

**Impacts of Cordyceps Collection on  
Livelihoods and Alpine Ecosystems in Bhutan as  
Ascertained from Questionnaire Survey of  
Cordyceps Collectors**





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# Abstract

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*Ophiocordyceps sinensis* is an Ascomycetes medical fungus with a long and illustrious history. The fungus is a coveted medicinal product in traditional Tibetan and Chinese medicine for the last 2000 years, and is known in the west as “Himalayan Viagra”. It is highly priced with a kilogram fetching as much as USD 24,500.00/ kg (as of 2012 in Bhutan).

It is found throughout the eastern Himalayas and eastern parts of China. It appears annually and is harvested between the months of April and August.

The Royal Government of Bhutan legalized harvesting of Cordyceps in the year 2004. Since then, it is being harvested extensively in the alpine meadows of the country. This study quantifies the amount earned and contributions made to livelihood of Bhutan’s remote people living in the Cordyceps growing areas after legalizing the collection. 394 Cordyceps collectors from five gewogs in Bhutan were interviewed and they earned about Ngultrum 57 million from 2004 to 2009. On average, this translates to each household earning about Nu. 0.14 million since they started collecting. Average annual income from the sale of Cordyceps is estimated at Nu.23,000 per household. Majority of this income is used to procure household needs and to construct new houses or to repair old ones.

More than 79% of the collectors interviewed use fuelwood (Rhododendron and Juniper) for heating and cooking purposes. Only 14% of the collectors used kerosene for cooking during the entire period of Cordyceps collection. Garbage is a huge problem on the collection grounds with 96% of the collectors leaving garbage on camping and collection grounds.

The study highlights significant impacts on livelihoods from the sale of a highly valuable non-wood forest product. Given that people spend a majority of their incomes to supplement food and household expenses, our findings bring to light previously unrecognized potential dietary and income shortages. Also, incomes being used for construction of new houses with possible transmigration of populace will have considerable bearing on landscapes and culture.

The collections of cordyceps on some of the last pristine alpine Himalayan landscapes are also bringing about novel and negative changes on the ecosystem. The extensive use of slow growing rhododendron and Juniper as fuelwood poses the risk of such shrublands from getting decimated completely. This problem is

further compounded by growing problems of litter. As such, if left unregulated and unmonitored, the impacts from the collection of this highly priced fungi while helping improve livelihoods will leave some of the last pristine alpine ecosystems on this planet transformed for the worse.

The study recommends the introduction of improved wooden stoves as carrying kerosene or any alternative energy to last for a month in the hostile environment is not practical. It further recommends reducing the number of Cordyceps collectors and instituting proper garbage management schemes in addition to strengthening research to understand Cordyceps biology.

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# 1 Introduction

## 1.1. Biology and Distribution

*Cordyceps sinensis* is an Ascomycetes medical fungus with a long and illustrious history. The genus *Cordyceps* is mostly entomophagous flask fungi belonging to the family Clavicipitacea (Winkler, 2008). Although it is not actually a mushroom in the taxonomic sense, it has been regarded as a medicinal mushroom throughout history. The name *Cordyceps* comes from the Latin words “cord” and “ceps”, meaning, “club” and “head”, respectively (Holliday, et.al., 2005). The Latin word accurately describes the appearance of this fungus, whose stroma and fruit body extends from mummified carcasses of insect larvae, usually that of the Himalayan ghost moth belonging to the genus *Thitarodes* (Hepialidae, Lepidoptera).

According to recent DNA review of the genus *Cordyceps*, it was found that the DNA of *C. sinensis* was not the same as that of *C. militaris*, thus the change of genus to *Ophiocordyceps* was recommended within the newly recognized family Ophiocordycipitaceae (Sung, et.al, 2007; Cannon, et. al., 2009 and Boesi and Cardi, 2009). In this report, we will refer to the fungi as *Cordyceps* rather than *Ophiocordyceps sinensis*, since the former is the widely used name. In Bhutan and Tibet, it is called ‘Yartsa Gunbub’, the literal translation of the name is “summer grass and winter worm” (Holliday, et.al., 2005). *Cordyceps* appear annually between the months of April and August when it is harvested (Holliday, et.al., 2005; Gould, 2007; Winkler, 2008 and Cannon, et. al., 2009).

There are no scientifically studied reports on lifecycle of *Cordyceps*. Zhang, et.al., (2012) reports that in late autumn the fungus infects the larvae of ghost months, but how the fungus infects the caterpillar is not known. They describe three possible ways of infecting the larvae: 1) Caterpillar ingests a fungal spore; 2) Fungal hypha penetrates a spiracle of the insect; or 3) an ascospore or a conidium germinates after getting in contact with the larvae (Figure 1).





Figure 2: Distribution of *Cordyceps* in the region (Source: Winkler, 2009)

## 1.2. Cordyceps in History

The first written record of the *Cordyceps* mushroom comes from China. In the year 620 AD, at the time of Tang Dynasty (618 AD – 907 AD), *Cordyceps* is alluded to as a magical creature, whose annual existence is subjected to miraculous transformation from animal to plant in summer and then again from plant to animal in winter (Holliday and Cleaver, 2004). It is reported that the first mention of the *Ophiocordyceps sinensis* under the name of Yartse Gunbub occurs in the writings of the 15<sup>th</sup> century doctor and scholar Zurkhar Nyamnyi Dorje (1439-1475) in a work known as “Oral Instruction on a Myriad of Medicines” (Winkler, 2008b).

## 1.3. Cordyceps as a Health Supplement and Its Market Economy

The fungus has been recognized as a medicinal product in China for at least 2000 years (Shrestha et al., 2010) and the fungus is a coveted medicinal product in traditional Tibetan and Chinese medicine, and is known in the west as “Himalayan Viagra” (Gould, 2007).

*Cordyceps* is found to be effective against tuberculosis, leprosy and human leukemia in several trials conducted in China, Japan and elsewhere in the world (Miller, 2009). Miller (2009) further reports that *Cordyceps* help reduce tumor size and improve liver functions and helps infected kidneys recover. Also, it has been found that *Cordyceps* improve respiratory functions (Holliday and Cleaver, 2004) and blood circulation.

The market of the Cordyceps is driven by Chinese consumers and the value of the Cordyceps has increased by some 900% between 1997 and 2008, creating a globally unique rural fungal economy in Tibet, Nepal, India and Bhutan (Winkler, 2010). The insect-pathogenic fungus is harvested over much of the Himalayan plateau (Figure 2) with collectors being paid as high as US \$ 12,500.00 kg<sup>-1</sup> for top quality Cordyceps (Cannon, et. al., 2009).

#### **1.4. Cordyceps in Bhutan**

After the legalization of the harvesting of Cordyceps by the Royal Government of Bhutan, in the year 2004 (Cannon, et. al., 2009), it is harvested extensively in the alpine meadows of the country. Cordyceps has been a resource for Bhutanese traditional medicine for many years (Cannon, et. al, 2009). Since the habitat of Cordyceps is in the high alpine areas of the national parks and near the border of Tibetan Autonomous Region of China, direct protection of the species has always been a great problem due to the inadequate number of forest personal in those areas, making it difficult to monitor unauthorized harvesting.

Prior to 2004, harvesting of Cordyceps was allowed only in Lunana (Tshitila, 2009). But, in 2004, the policy allowed the limited collection of Cordyceps by the yak herders whose herds traditionally graze in the pastures where the fungus occurs through a Royal Decree issued on 17<sup>th</sup> June, 2004 (RA Online). Various measures are put in place to restrict the overall harvest including a ban on collection except during the months of mid-May to mid- June. From 2008, the policy of letting only one person from each household to harvest the fungus was lifted allowing every person from a household to collect (Gould, 2007; Wangchuk, 2008 and Cannon, et. al, 2009). Again from 2009, a new rule of issuing the permit to only 3 persons from each household was enforced (Tashi, 2012 pers.com).

Many of the harvest sites in Bhutan are near the border areas of Tibetan Plateau, which makes it easier for the people from the other side of border to harvest Cordyceps illegally in Bhutan. This trend continues, even with the strict monitoring by the forestry and army personal of Bhutan. In 2008, Forestry monitoring team of Bumthang apprehended 13 Tibetan poachers (Wangdi, 2008). Namgyel and Tshitila (2003) reported encountering over 65 Tibetan Cordyceps poachers in one region and local people reported sighting of 200-300 Tibetan poachers at another site and regularly encounter with groups of 10 to 25 individuals.

Till 2012, the highest price for Cordyceps paid in Bhutan was in 2007 which was US\$ 6126.00 – 10,450.00 kg<sup>-1</sup> at an auction in Dodena (Wangchuk, 2008). However in 2012 auction yard, the highest price paid for a kilogram of Cordyceps was US\$ 24,500.00 approximately.

## 1.5. Objectives of the Study

Many observers believe that income obtained from the sale of Cordyceps is changing livelihood patterns of alpine dwellers with significant impacts. Furthermore, it is likely that high intensity collection in the months of May and June, where the normally isolated and unpopulated alpine regions are subjected to huge influxes of collectors would bring significant ecological and environmental changes to the region. Here, through interviews, we assess: 1) the impacts of additional income from the sale of Cordyceps on people's livelihoods; 2) the negative impacts on the environment from the collection of Cordyceps. We provide recommendations to sustain Cordyceps production and minimize the impacts on high altitude alpine environments.

## 1.6. Methods

This study was undertaken through extensive interviews of Cordyceps collectors residing within two dzongkhags (Bumthang and Wangduephodrang). We randomly selected 60% of households who collect Cordyceps from five gewogs of Chokor, Dangchu, Gangtey, Kazhi and Sephu within the two dzongkhags (Figure 3).

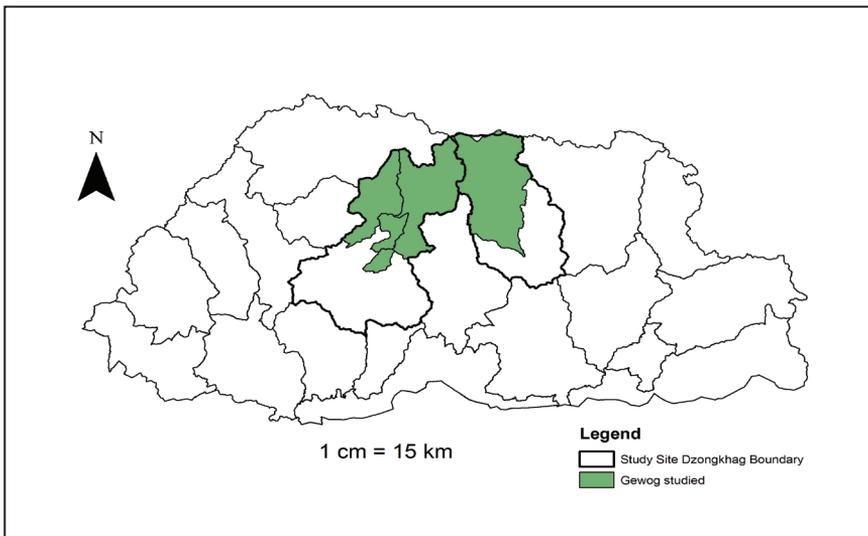


Figure 3: Map showing study area

# 2 Results and Discussion

## 2.1. Demography of Collector's Interviewed

We interviewed 168 and 226 Cordyceps collectors from Bumthang and Wangduephodrang Dzongkhag respectively (Figure 3). Majority of the collectors are within the age range of 16-35 years. It is interesting to note that there are more females than men within the age group of 16-35 years. However, female collectors decrease significantly after the age group of 42.

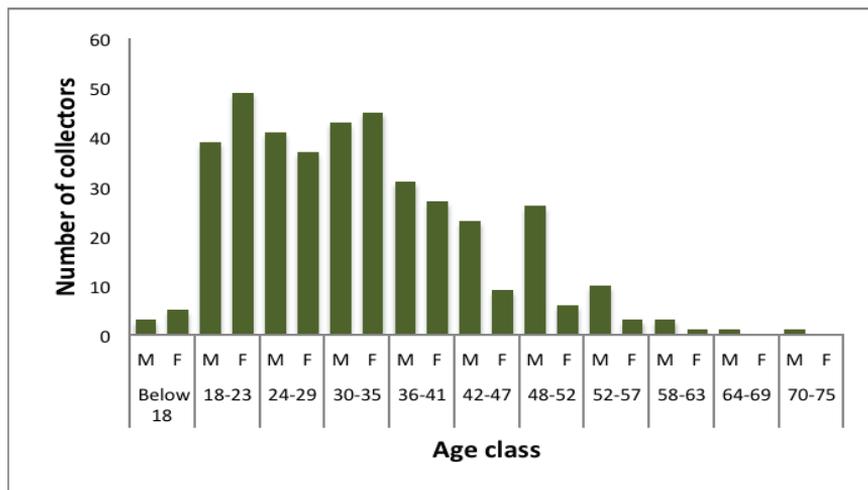


Figure 4: Demography of Cordyceps collectors

## 2.2. Income

Till 2009, each household earned about Nu. 0.14 million since they started collection (provided each collectors collected without fail since 2004). Average annual income from the sale of Cordyceps is about Nu.23,000 per household. In total, a sum of Nu 57 million has been earned from 2004 to 2009. Amount earned increases from 2004 to 2008 and drops in 2009 despite the increase in number of collectors (Figure 5). The reason may be because of the difference in the price for Cordyceps per kilogram in the market/auction yard. Till 2005, only

one person from a household was allowed a permit to collect Cordyceps. This rule was amended in 2006 where every member of a household was allowed to collect Cordyceps. Then, in 2008, only 3 collectors from each household was issued a permit. This explains the rise in number of additional collectors after 2005 and the fall after 2008 (Figure 5).

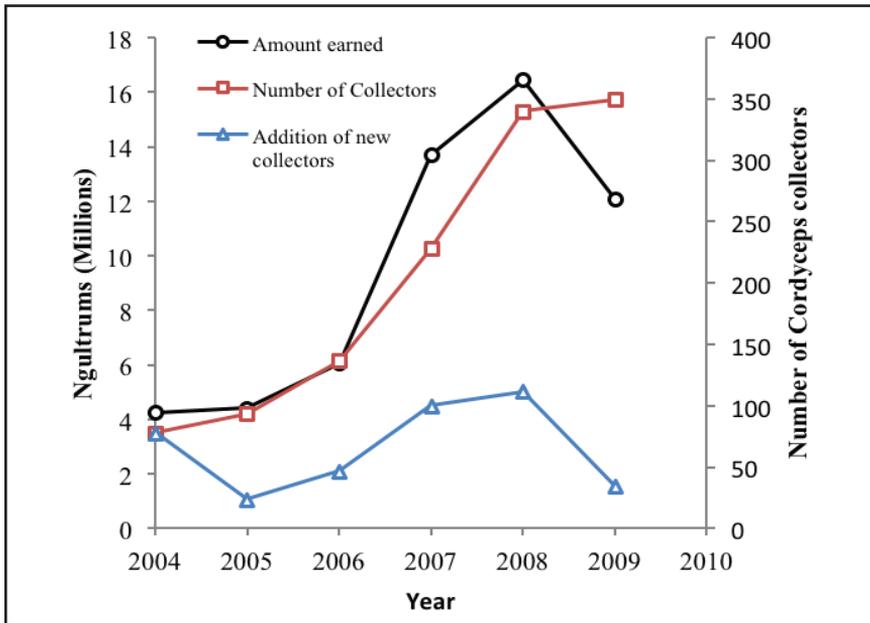


Figure 5: Number of Cordyceps collectors and earnings made from the sale of Cordyceps

We classified interviewees as Brokpas and Non-Brokpas, where Brokpas were communities who did not practice intensive agriculture (essentially nomadic herders reliant on livestock) while Non-Brokpas are generally engaged in intensive agricultural farming activities. Brokpas earned (Nu. 0.22 million per household within the six years) more than Non-Brokpas (Nu. 0.15 million). This means that Brokpas earn about Nu. 34000 per household per year while Non-Brokpas earn about Nu. 25000 per household per year.

This meager amount of money earned by the collectors does not seem to support many reports of earnings from Cordyceps significantly contributing to the improvement in living standards of collectors. For instance, Wangchuk (2011) reported that for about 30% of the collectors (N=36), about 80 -100% of their income comes only from the sale of Cordyceps. This is significant and raises the question of how communities managed their livelihood before the legalization

of Cordyceps harvesting. Interviewees also claim that they build houses (Plate 1) and supplement household purchases with earnings from Cordyceps (Figure 6). As such, the low income figures obtained from interviews may be that they are not reporting earnings correctly. This could be because Cordyceps are being traded illegally.

### 2.3. Use of Income

93% of the Cordyceps collectors interviewed said that they collect Cordyceps for monetary gains, while 6% and 1% said they collect for family use and to give as gifts respectively. 49% of these collectors who collect for monetary gains spend their earnings in procuring food items. About 21% of them use their earnings to repair or construct new houses and about 11% spend to continue their own education or to educate their children (Figure 6). We conclude that sale of Cordyceps contribute a major share of collector's annual income. Given that most of these are spent on purchase of food and household items, our findings highlight previously unidentified shortages of food.



*Plate 1: A new house being built by a Cordyceps collector in Nasiphel, Bumthang*

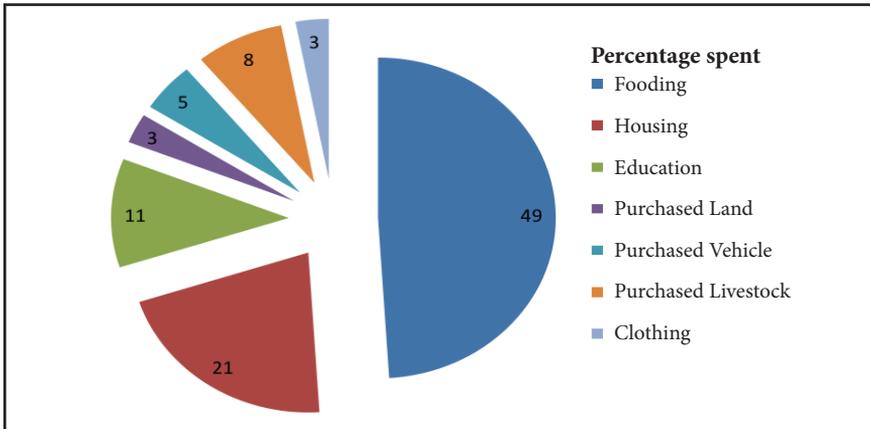


Figure 6: Income from the sale of Cordyceps spent on different things

## 2.4. Conflicts

The collection of Cordyceps comes at a cost: both social and environmental. Increasing community disputes over the collection area rights (Gould, 2007) have been reported. Also, with transboundary implications, there are increasing conflicts with collectors outside Bhutan's borders (Wangmo, 2012).

## 2.5. Environmental Concerns

Every year, mid-May to mid-June, huge numbers of people spend about a month in the high alpine environment collecting Cordyceps. We tried to understand the extent of environmental degradation in four categories:

1. Degrading shrub lands
2. Littered landscapes
3. Changing grasslands
4. Associated forest degradation

### 2.5.1. Degrading Shrub lands

Fuelwood is scarce in the high altitude collection grounds which are above tree line. The only available wood are Rhododendron, Dwarf Juniper and Willow, which are harvested extensively leading to opening of the areas in the fragile environment. Such openings may accelerate the process of mass wasting thereby leading to many ecological and environmental hazards.

In this study, we found that more than 78% of the collectors interviewed use fuelwood (Rhododendron and Juniper) for heating and cooking purposes. Only 15% of the collectors used kerosene for their cooking purpose during the entire period of Cordyceps collection.

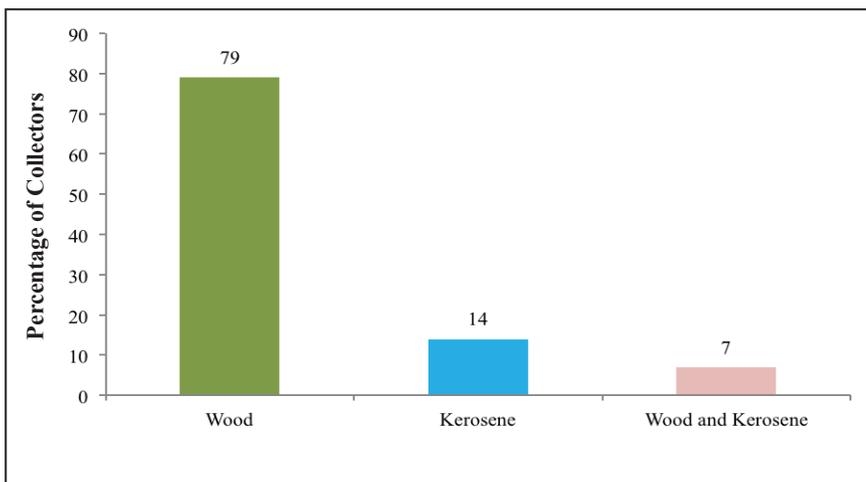


Figure 7: Type of fuel used by *Cordyceps* collectors

Studies have shown that it takes nearly 169 years for *Rhododendron aeruginosum* to attain the “base” diameter of just 8 centimeters, with an annual increment of only about 0.6 millimeter (Wangchuk, 2011). The slow growth of *Rhododendron* coupled with huge extraction by the collectors is a big concern. It is however encouraging to note that the collectors themselves are aware of this problem. 5% of the collectors stressed that it should be made compulsory for everyone to stop burning wood and go for alternate sources of energy including kerosene and Liquid Petroleum Gas (Figure 10).



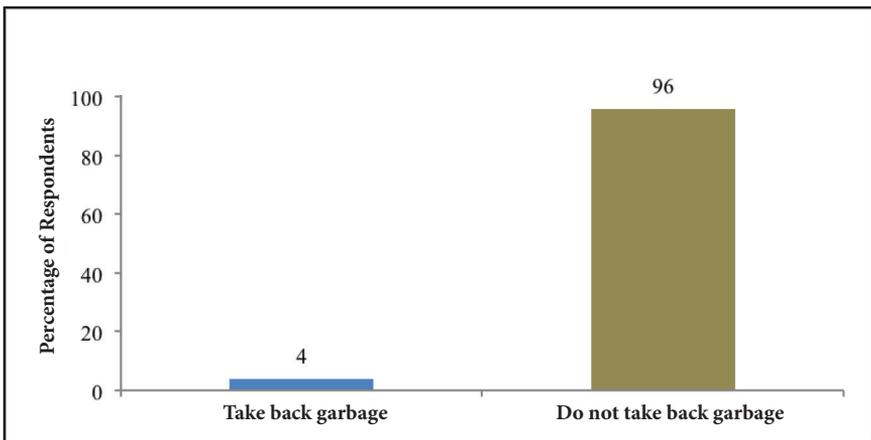
Plate 2: *Cordyceps* collector carrying fuelwood of *Rhododendron*



*Plate 3: Portion of an area from where Rhododendron was harvested*

### **2.5.2. Littered Landscapes**

Garbage management is also a serious concern in the Cordyceps collection areas. Garbage are mostly plastics and bottles. There are no proper garbage disposal strategies adopted in the collection areas and camping grounds. People throw garbage everywhere: both in the collection and camping ground as well as the routes leading to the collection site.



*Figure 8: Garbage management*

Only 4% of the collectors carry back the garbage (Figure 8). Of the 96% who do not take back garbage, 58% dispose their waste either by the side of the rocks or underneath the rocks. About 9% claim to burn the waste, and only about 6% bury the garbage. About 3% of the collectors dump garbage in streams. This will be hazardous both to fresh water biodiversity as well as people living downstream.

To tackle this problem, 28% of the collectors suggested the need of identifying proper garbage disposal site in the collection and camping sites (Figure 10). Few of them (about 2%) even suggested returning back to the collection site to clean the area after auctioning the Cordyceps. Some even suggested that temporary shops set up in the collection sites should not be allowed.

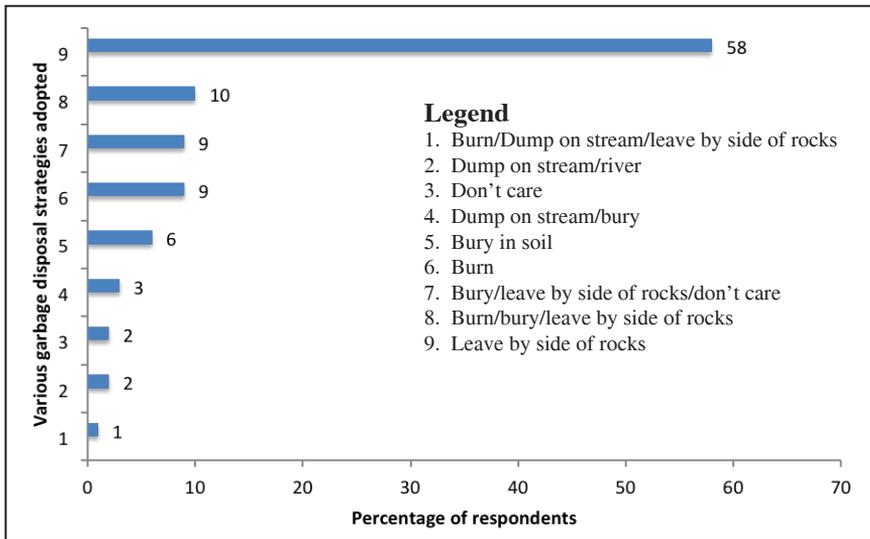


Figure 9: Garbage disposal strategies adopted by Cordyceps collectors

### 2.5.3. Changing Grasslands

Cordyceps collection season coincides with the time when young shoots of grasses start to come out. As such, the possible degradation of alpine grasslands is an important issue raised by the people of the area. They reasoned that increased number of people in their grazing area has lead to trampling of young grasses decreasing the quality of forage for their yaks.

Also about 16% of the collectors interviewed felt the need to seriously monitor collection grounds as some of the collectors were seen digging out Cordyceps, leading to the formation of holes. Digging out Cordyceps not only disturbs the grassland ecosystem but may also accelerate erosion.

#### 2.5.4. Associated Forest Degradation



*Plate 4: Extraction of timber by chainsaw in Nasiphel, Bumthang*

Income from the collection and sale of Cordyceps has also increased the purchasing power of the people. Apart from contributing to improved living standards of the collectors, the income made from Cordyceps has also been used to purchase power chainsaws. About 13% of the collectors purchased power chainsaws (Plate 4) and the number is expected to increase with time. This may increase since they are able to supplement incomes from the use of chainsaws for converting wood to timber and fuelwood. With increasing chainsaw operators in the community and without proper understanding of felling techniques, we contend that forests will be harvested at increasing rates and may also lead to wastage of wood during conversion. The destruction is not only in the temperate belt of the



*Plate 5: Juniper felled by chainsaw near tree line*

country but even in the sub-alpine (Plate 5) region of the country as Brokpas also buy chainsaws which is of immense use to them during the extraction of wooden shingles for roofing their houses.

## 2.6. Sustainability

With increasing number of Cordyceps collectors annually, sustainability of this resource is a great concern. When we raised the question of sustainability to collectors, some collectors did not show any concern. A statement to this effect is as such: “*Cordyceps has been there since time immemorial and will continue in the future too*”. Such notion towards Cordyceps could mean that either the collectors are not concerned with sustainability or they are trying not to voice concern fearing the consequences of government policies banning its harvest in the future. Only few collectors (2%) expressed the need to introduce the system of allowing the collection of Cordyceps in alternate years.

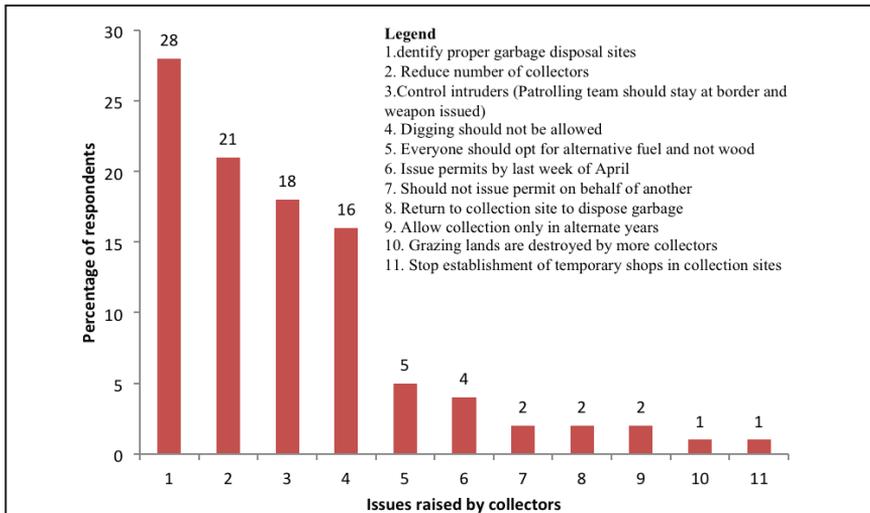


Figure 10: Some prominent issues raised by collectors

# 3 Conclusion and Recommendations

The study highlights significant impacts on livelihoods from the sale of a highly valuable non-wood forest product. Given that people spend a majority of their incomes to supplement food and household expenses, our findings bring to light previously unrecognized potential dietary and income shortages. Also, incomes being used for construction of new houses with possible transmigration of populace will have considerable bearing on landscapes and culture.

The collections of cordyceps on some of the last pristine alpine Himalayan landscapes are also bringing about novel and negative changes on the ecosystem. The extensive use of slow growing rhododendron and Juniper as fuelwood poses the risk of such shrublands from getting decimated completely. This problem is further compounded by growing problems of litter. As such, if left unregulated and unmonitored, the impacts from the collection of this highly priced fungi while helping improve livelihoods will leave some of the last pristine alpine ecosystems on this planet transformed for the worse

In the light of our findings, we recommend the following:

1. Reduce burning of wood by introducing improved wooden stove given that carrying of kerosene or any alternative energy to last for a month is not practical.
2. Collectors should be organized to identify proper waste disposal sites. Given that collectors are willing to clean, campaigns should be conducted after the collection season to clean collection and camping sites. Collectors should also be educated on waste management.
3. Reduce the number of permits issued. We suggest that only one or two permits be issued per household. This will reduce the pressure on alpine woody vegetation and may also reduce the garbage problem.
4. Enforcement should be increased. Deputation of forestry and army personnel should be increased. We suggest that collection areas be monitored for 3 months encompassing before, during and after collection. Following such a strategy will discourage illegal collectors and help minimize transboundary conflict.
5. Since the biology of Cordyceps is not well understood, we suggest further studies to understand the organisms, to enable development of proper management strategies.

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