharellus isabellinus* and *C. symoensii*, and *Termitomyces microcarpus*. Additional surveys in Mlele and Rungwa River Forest Reserves will certainly confirm and complement the current list of 60 species.

The brief mushroom forays confirmed the high abundance of wild edible mushrooms in miombo woodlands. The most common and edible mushrooms are mycorrhizal including the genera *Amanita, Cantharellus*, *Lactarius* and *Russula*. They live all in symbiosis with certain tree species.

We suggest setting up a mushroom association for better supporting the interest of the mushroom groups and for taking the lead in the marketing of wild edible mushrooms. According to first market visits and interviews with mushroom sellers at Tabora and Sikonge markets the demand of fresh and dried mushrooms is confirmed and more mushrooms could be sold if more regularly available.

The planned mushroom study that will take place at the beginning of the next rainy season in the context of the new ADAP project in Mlele Forest Reserve titled *Co-management of the forests in the Katavi-Ugalla Corridor* will also allow to conduct a) interviews of Isegenezya and Ilunde villages together with mushrooms forays in the adjacent Rungwa River Forest Reserve of Mlele district, and b) market interviews and assessments for both, Katavi-Ugalla and Rungwa corridors, including supermarkets, stores, restaurants and hotels.

A comprehensive marketing strategy for the mushrooms harvested in Katavi-Ugalla and Rungwa corridors will be elaborated following a market systems development approach. Contrary to traditional project approaches, in which implementing agencies provide services directly to the poor, an agency applying Making Markets Work for the Poor (M4P) acts as a facilitator to align key players and functions of a market system to produce sustainable results.

The mission makes recommendations for the development and implementation of a wild mushroom value chain for the current phase which ends on 31 October 2020 and the next phase of the Rungwa corridor project from November 2020 to October 2022 including a timetable for the implementation of the key activities.

1) Introduction

The Association for the Development of Protected Areas (ADAP) is implementing the project entitled *Community forest management of the Rungwa corridor* in Mlele district (Katavi region) and Sikonge district (Tabora region) in western Tanzania. The Rungwa corridor project aims to ensure the conservation of the Rungwa-Katavi ecological corridor (Ushoroba) by giving local communities more rights to forests. Sustainable community-based forest management will improve the livelihoods of the locals through the development of income generating activities such as beekeeping and marketing of wild edible mushrooms thereby inciting the local population for the conservation of the miombo ecosystems.

ADAP has mandated Adansonia-Consulting to conduct a wild mushroom study in the project area to assess their use and marketing potential (see terms of reference in Annexe A):

1) Make an inventory of edible mushrooms including the description of their habitat (through questionnaires and field work);
2) Assess the current use of mushrooms by local communities (species, harvesting and preservation, sales on markets…);
3) Make a preliminary evalutation of the marketing potential of the edible mushrooms in local markets.

The field mission to Tanzania was conducted from 9 to 22 March 2020 and focussed on the first two tasks. Out of the six villages of Kitunda and Kiloli wards participating in the project, Mkola, Mwitikio, Majojoro and Mwenge (see mission programme in Annexe B and organisations and people met in Annexe C) have been visited.

ADAP, in collaboration with UNDP/GEF/GTZ-IS, has formerly mandated two mushroom studies in the Selous-Niassa Wildlife Corridor in Ruvuma region in Southern Tanzania (Bloesch & Mbago 2008, 2009a). These studies clearly demonstrated the high potential of wild edible mushroom in the miombo woodlands and their importance for the diet of the local communities during the rainy season. The studies showed also the high interested of the locals to be involved in the commercialisation of this highly priced food. In addition, a mushroom flyer with coloured photographs of the most important edible mushrooms of the Selous-Niassa Wildlife Corridor was elaborated for supporting the promotion of wild edible mushrooms (Bloesch 2009b).

The excessive rainfall of this season has led to unusual high water levels in rivers and depressions (Mbuga). Due to the high water level at Kululu River (see Fig. 1) we had to leave the project car at Wembele hunting camp and had to use motorbikes for the field visits. The villages of Isegenezya and Ilunde of Ilunde ward in Mlele district and the adjacent Rungwa River Forest Reserve as well as the Kululu Village Forest Reserve in Sikonge District could not be visited at all due to inaccessibility (extensive flooding of Mbugas). The interrupted access from Sikonge Town to Lukula by road made impossible the participation of the Tanzania Forest Service Agency (TFS) and the District Forest Officer (DFO) from Sikonge in the planned joint field mission.

Moreover, due to the outbreak of the coronavirus the Swiss Government asked their citizens abroad to be repatriated home as soon as possible and we could not conduct a comprehensive market survey with questionnaires in Tabora and in Sikonge. Therefore the two markets of Tabora and Sikonge have been only briefly visited before going to Lukula. The rushed return journey made it impossible to discuss with Small Industries Development Organisation (SIDO) in Tabora the different challenges related to the marketing of wild edible mushrooms. Finally we manage to leave the project area from Lukula via Rungwa and Igiti to Tabora despite extremely difficult road conditions.

The mushroom study will be completed by a forest study during the next dry season. In addition, a similar mushroom study is foreseen by ADAP in the Mlele Forest Reserve which could also complement the study for the Rungwa corridor.

Fig. 1. The high water level of Kululu River made the crossing by car impossible.

2) Background

This first phase of the Rungwa corridor project runs from April 2018 to September 2020 including a six months no-cost extension. The project area includes the villages of Isegenezya and Ilunde and the adjacent Rungwa River Forest Reserve (2300 km^2) in Mlele District and the villages of Mgambo, Mwenge, Mkola, Kapumpa, Mwitikio and Majojoro and the adjacent eastern part of Rungwa River Forest Reserve and Kululu Village Forest Reserve (880 km^2) in Sikonge district (see Fig. 2). The project aims to promote community forest management with a focus on the sustainable use of forest products such as the development of modern beekeeping and the promotion and marketing of wild edible mushrooms. Therefore ADAP supports two Community-based organisations (CBOs), INHBO (Ilunde Natural Honey Beekeepers Organisation) and JUHIWAKO (Jumuiya ya Hifadhi ya Wanyamapori Kululu), active in Mlele and Sikonge districts, respectively, for the implementation of the activities. The development of income activities will enhance the conservation of the miombo woodlands by the local communities which will benefit from well protected ecosystems.

Large parts of the Mlele and Sikonge districts are covered with miombo woodlands where wild edible mushrooms are plentiful (Bloesch & Mbago 2008, 2009a). In addition, mushrooms growing on termite mounds and agarics are frequent on cultivated lands.

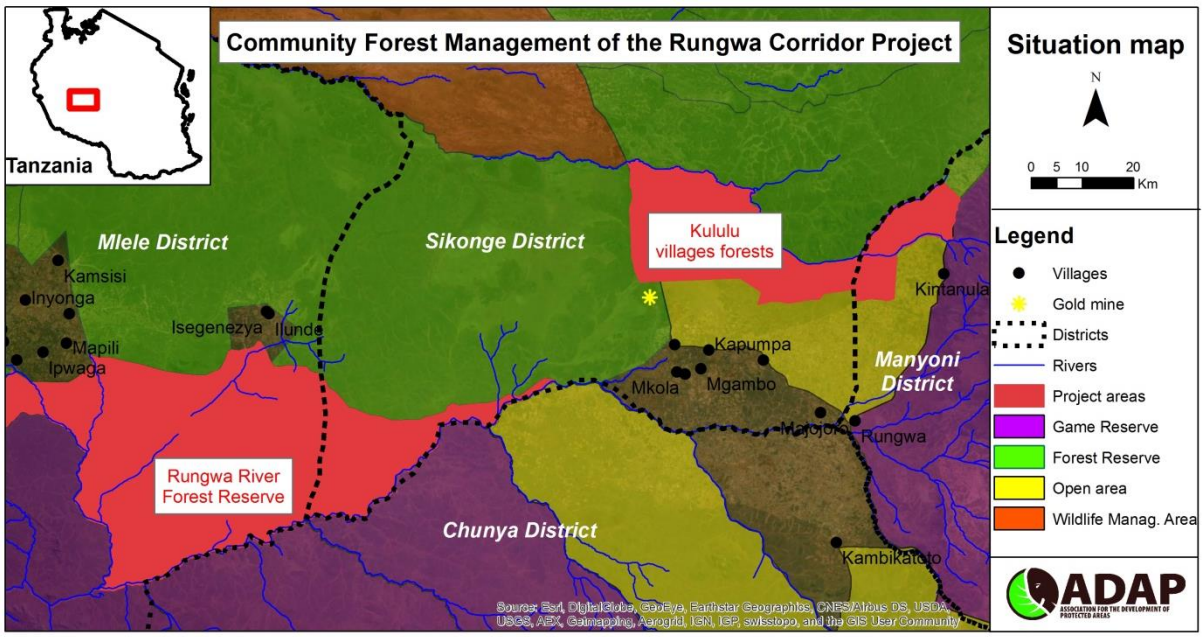

Fig. 2. Location of project area.

During this first phase of the project several socio-economic and ecological baseline studies will be undertaken. The socio-economic baseline survey (Mwakimata 2018) revealed that mushrooms are the second most Non-Wood Forest Products (NWFPs) after beekeeping. 40.5% of interviewees were engaged in gathering wild edible mushrooms whereof 91% of the households were picking mushrooms for food purpose only while 9% of the households were using the mushrooms for self-consumption and for sale. None of the households were collecting mushroom for sale purpose only. Some people lack the knowledge to differentiate clearly edible from poisonous mushrooms.

There is a great opportunity to identifiy the wild edible mushrooms of the project area and assess their marketing potential in order to develop a sustanaible value chain for this forest product. Furthermore, improved drying of fresh mushrooms considering hygenic aspects will extend their preservation and will respond to quality requirements of the market. Proper drying of fresh mushrooms will also increase the self-consumption during the dry season of this highly nutritional diet in benefit of the food and nutrition security of the local communities (see also Chelela et al. 2014). Being rich in proteins and vitamins, mushrooms are a potentially valuable source of proteins, particularly for the poor section of the population (Kivaisi 2007). The Rungwa corridor project started to organise the local communities by initiating mushroom groups in all villages except Mgambo which has no forest.

3) Methodology

This study was conducted in March 2020 toward the end of the rainy season which was exceptionally wet this year. Initially, it was foreseen to sample all participating villages of the Rungwa corridor project, i.e. the two villages of Ilunde ward (Ilunde and Isegenezya) in Mlele District and the 4 villages of Kitunda ward (Mgambo, Mkola, Mwenge, Kapumpa) and the 2

villages of Kiloli wards (Mwitikio, Majojoro) in Sikonge district. As explained, the 2 villages of Mlele district were not accessible. Mgambo was not sampled since the local community does not have access to forests, Kapumpa is currently rejecting any collaboration with the project and the members of the mushroom group in Mwenge did not come to the meeting.

Prior to the interviews / discussions with the mushroom group members we introduced ourselves to the village authorities. The mushroom group members were informed about the meeting on the previous day what allowed their mobilisation on time. For the individual interviews of mushroom group members we reviewed and adapted the questionnaire in Swahili which ADAP used in their former project at Namtumbo in Ruvuma region of Southern Tanzania (see questionnaire translated in English in Annexe D). 17 members of mushroom groups, whereof 3 men and 14 women were interviewed by Romanus Mwakimata and Isaya Godfrey Sungura. The selection of the interviewees was done randomly.

The questionnaire focussed on the recognition and use of wild mushrooms, including amongst others vernacular name, fructification period, edibility, medicinal uses, habitat of mushroom sites, consumption, mushroom picking and preserving techniques, marketing, and villagers suggestions (see Annexe D). At the same time a group discussion (*open-ended-questions*) with mushroom member groups not busy with the interviews was animated by the team leader (see Fig. 3).

We used the colour photographs in the book from Härkönen et al. (2003) to obtain more vernacular names and people's knowledge about a particular species. These group discussions allowed us to check and complete some of the information received from the questionnaires. After the interviews/group discussions the key informants brought us to some of their usual mushroom picking sites (not realised in Majojoro because the mushroom picking sites were not reachable). Representative fruit bodies of all found mushrooms were systematically photographed.

All mushrooms mentioned by the locals and/or found in the field were recorded including vernacular names (Kinyamwezi and Swahili for few mushrooms, see Table 1). The books from Härkönen et al. (2003) and Härkönen et al. (2015) were very helpful in the identification of the mushroom species. The edibility of each eatable mushroom was evaluated by the locals in comparison with other mushrooms. For the edibility rating we followed Härkönen et al. (2003):

* = edible species
** = good edible species
*** = edible, delicious

For facilitating the identification of unknown species at later stage we produced 5 exsiccates. We cut thin slices along the cross section from good specimens which we immediately put in a small hermetic plastic bag. We added silica gel with moisture indicator (silicagel red, Districhimie Art.14191) in an approximate proportion of 10 grams silica per one gram of mushroom. Samples dried within a few hours and were periodically checked for re-hydration (if necessary more silica gel was added). In addition, we took notes about important taxonomic characteristics including substrate, consistency, smell and taste, colour changes, latex (colour and possible colour changes) and spore print.

Fig. 3. Discussion with the mushroom group at Mwitikio.

For the market study we reviewed and adapted the questionnaire in Swahili which ADAP used in their former project at Namtumbo in Ruvuma region of Southern Tanzania. The questionnaire focusses mainly on the species sold, season, sources of supply, purchase and selling price (see questionnaire translated in English in Annexe E). Due to the outbreak of Covid-19 and the required repatriation to Switzerland the planned survey of Tabora and Sikonge markets could not be realised as planned and the two markets have only be visited briefly at the beginning of the mission and R. Mwakimata managed to conduct 4 interviews with mushroom sellers (2 men and 2 women) in 3 different markets of Tabora town.

4) Results

4.1 Species inventory

All mushroom species found in the field and/or mentioned by the locals during the interviews/discussions (and identified with the book from Härkönen et al. 2003) including their scientific and vernacular names, edibility and locality are listed in Table 1 below. The growing habitat is miombo woodland if not otherwise stipulated. In total 60 mushroom species from 19 genera belonging to 12 families were recorded whereof 21 were found in the field.

Out of the 60 recorded species, 45 could be identified at species level, 7 at genus level only and 8 species could not yet been identified. For 41 species a vernacular name (Kinyamwezi,

Swahili) was received from the local communities. About 75% of group members are picking at least twice a week mushrooms. The average walking distances (one way) for picking mushrooms from Mkola, Mwitikio and Majojoro ranges from half an hour up to 5 hours (Kululu forest from Majojoro). Traditional mushroom knowledge is transferred mainly from grandparents or mothers to the young generation.

The **most common families** are as follows:

***Amanitaceae*:** The cup-like remnant of universal veil surrounding the stipe (the volva) is characteristic for this genus. All 6 recorded species have been named scientifically and are edible.

***Boletaceae*:** Usually boletes have a robust appearance with a hemispherical cap, and a well-developed stipe. Typical of boletes is that instead of gills they have tubes. Many species are bright-coloured, and often bruised pore surface and exposed flesh show rapid and bright colour changes. None of the recorded boletes is eaten by the locals although some might be edible. The collected exsiccates may help in the identification.

***Cantharellaceae*:** Chanterelles are the prominent species of the miombo woodlands and are also very abundant in the project area especially the fleshy *C. isabellinus* (see Fig. 4). Six species have been identified. All of them are eaten by the local communities and can be preserved fresh for several days.

***Russulaceae*:** This family is the most speciose including 10 *Lactarius* species (milk caps) and 7 *Russula* species recorded, most of them edible.

***Tricholomataceae*:** This tropical genus is typified by its symbiotic life together with termites often found in agricultural fields nearby termite mounds. The local communities recognised 6 *Termitomyces* species according to Härkönen et al. (2003) however only *Termitomyces microcarpus* (Kansolele) was found in the field due to their specific fructification period (see Fig. 5).

4.2 Edibility

36 species out of 60 species are eaten by people (see Table 1). All interviewed people valued mushrooms as food very highly.

Most of the edible species are from the genus *Amanita, Cantharellus* (chanterelles), *Lactarius* and *Termitomyces* (termite mushrooms). Most preferred species are *Lactarius kabansus*, *L. tanzanicus, L. xerampelinus*, *Cantharellus isabellinus* and *C. symoensii*, and *Termitomyces microcarpus*. *Boletaceae* are not eaten anywhere. 3 poisonous mushrooms were named during the interviews.

4.3 Medicinal uses

Several polypores are used for treating cough including *Cyclomyces tabacinus, Funalia polyzona and Trametes* spp. (the taxonomic identification of the species have to be confirmed). The mushrooms are first burnt and then grinded to powder and eaten with salt (maize flour). One out of the 17 interviewees is collecting mushrooms for medicinal purpose.

Table 1. Recorded mushroom species in the Rungwa corridor project area

Mushroom species	Kinyamwezi	Swahili	Edibility	Locality
Agaricaceae				
Agaricus aff. *arvensis*			(**)	Mwitikio, Majojoro; cultivated land on dung
Coprinus cinereus sensu lato	*Umpumwe*		(**)	Mwitikio
Amanitaceae				
Amanita loosii	Ulelema		***	Market Tabora, Mkola, Mwitikio, Majojoro
Amanita mafingensis	*Ugongolo*[1], *Wisani*		**	Mkola, Mwitikio
Amanita masasiensis	*Ugongolo*		**	Mkola, Mwitikio, Majojoro
Amanita miomboensis			*?	Mwitikio
Amanita tanzanica	*Ugongolo*		**	Mkola, Mwitikio, Majojoro
Boletaceae				
Afroboletus luteolus			not eaten	Mwitikio, Majojoro
Boletus pallidissimus			not eaten	Mkola, Mwitikio, Majojoro
Boletus spectabilissimus[3]			not eaten	Mwitikio, Majojoro
Boletus sp.1			not eaten	Wembele hunting camp
Boletus sp.2			not eaten	Mwitikio
Suillus granulatus	*Makikuku*		not eaten	Mwitikio, Majojoro
Cantharellaceae				
Cantharellus congolensis	*Utowa*, *Wikese*		***	Tabora market, Mkola
Cantharellus cf. floridula / C. addaiensis	Wijogoro (nyekundu) Ukakungulume		**	Wembele hunting camp, Mkola, Majojoro
Cantharellus isabellinus	Ukukwe?, Wikese		*** b?&d	Market Tabora, Mkola, Majojoro
Cantharellus platyphyllus	Wijogoro (nyekundu) Ukakungulume		***	Wembele hunting camp, Mkola
Cantharellus symoensii	Wijogoro Wikese? Ukakungulume		***	Wembele hunting camp Mkola
Cantharellus sp.	Wijogoro (njano)		**	Wembele hunting camp
Coriolaceae				
Cyclomyces tabacinus[2]				Mwitikio
Funalia polyzona[1]	*Mavikuku*			Mwitikio, Majojoro
Pycnoporus sanguineus				Wembele hunting camp, Mkola; Mwitikio; on dead wood
Trametes sp. 1[2]	*Vikukoa*			Mkola; on dead wood
Trametes sp.2[2]	Ikikuku			Mkola; on dead wood
Clavulinaceae				
Clavulina wisoli		*Kilezu chamwa guku, Ulim wa ng'ombe*	not eaten	Mkola, Mwitikio, Majojoro
Ganodermataceae				
Humphreya eminii				Wembele hunting camp, Mkola, Mwitikio, Majojoro

Pluteaceae				
Volvariella volvacea			(***)	Mwitikio
Russulaceae				
Lactarius denigricans	*Uskowha*	*Umpalala wa dume*	(inedible)	Mwitikio
Lactarius densifolius	*Uskowha*		(***)	Majojoro
Lactarius edulis	*Uskowha*		(***)	Majojoro
Lactarius heimii	*Uskowha*		(*)	Majojoro
Lactarius kabansus	Umpalala		*** b?&d	Wembele hunting camp, Mkola, Mwitikio, Majojoro
Lactarius luteopus			not eaten	Mwitikio
Lactarius medusae	*Uskowha*		(*)	Mwitikio, Majojoro
Lactarius tanzanicus	Ulimba, Usensuka		*** b?&d	Mkola, Mwitikio, Majojoro
Lactarius volemoides			(***)	Wembele hunting camp
Lactarius xerampelinus	Ukikova		(***)	Mkola
Russula albofloccosa			inedible	Wembele hunting camp
Russula compressa		*Umaharagwe*	(**)	Mwitikio, Majojoro
Russula congoana	Umpotya	*Umaharagwe*	(**)	Mkola, Mwitikio, Majojoro
Russula hiemisilvae			(**)	Majojoro
Russula roseoviolacea	*Ukakuva*		(**)	Mwitikio
Russula sp. 1	Uyungwe		***	Wembele hunting camp Mkola, Mwitikio
Russula / Lactarius	Usikova		*** b?&d	Sikonge market
Schizophyllaceae				
Schizophyllum commune				Mwitikio
Sclerodermataceae				
Scleroderma verrucosum				Mwitikio
Tricholomataceae				Termitomyces on termitaria mainly on cultivated land
Termitomyces aurantiacus	*Untele, Utyelele*		(**)	Mkola, Mwitikio, Majojoro
Termitomyces clypeatus	*Utyelele*		(**)	Mwitikio
Termitomyces letestui	*Buhima/Uhima, Ufuma patale*		(***)	Market Tabora, Mkola, Mwitikio, Majojoro
Termitomyces microcarpus	Kansolele		*** d	Tabora, Sikonge markets, Mkola, Mwitikio, Majojoro
Termitomyces singidensis			not eaten	Mwitikio
Termitomyces tyleranus			(**)	Mwitikio, Majojoro
Family not known	*Uuyumbo*			Mwitikio
		Ulimi wa ng'ombe	?	Mwitikio
	Ukema wifulele		?	Mwitikio
		Def ya babu		Majojoro
		Kidevu cha babu	?	
Poisonous species				
Kikuku				
Kibamila mbanga				
Umpalala Dume				

60 species in total whereof 21 recorded in the field; 36 edible species

Legend:
Locality: miombo woodlands when not otherwise specified;
Mushrooms written in *italic*: not seen in the field / market;
(*) edibility rating according to Härkönen et al. 2003; b = boiling; d = also eaten dried;
1) Plural Wigongolo tbc;
2) Powder used against cough;
3) When touching this mushroom the person will be lost in the forest.

Fig. 4. Two-coloured *Cantharellus platyphyllos* nearby Wembele hunting camp.

4.4 Consumption and preserving techniques

All group members are consuming at least twice a week mushrooms during the rainy season while about 60% of the members are eating at least once a week in off-season dry mushrooms.

Usually the people are drying the surplus of the mushroom harvest for the consumption during the dry season. Mainly chanterelles, milk caps (*Lactarius*) and *Termitomyces microcarpus* (Kansolele) are frequently dried. *Amanitaceae* and *Russula* are generally too soft and fragile to be dried. The mushrooms are generally first boiled and then sun-dried on a mat. Due to the pre-boiling the mushrooms become very hard and have to be soaked before cooking. The quality of the drying is often imperfect including mushrooms which are dirty/dusty and/or not fully dried thereby decaying rapidly due to mould fungi infestation.

Fig. 5. *Temitomyces microcarpus* (Kansolele) in an agricultural field in Mkola.

4.5 Marketing

About 70% of group members are collecting mushrooms also for selling. Most sold mushrooms by the group members are *Lactarius kabansus*, *L. tanzanicus, Cantharellus isabellinus* and *C. symoensii*, Usikova, and Cantharellus cf. floridula / C. addaiensis and C. platyphyllos. According to the field survey the mushrooms are sold by the mushroom group members at a price varying between 500 and 2000 TSh for a small bowel (<0.5 litre) depending on the species and the season.

Comprehensive market interviews could not be conducted because the mission was aborted due to the coronavirus pandemic. Therefore, we got only a snapshot of the market situation by visiting Tabora and Sikonge markets before going to Lukula. Fresh and dried mushroom species are sold in the markets including *Cantharellus isabellinus* (*C. platyphyllus/symoensii*), *Amanita loosii, Lactarius kabansus, Termitomyces microcarpus* (see Fig. 6).

Fresh mushrooms dominate the market in the rainy season and are more preferred by the urban consumers in Tabora. Dry mushroom have good market during the dry season when fresh mushrooms are not available. Most of the urban buyers are not able to distinguish different mushroom species and are not able to differentiate edible from and inedible or even poisonous mushrooms.

Fig. 6. Selling of *Cantharellus isabellinus* (*Lactarius* sp.) at Town Clinic market in Tabora

5) Discussion

The brief mushroom forays confirmed the high abundance of wild edible mushrooms in miombo woodlands (Bloesch & Mbago 2008, 2009a, Mlambo & Maphosa 2017). They generally prefer sites with low vegetation cover and short grasses. The most common and edible mushrooms are mycorrhizal including the genera *Amanita, Cantharellus*, *Lactarius* and *Russula*. Mycorrhizal fungi form a mutualistic symbiosis with numerous tree species (Bâ et al. 2011). Mycorrhizal fungi can form structures either on the outside (ectomycorrhizae, macrofungi) or inside (endomycorrhizae) of plant roots. Ectomycorrhizal trees predominate in miombo woodlands what explain the abundance and diversity of macrofungi in these ecosystems. Ectomycorrhizal fungi often live in symbiosis with trees of the *Caesalpinioideae* subfamily including the genera *Afzelia*, *Bauhinia*, *Berlinia*, *Brachystegia*, *Cassia*,

Erythrophleum, *Isoberlinia*, and *Julbernardia*. If Miombo trees are killed for instance by girdling, their mycorrhizal mushrooms disappear too (Härkönen et al. 2015).

Out of the recorded 60 species, 21 species could be found on sites the others were only cited by the local communities during the interviews / discussions or recognised in the book from Härkönen et al. (2003). Due to inaccessibility of many sites only in Mkola and Mwitikio short mushroom forays could be organised in nearby sites. The received vernacular names of a mushroom species is not always consistent and additional assessments are necessary for clarification. (Mwakimata 2018) listed 28 species in his socio-economic survey of the Rungwa corridor whereof 12 species were not recorded during this survey. Additional surveys in Mlele FR and Rungwa FR will certainly confirm and complement the current list of 60 species. In a similar study Chelela et al. (2014) reported 45 wild edible mushrooms collected by Benna and Hehe communities in Njombe and Iringa regions in the Southern Highlands of Tanzania.

The survey confirmed the strong seasonality of many mushroom species (Härkönen et al. 2015). For example *Amanita tanzanica* occurs at the beginning of the rainy season, while many termite mushrooms appear in the second half of the rainy season. Therefore we recommend conducting the planned similar mushroom study for Mlele Forest Reserve rather at the beginning of the dry season in November / December 2020 what will allow assessing a wider range of edible mushrooms.

One limitation from the interviews is that all interviewees are members from mushroom groups and therefore not representative for the whole local population. For example the average frequency of picking and consuming mushrooms by the mushroom group members may differ from that of the local population.

5.1 Principles for picking and handling mushrooms

The following principles should be respected in the proper picking and handling of mushrooms:

***Mushroom foray*:** Careful picking is very important to meet high quality and hygiene standards for a successful marketing of mushrooms. Only fresh and undamaged mushrooms should be collected. Mushrooms should be cut off near the ground (instead of plucking) and remaining soil from the base of the stipe should be cut off to keep the mushrooms clean in the container thereby avoiding any later washing. Every mushroom should be split into two halves to see if there are no maggots inside. Unknown mushrooms should be kept away from edible ones which are known.

***Container*:** The newly available cotton bags or weave basket out of organic material should be used for collecting mushrooms. Closed containers like plastic bags or buckets accelerate the decomposition of the mushrooms. Stacking layers of mushrooms should be avoided since mushrooms are very delicate and risk to be spoiled quickly. The same principle should also be applied for packaging of the mushrooms for its transport from the collection centres to the market.

Preservation techniques: Fresh mushrooms have to be consumed rapidly in order to avoid deterioration of their quality. However, there are quite big differences between species. For example, termite mushrooms have to be consumed the day they were picked. On the other hand, chanterelles in general can be preserved in good quality for several days if stored properly. The development of appropriate preservation techniques will not only be in profit of marketing mushrooms but also of self-consumption during the dry season of properly dried mushrooms what will improve the quality of the diet of the locals.

***Sun drying*:** Mushroom should be cut in slices of 3-4 mm of thickness before drying in the sun (open-air and solar dryer). Fully dried mushrooms break very easily. Dried mushrooms should be preserved in a covered container to prevent them from absorbing air moisture what would accelerate spoiling of the mushrooms by microorganisms. ADAP staff should be actively involved in drying (including the assessment of possible changes in the flavour of the mushrooms) and preservation tests by carrying out their own tests to gain practical experiences. The necessity of boiling mushrooms before drying them will be discussed in the mission report. Proper drying will also promote the domestic consumption during the dry season of this highly priced food.

***Storage*:** Mushrooms should be stored in dry and well aerated places.

5.2 Marketing

According to first market visits and interviews with mushroom sellers at Tabora and Sikonge markets the demand of fresh and dried mushrooms is confirmed and more mushrooms could be sold if more regularly available. Chelela et al. (2014) mushroom collectors were able to earn US$ 500 to 650 US$ per season while the retailers gained US$ 750 to US$ 1000 per season {see also similar study from Mlambo & Maphosa (2017) from Zimbabwe}.

Quality standards have to be respected for successfully marketing wild edible mushrooms. Only fresh and undamaged mushrooms or properly dried mushrooms free of dirt / dust should be properly packaged for the market. However, the current practice of open-air drying of mushrooms does barely meet minimal hygienic standards. Therefore, we suggest using solar dryers leading to better quality dried products and possibly better market prices (GTZ-GATE 2001). They generally allow more complete drying and therefore longer storage and reduce losses and contamination from insects, other animals and dust.

The planned mushroom study for the Katavi-Ugalla corridor project at the beginning of the next rainy season will focus on the assessment of the marketing potential for wild edible mushrooms. In addition to the interviews with the sellers and retailers of wild edible mushrooms potentially larger scale buyers such as supermarkets, stores, restaurants or hotels will be contacted to assess their interest for high quality mushrooms (fresh or properly dried). First the potential demand for wild mushrooms in Tabora and Katavi regions will be assessed. Other more distant urban centres will be evaluated at later stage considering also additional preservation technics (curing, vinegar, canning…).

We suggest following a Market Systems Development (MSD) approach to design a value chain for promoting and marketing wild edible mushrooms from the miombo ecosystem (DCED 2020, 6 April). Contrary to traditional project approaches, in which implementing agencies provide services directly to the poor, an agency applying *Making Markets Work for the Poor* (M4P) acts as a facilitator to align key players and functions of a market system to produce sustainable results. The Rungwa corridor project should therefore only facilitating / advising key players in the marketing of wild edible mushrooms but not taking the lead role (direct implementation).

A realistic vision should be developed, e.g., *the steadily increased market demand for quality wild mushrooms is met by regular supply of mushrooms from the Rungwa corridor leading to higher income and better nutrition of the local communities during the dry season*. The core problem(s) for the marketing of mushrooms should be clearly identified. The supporting functions (e.g. proper mushroom drying technics or media campaign), the relevant rules (e.g. hygienic standards) and the role of the key players should be well understood. The development of a comprehensive marketing strategy can profit from the large experience of the beekeeping value chain established with the support of ADAP in Mlele District We

suggest setting up a mushroom association for better supporting the interest of the mushroom groups and for taking the lead in the marketing of wild edible mushrooms. The mushroom association should be represented in the community-based organisations (INHBO and JUHIWAKU).

SIDO is a parastatal organisation under the Ministry of Trade, Industry and Investment. It is a leading institution in promoting the development of small and medium-sized enterprises (SMEs) for sustainable industrialisation in Tanzania. Their experience in the organisation of agricultural producers, traceability of products, private sector involvement and their technical advice for the drying process and packaging of mushrooms will be very beneficial for elaborating the marketing strategy.

ADAP elaborated in its former mushroom project in Namtumbo in Ruvuma region a well-illustrated flyer with the most important edible mushrooms for their promotion and marketing (Bloesch 2009b). The flyer aims to document and illustrate the rich potential of wild edible mushrooms having a high nutritional value. It includes also instructions regarding identification of mushrooms, sustainable harvesting, proper picking techniques, containers for the foray, and appropriate drying techniques. We suggest producing a similar flyer in English and Swahili for the Katavi-Ugalla and Rungwa corridors. The English version will target the English spoken audience (authorities, technical services, private sector, hotels, developing agencies, donors...). The English version will be translated in easy Swahili for the local communities who will be the main beneficiaries of the promotion and marketing of wild edible mushrooms.

6) Conclusions

Overall the mission has confirmed the high abundance (supply) of wild edible mushrooms in the project area and the interest of the local communities to develop a mushroom value chain. There is an existing demand for mushrooms in the markets of Tabora and Sikonge and a potential demand by supermarkets, stores, restaurants and hotels which will be further investigated.

The planned mushroom study for Mlele Forest Reserve at the beginning of the next rainy season will also allow to conduct a) interviews of Isegenezya and Ilunde villages (including mushroom group members and non-members) together with mushrooms forays in the adjacent Rungwa River Forest Reserve of Mlele district, and b) market interviews and assessments for both, Katavi-Ugalla and Rungwa corridors, including supermarkets, stores, restaurants and hotels.

A comprehensive marketing strategy for the mushrooms harvested in Katavi-Ugalla and Rungwa corridors will be elaborated following a market systems development approach (Making Markets Work for the Poor, M4P).

7) Recommendations

A) Recommendations to the project team for the remaining current phase of the Rungwa corridor project (until 31 October 2020):

1) Evaluate different solar dryers, select an appropriate type and order at least 2 units (if not constructed locally).
2) Discuss possible challenges and the role of different stakeholders related to the marketing of wild edible mushrooms with experienced organisations (SIDO office Tabora, Tanzania Chamber of Commerce, Industry and Agriculture office Tabora), private sector representatives…).
3) Discuss relevant food safety and quality regulations and standards with Tanzania Food and Drugs Authority (TFDA) and Tanzania Bureau of Standards (TBS) for selling wild edible mushrooms.
4) Order for the project team the book *Tanzanian mushrooms. Edible, harmful and other fungi*. (Härkönen, Niemelä, & Mwasumbi 2003) from nhbs (https://www.nhbs.com/en/title?slug=tanzanian-mushrooms-book).

B) Recommendations to the project team for the next phase of the Rungwa corridor project (November 2020 – October 2022)
See also corresponding activities in timetable in Table 2.

1) Training of mushroom pickers in proper handling of mushrooms (see chapter 5.2).
2) Testing, experimentation and adjustments of solar dryers on site with mushroom pickers.
3) On-the-spot training of mushroom pickers in the proper handling of solar dryers and packaging of dried mushrooms.
4) Conduct preservation tests (shelf life) of fresh Chanterelles and other species with interested mushroom pickers.
5) Conduct the interviews of Isegenezya and Ilunde villages (including mushroom group members and non-members) and the mushroom field inventory of the adjacent Rungwa River FR in Mlele district together with the mushroom study for Mlele FR at the beginning of the next rainy season.
6) Conduct the market interviews and assessments for Katavi-Ugalla and Rungwa corridors including supermarkets, stores, restaurants and hotels at the beginning of the next rainy season.
7) Develop a marketing strategy for Katavi-Ugalla and Rungwa corridors.
8) Monitor mushroom quantities collected and handled by members of mushroom groups (fresh, dried, sold).
9) Support creation and functioning of mushroom marketing associations.
10) Design and print mushroom flyers in English and Swahili.
11) Establish central mushroom storage facilities (depot) for the market supply.
12) Organise market media campaign (radio, newspaper) and market sale booth (with posters, distribution of leaflets…) for promoting the consumption of wild edible mushrooms.

Table 2. Tentative timetable for promoting and marketing activities of wild edible mushrooms for the next project phase

Activity	Time period October 2020 – September 2022											
	N/D	J/F	M/A	M/J	J/A	S/O	N/D	J/F	M/A	M/J	J/A	S/O
1) Training of mushroom pickers in proper picking and handling of mushrooms												
2) On site testing, experimentation and adjustments of solar dryers												
3) On-the-spot training of proper handling solar dryers and packaging												
4) Conduct preservation tests of fresh mushrooms (different species)												
5) Conduct Isegenezya and Ilunde interviews and Rungwa River FR inventory												
6) Conduct market interviews and assessments for both projects												
7) Develop marketing strategy for MBZ and Rungwa corridor												
8) Monitor mushroom quantities collected (fresh, dried, sold)												
9) Support creation and functioning of mushroom marketing associations												
10) Design and print mushroom flyers in English and Swahili												
11) Establish central mushroom storage facilities for market supply												
12) Organise market media campaign and market booth												

8) References

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Annexe A: Terms of Reference

Study on mushroom species and their potential marketing

Terms of Reference

1. Background information

The project "Community Forests Management of the Rungwa Corridor" aims to improve the livelihoods of local communities living in the Rungwa-Katavi ecological corridor by giving them more rights to forests throuhg community conserved areas and supporting the development of sustainable activities such as beekeeping and mushrooms gathering. The project also aims to develop collaboration among all stakeholders to ensure the management and conservation of forests and resources for and by local communities and to help reduce conflict. During the first phase of the project, socio-economic and ecological baselines studies will be understaken in order to propose mesures for improving livelihoods and ecological values.

During the socio-economic survey done in 2018, we found that 40.5% of interviewees were engaged in collecting wild mushrooms from the forest. However, they use only few species and there is a lack of knowledge to differentiate the edible mushrooms. There is thus a great need to identifiy the mushrooms of the project area and present their marketing potential in order to develop a sustanaible value chain for this forest product.

2. Objectives

The mushroom study undertaken by an external consultant should:

- Make the inventory of edible mushrooms and the description of their habitat (through questionnaires and field work). *Priority 1*
- Assess the current use of mushrooms by local communities (species, harvesting and conditioning practices, sales on markets…). *Priority 1*
- Make a preliminary evalutation of the marketing potential of the edible mushrooms in local markets *Priority 2*

The mushroom study will be completed by a forest study that should be undertaken during the dry season and be subject to separate ToR and report.

3. Implementation of the study

The consultant will combine field work during rainy season and the report writing.

Timeframe of field work: 15 days

Reporting requirement: short verbal debriefing to the project team and TFS officer or District Forest Officer after accomplishing the field work. Then the consultant will present the findings, conclusions and recommendations in a report in English language before July 2020.

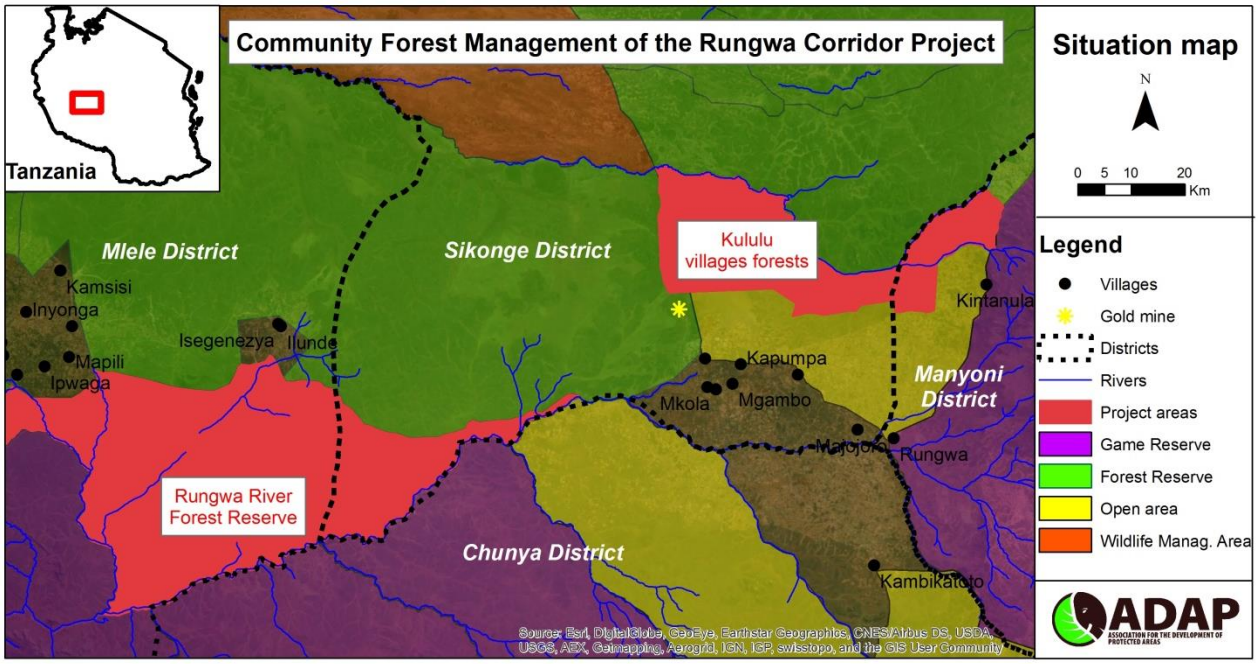
Means in the field: the car of the project or motorbikes will be at the disposal of the consultant for his field work. Fuel and food in the bush will be covered (code 2.40).

Resource persons to support the implementation: the project driver, one assistant knowing trees species and 1 VGS will accompany him in the bush (code 2.40).). A TFS officier (2.32) will join the field work for Rungwa River FR. Moreover, the consultant will be assisted by Romanus Mwakimata, Livestock and Natural Rescources Officier of the project, especially for the follow-up on local markets (3.13).

Reference documents: Socioeconomic baseline survey report for the community forest management of the rungwa corridor project (2020), project document (2018), field maps produced by ADAP will roads, river and vegetation types.

4. Study area

Six villages (Mwenge, Mgambo, Lukula, Kapumpa, Mwitikio, Majojoro) in Sikonge District and two villages (Ilunde, Isegenezya) in Mlele District will be studied. Some Wasukuma settlements can be visitedt too. Two protected areas will be sampled according to people's use and acces contraints : Rungwa River Forest Reserve (2300km^2) in the Mlele District and Kululu village forests (total of 880km^2) in the Sikonge District.



5. Budget

The budget code 2.32 will be divided between forest and mushroom study. For the mushroom study the budget is the following one:

Code	Item	Information	Amount
2.32	International consultancy (incl. allowances).	15 days	5000 CHF
2.32	Travel costs	Zurich-Tabora roundtrip	750 CHF
2.32	Visa	Business visa	270 CHF

Annexe B: Mission Programme

Date	Programme
9/3/2020	Travelling from Evilard to Zurich by train, flight Zurich – Dar es Salaam
10/3/2020	Flight Dar es Salaam – Tabora; meeting with TFS
11/3/2020	Tabora – Kululu river by car; overnight at Wembele hunting camp
12/3/2020	Wembele hunting camp – Lukula by motorbike
13/3/2020	Briefing ADAP team and discussion programme; visit Kitunda Ward authorities; reviewing field questionnaire
14/3/2020	Discussion Mkola mushroom group and mushroom picking
15/3/2020	Harvesting of Termite mushrooms with members of Mkola mushroom group; checking water level at river number modja; report writing
16/3/2020	Discussion Mwitikio mushroom group and mushroom picking
17/3/2020	Discussion Majojoro mushroom group; visit Rungwa market
18/3/2020	Mwenge mushroom group (no discussion, members did not show up); checking water level at river number modja; updating programme; reviewing market questionnaire
19/3/2020	Lukula – Rungwa (motorbike) – Itigi (car) – Tabora (bus)
20/3/2020	Flight Tabora – Dar es Salaam
21/3/2020	Flight Dar es Salaam – Dubai
22/3/2020	Flight Dubai – Zurich; travelling Zurich – Evilard (train, cable car)

Annexe C: Organisations / people met

Organisation	People met
ADAP Headquarters Geneva	Yves Hausser, head of operation Sandy Mermod, project officer
ADAP Rungwa Corridor Project	Issa Hamis Mpinga, project supervisor Romanus Mwakimata, livestock and natural resources officer Christina Komba, accountant Gabinus Tankdika, driver
Local authorities and technical services	Michael Caesar Mimalimo, WEO Kiloli ward Gerald K. Hameti, VEO Mgambo Juvenile Melkiory Assey, livestock field officer Lukula Salum Masoud Selemani, livestock field officer Lukula Greyson January Miguma, acting VEO Mkola James Adolofu Mallo, VEO Mwitikio Baraka Pius Lyandara, teacher Majojoro
DFO	Hemed Utawangu, acting forest manager Sikonge
Mushroom seller	Hildefonce Dominic Bombom, Tabora market, 0767024261
TFS	Valentine Msusa, zonal manager western Tanzania Thomas Wambura, assistant manager forest development Paul Bituro, beekeeping officer Sikonge Abubakary Mboya, forest officer Sikonge Lambert Komba, acting forest officer Sikonge
VGS	Isaya Godfrey Sungura, Majojoro

Annexe D: Questionnaire village

COMMUNITY BASED FOREST MANAGEMENT OF THE RUNGWA CORRIDOR PROJECT

MUSHROOM FEASIBILITY STUDY

FIELD QUESTIONNAIRE

This questionnaire is about mushroom availability in forest reserves of Kululu and Rungwa .

Main purpose of this questionnaire is to improve mushroom availability or collection, preservation and marketing.

<u>Section One</u> : Introduction

1. **Name ……..**
2. **Sex**
   Male ( )
   Female ( )
3. **Age**
   15-29 ( )
   30-44 ( )
   45-54 ( )
   55-64 ( )
   65-74 ( )
   75-84 ( )
   85-94 ( )
4. **Occupation (Job) ……**
5. **Settlement Places**
   a) **Sub-Village ……..**
   b) **Village ……**
   c) **Ward ……..**
   d) **Division ……..**
   e) **District ……..**
   f) **Region ……**

<u>Section Two</u> : Mushroom Information.

6. **Mushroom Collection Purpose?**

a) Food ( )
b) Medicine ( )
c) Business ( )

7. Mention names of mushroom and their collection purposes?

	Name of the Mushroom	Collection Purpose (a, b, c)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

7. Name three names of mushroom that you prefer to collect most?

……..
…….
……

8. Who taught you collecting mushroom?

……
……
……

9. How can you differentiate edible and inedible mushroom?

…….
……..
……..

10. Mention names of mushrooms that are poisonous?

…….
……..
…….
…….

11. Mention places where mushroom is found and their walking distances?
(Only one way minutes)

	Name of place where mushroom is found	One way walking minutes
1		
2		
3		
4		
5		

12. Mention names of mushroom and characters of places or trees where they are found?

	Name of mushroom	Character of a Place or Tree where Mushroom is Found
1		
2		
3		
4		
5		

13. How many times per week or month do you go and collect mushroom in a season where mushroom is available?

.....

14. How much in term of a busket do you collect mushroom per day or trip?

.....

15. Are there any ways you use to preserve mushroom to avoid from being decayed?

Yes ( )

No ( )

16. If yes in number 15 tell me the ways?

a)……..

b)…….

c)…….

17. Plese tell me how long it takes for each mushroom to stay fresh after being collected?

	Name of the mushroom	Time of being fresh (Days)
1		
2		
3		
4		
5		

18. Mention names of mushroom and months that the mushrooms are available in the forest?

	Name of the Mushroom	Month or Months of its Availability
1		
2		
3		
4		
5		

19. How many times do you consume mushroom in a household during the season that the mushroom is available?

.....

20. How many times do you consume mushroom in your household during the off-season?

.....

21. Do you sell part ot the mushroom that you collect?

Yes ( )
No ( )

22. How much mushroom collected in single trip or day you used to sell?

.....

23. Which mushroom you sold most?

.....

24. At what price did you sold mushroom?

.....

25. Money you got from selling mushroom, you used for what purposes?

.....

26. Are there any problems you experienced during the marketing or selling of mushroom?

Yes ( )
No ( )

27. If yes in question 26 above mention them below?

a)……..
b)…….
c)……..

28. In case there is the availability of enough mushroom and good market do you think you will face any problem in marketing your mushroom? If yes explain.

.....
.....
.....

29. Please give your opinion that will help to improve the mushroom business?

.....
.....
.....

Annexe E: Questionnaire market

COMMUNITY BASED FOREST MANAGEMENT OF THE RUNGWA CORRIDOR PROJECT

MUSHROOM MARKET FEASIBILITY STUDY

This questionnaire is about assessment of the mushroom market

First Section: Introduction

1. Name ……..

2. Sex

Male ( )
Female ( )

3. Age

15-29 ( )
30-44 ( )
45-54 ( )
55-64 ( )
65-74 ( )
75-84 ( )
85-94 ( )

4. Your occupation? ……

5. Communication? …….

6. Where is your business located?

a) **Street ……..**
b) **Village……**
c) **Ward ……..**
d) **Division ……..**
e) **District ……..**
f) **Region ……**

<u>Second Section: Mushroom Information</u>

7. What are the names of mushroom you used to sell?

…….
…….
…….

8. Where do you get the mushroom? Or where are the mushroom coming from?

……
……

9. How much mushroom do you sell per day?

……..

10. At what months or season do you sell the mushroom here in the market?

……

11. In which unit of measurement do you use to sell the mushroom and what is its price when selling the mushroom?

…….

12. Mushroom price information in different forms and season

Name of mushroom	Price	Rain Season		Dry Season	
		Fresh mushroom	Dried Mushroom	Fresh mushroom	Dried mushroom
	Buying price				
	Selling price				
	Buying price				
	Selling price				
	Buying price				
	Selling price				
	Buying price				
	Selling price				

13. Who are your mushroom customers and where are they coming from?

……

……

14. Which method do you use to preserve the remaining fresh mushroom?

…….

15. At what time (duration) can you preserve the dried mushroom to avoid from being damaged?

…….

16. What problems have you been facing in this mushroom business?

……

……..

17. At what time (months) the mushroom is highly demanded by customers but is not available?

……

18. What are the mushrooms that are highly demanded by the customers?

……..

19. What are your opinions in improving the mushrooms business (promotion)?

……

……