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Adverse Anthropogenic Impacts in Yarsa-Gambu and Alpine Region in the Gori Ganga Watershed Kumaun Himalaya

D. S.Parihar[1], J. S. Rawat[2] and Deepak[3]
Department of Geography, Kumaun University, S.S.J. Campus, Almora, India- 263601

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ABSTRACT

Caterpillar Fungus is an endemic herb of the higher Himalayan regions. It has become the very important source of cash income in whole areas of Kumaun Himalaya, where it is known as Yarsa-Gambu, 'summer-grass-winter-worm', this new occupation of the local inhabitant arisen out of extraction of Yarsa-Gambu in the higher Himalayan areas is now struggling for its survival due to various anthropogenic activities. The adverse anthropogenic activities are (i) increase human pressure in the caterpillar growing areas is steadily increasing the atmospheric temperature in the region, which is not good for the health of caterpillar, (ii) use of plastic materials is in the region by the tourists and local inhabitant and (iii) felling and burning of trees and shrubs in the region. All these anthropogenic activities have accelerated the process of warming and de-glaciations in the region. The fundamental objective of this paper is to study in detail about distribution, production, and impacts of anthropogenic activities in the growth of caterpillar fungus in the higher Himalayas by employing a higher Himalayan watershed viz., Gori Ganga as an experimental laboratory.

KEYWORD: *Adverse Anthropogenic,Yarsa-Gambu, Alpine region,GIS and GPS*

I. INTRODUCTION

Environmental, snow, herbs, and forest resources are played a very important role in rural societies for livelihoods: they supply a huge variety of materials for consumption and provide cash income (Pouliot and Treue, 2013). The low-volume, high-value caterpillar fungus(*Plate 1*) inChina, scientific name OphioCordycepsSinensis, known locally as Yarsa-Gumba (adopted from YartsaGunbuin Tibetan), is one of the most important medicinal value (Gupta and Manvitha, 2017), medicinal species(Luitel et al., 2020)harvested by local habitants in mountainous parts of India (Kuniyal andSundriyal, 2013), in Darchuladistrict of Nepal (Karki et al., 2020),Jumladistrict, Nepal (Timmermann and Smith-Hall, 2019), Nepal (Shrestha andBawa, 2014a, Singh et al., 2020), Bhutan (Wangchuk et al., 2012) and China (Woodhouse et al., 2014). Caterpillar fungus playsaprominentrolein the Himalayan region, in the socio-economy of rural people (Shrestha et al., 2014,Pantetal2017). Various parts of the Tibet region show that soaring prices of caterpillar fungus have to increases in annual cash income for certain households. In some locations, caterpillar fungus accounts for 50-80% of total rural income, making it one of the most common profitable local sources of income (Winkler 2008; Woodhouse et al., 2013).Pandey andPokhrel, 2020 presented opportunities and challenges in Yarsagumba collection and onsite trading in district Darchula (Nepal) and district Pithoragadh (India) from an institutional perspective.

Plate 1: Showing Caterpillar Fungus/KeedaGhas/YarsaGumba.

In India earliest documentation of Yarsa-Gambu contribution to the rural economy was from Dharchula block in Kumaun Himalaya, when 0.5 kg of Yarsa-Gambu was found to fetch- US $ 667 in early 2000 (Garbyal et al., 2004). Some Researchers reported a 1256% increase in the price of Yarsa-Gambu locally in Kumaun between 1999 and 2004 (Negi et al., 2006). Furthermore, between 2004 and 2009, the estimated per year income contribution of Keera Ghaas in Munsyari Block, Kumaun, was reported to be the US $ 972-1485 per collector (Pant and Tiwari, 2014). There have been no estimations of Yarsa-Gambu economic contribution to the household source of income since then. However, the ongoing income contribution of Yarsa-Gambu to the households of Kumaun Himalayan region is important to understand because of this natural resource-dependent livelihood strategy.

Yarsagumba is a caterpillar fungus that grows naturally in the northern alpine grassland of Bhutan, India, Nepal, and the Tibetan plateau of China at an altitude of 3000 to 5000 m (Zhang et al., 2009).Yarsagumba is distributed around 4000 m to 5500 m altitude in high-altitude grassland and on sloppy land in Darchula district in and around Bhagawati, Ghunsha, Byas, and Rapla areas (Uprety et al., 2016).

Yarsa-Gambuis was found at an altitude above 4000 m in high mountains, which was noticed and reported in the year 2000. It is found in the sub-alpine and alpine zones between 3600–4200 m above sea level. It is found in Tibet, Bhutan, Nepal Himalaya, Sikkim, Sichun, Qunghai, and Yunnan provinces of China. In India, it is mainly found in Arunanchal Pradesh, Sikkim, Uttarakhand etc., and also in the alpine meadows of Gori Ganga watershed,Chiplakedar, Darma,Vyas and Ralamdhura in the higher altitudes of Kumaun Himalaya where it is referred to as *"KeedaGhaas"*.

Plate 2 depicts the stage of growing the Caterpillar Funguswhich is a parasitic lepidopteron larva that is found during May–July, and Caterpillar Fungus has multiple names in different countries registered in Table 1.They grow on caterpillars and pupae buried in the soil of meadows. The Yarsa-Gambu exploited in the Kumaun and Garhwal Himalaya has not been positively identified. However, KeedaGhaas of HepialusOblifurcus (Hepialidae) is known to be a host of Caterpillar Sinensis(Arora and Dhaliwal, 1997). The root has a worm-like head, body, and legs with many thin and fine across small lines. There are about eight pairs of legs on the body of the root, and out of the four, middle pairs are more important. Its lower part is thin, while the upper part is a little thicker. From the collar of this alone root grows a dark brown grassy one thin parts of Yarsa-Gambu, which is thickened at the middle with a slightly pointed tip and slender base. The larvae of Caterpillar Fungus get infected by the fungus at the end of the autumn season. It infects the complete body and covers the whole larvae, and kills it (Dube, 1983; Nair and Balakrishnan, 1995).

The fungus grows on the caterpillar from May to August as the spores of the fungus Terminate and grow on a living, caterpillar. The caterpillar eventually dies. It takes five to seven years for the fungus to complete its life cycle and produce the natural product. Presently it is found in Chiplakot, Charthi, Thalba, KhambaBagar, Ultapara, Brahmkot, Najari, and Nangnidhura–Munsyari region of district Pithoragarh. In some parts of Garhwal Himalaya, it is found in Niti and Mana valleys of Chamoli district and is known as *"Keera Jadi"*. The present study aims to study the impact of anthropogenic activities in the production of Yarsa-Gambu by employing a higher Himalayan watershed viz., the Gori Ganga, and natural laboratory. Yarsa-Gambu is one of the most important cash Income sources for villagers from the Gori Ganga watershed. It is very important for livelihood and conservation for the future.

Table 1: Multiple Names in Different Country of Yarsa-Gambu.

Different Languages	Names
Hindi	Keerajhar, Keedajadi, Keedaghas or Ghaasfafoond.
Sanskrit	Sanjiwani.
English	Cordyceps Mushroom, Caterpillar Fungus.
Nepali	Yarsagumba, Jeebanbuti, Sanjivani, Kiraghans.
Tibetan	Yarchakunbu, Dbyarrtswadgun.
Japanese	Totsukasu, Tochukasu
Chinese	Hiatsao Tong Tchong, Dongchongxiacao,

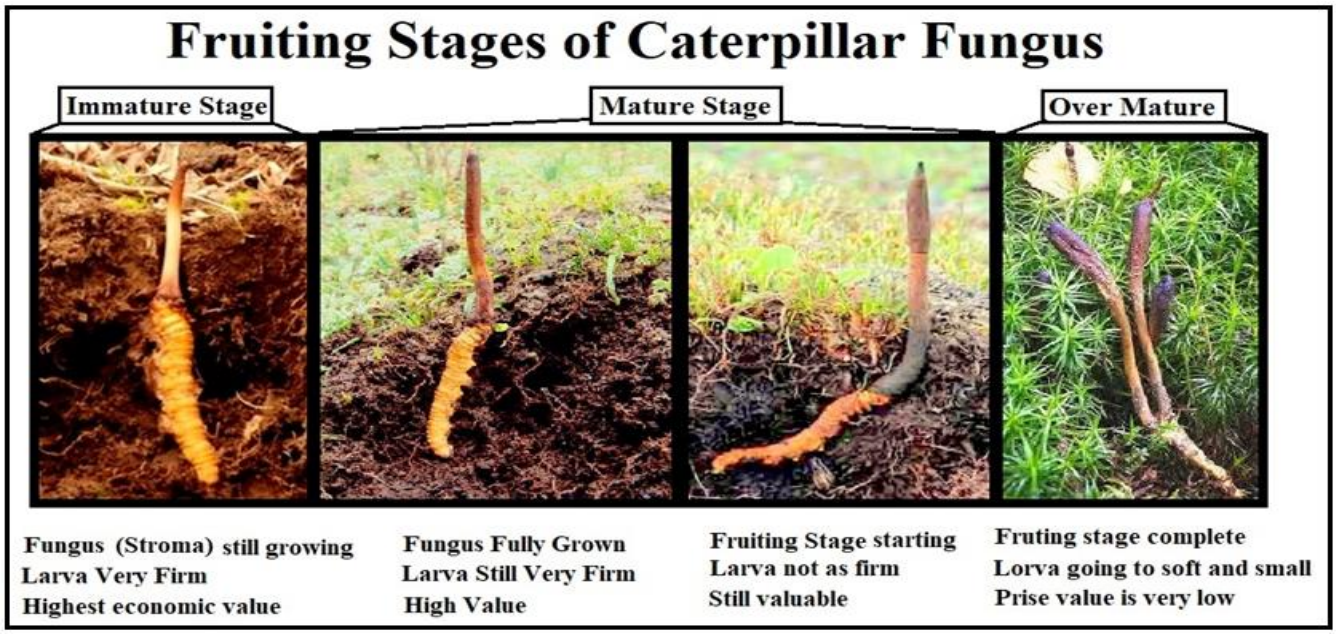

Plate 2: Stage of growing Caterpillar Fungus (Yarsa-Gambu).

II. OBJECTIVE

The fundamental objectives of the present investigation are to study the adverse anthropogenic impacts in Yarsa-Gambu harm in the higher Himalayan regionGori Ganga watershed, which incorporates the following aspect:

I. Detailed study about distribution of Yarsa-Gambu in the study area.
II. Study of Yarsa-Gambu as a source of livelihood for villagers of the study area.
III. Study of adverse anthropogenic impacts in Yarsa-Gambu of the study area.
IV. Formulation of a suggested plan of action for conservation and rejuvenation of Yarsa-Gambu.

III. METHODOLOGY AND DATA BASE

For delineation of the study area and demarcation of Yarsa-Gambu areas, Geographic Information System (GIS) Techniques were uses. The open-source GIS software Q-GIS 2.18 and Arc GIS 10.2 (Crack version) were used for GIS analyses with technical support of the Centre of Excellence for NRDMS in Uttarakhand at the Department of Geography, S.S.J. Campus. The Gori Ganga watershed was delineated using Digital Elevation Model (DEM) based on Cartosat-1 data. The location of Bugyal (Grassland) (Figure 4) and village (Figure 5) are collected by Global Position System (GPS)software. A Yarsa-Gambu growing altitudinal distribution in the study area presents in Figure 3, YarsaGambu growing climate is presented in Figure 6, distribution of villages dependent on Bugyals is presented in Figure 7was prepared by using Arc GIS. Primary data were collected from (i) the field study/observation method and (ii) the telephone interview method. The study was conducted in the October-November months of 2016 and 2019 in 21 villages, and one person (21 households) was interviewed in each village. Questionnaire focused on Caterpillar fungus and related Bugyals like harvesting experiences, a number of pieces harvested, price, earnings and expenditure related to the selling of Yarsa-Gambu, crowd in related Bugyals, staying days for Yarsa-Gambu, Related Bugyals, include household from a village and plastic uses during May to July. Secondary data are collected from a research article, research papers, and research journals and population as per Census of India (COI) 2011.

IV. STUDY AREA

The Study area, viz., the Gori Ganga Watershed at Kumaun Himalaya presents in Figure 1, which extends between $29^0 45'0''N$ to $30^0 35'47''N$ latitudes and $79^0 59'33''E$ to $80^0 29'25''E$ longitude, and encompasses an area of about $2191.52 km^2$. The well knownMilam Glacier lies in this watershed is a valley glacier having a compound basin belonging towards the southeast from the Trisul peak. The Milam Glacier is the second-largest glacier of the Kumaun Himalaya. The glacier is 16.7 km long, and it is receiving ice from the Trishul peak and seven tributary glaciers in the Gori Ganga Watershed. The Gori Ganga River originates from the Milam Glacier, a major tributary of the Kali River, which meets with Kali atJauljibi in the district Pithoragarh. The altitude of the Gori Ganga watershed varies between 626m and 6639m in Figure 2. The Gori Ganga Watershed has 168 villages (*Figure 3*), and the total population is about 40616 as per Census of India (COI) 2011. Gori Ganga watershed spreads in three Blocks, i.e., Munsyari, Dharchula and Didihat, in three Tehsils, i.e., Munsyari, Dharchula and Didihat, and in one Sub-Tehsil known as Bangapani. Munsyari remains one of the last accessible hill stations by motor road in the region. The Munsyari and Madkote towns located in the study area are currently starting points for many track routes into the Himalayan interior. Munsyari Town, one of its key advantages is the superb backdrop that is provided by the high Himalayan Panchachulirange, in full view; it is an awe-inspiring place surrounded by unspoiled nature and high mountains. Land uses spread across the region comprise Settlements, Terraced Farms, Van Panchayat (forests governed by village forest councils), reserve forests, and the Askote Musk deer Sanctuary. Gori Ganga region has 52 Van Panchayat. There is one tribal community that lived in this region called Bhotiyas/Shaukas, who move seasonally to their summer villages in the interior of the Johar valley located between 3000 to 3500m, the last village in the watershed is Milam which is 65 km far from the motor-able road.

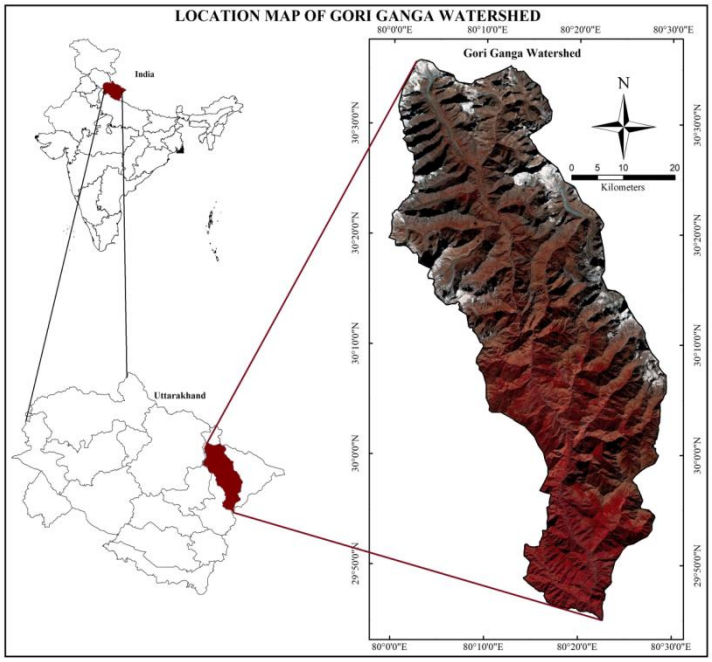

Figure 1: Location Map of the study area, viz., Gori Ganga Watershed.

V. RESULT AND DISCUSSION

Table 2 certain relief zones (3000 -5000 m) wise growing area of Yarsa-Gambu which reveals that about 1133.68 km^2Yarsa-Gambu is growing which is presenting in Figure 4 while Figure 5 presents the location of 19Bugyals in the study area geographically. Figure 6are presenting the area-Gambugrowing climate in the study area and registered in Table 3.Figure 7 presents

the geographical distribution of depending villages on different Bugyals and locations are registered in Table 4 and. Table 6 presented anthropogenic pressure for extraction of Yarsa-Gambu as well as other herbs by villagers on Bugyals. Plate 3-4-5 and 6 are an example of anthropogenic activity and creating a disturbance on growing herbs as well as Caterpillar Fungus in the alpine region of the watershed.

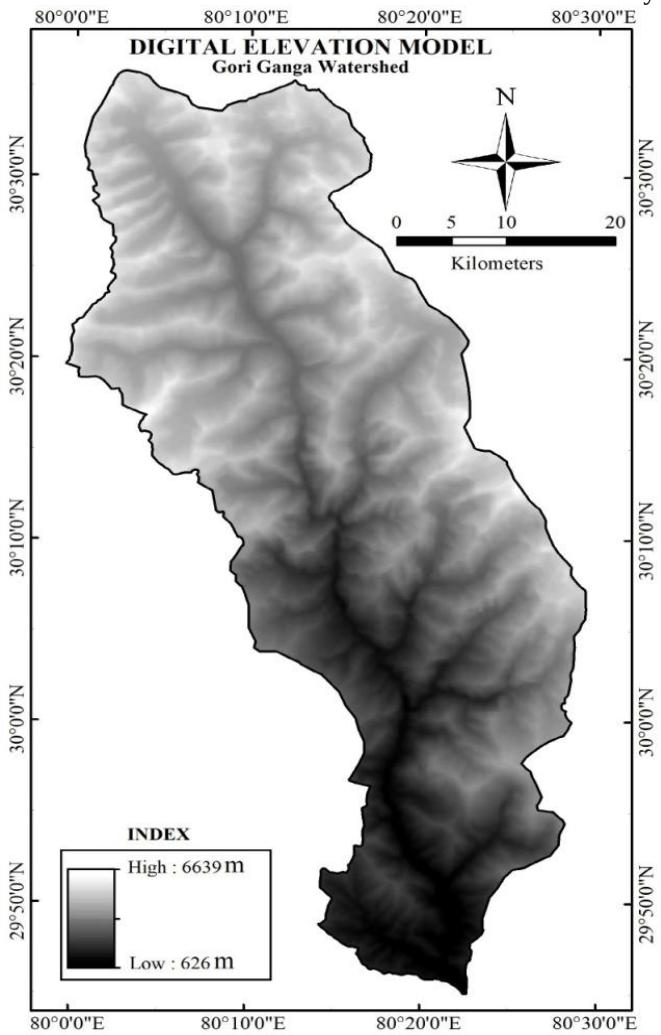

Figure 2: DEM Map of Gori Ganga Watershed *(Based on Cartosat-1 satellite, DEM).*

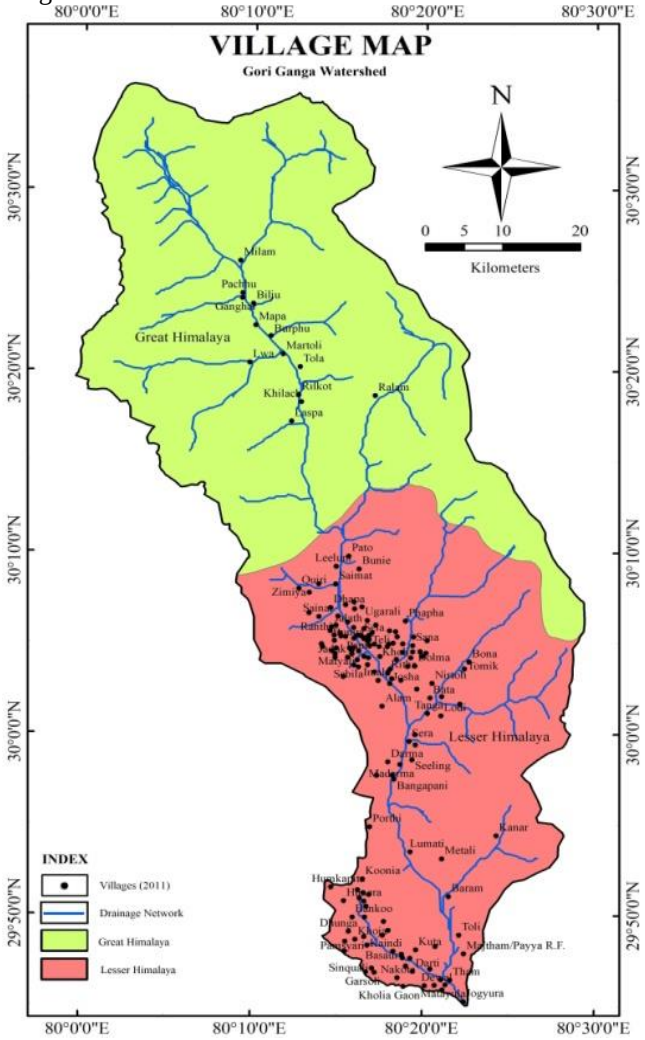

Figure 3: Villages in Gori Ganga watershed *(based on field survey and GPS).*

A. Distribution of Yarsa-Gambu Growing Relief Zones and Areas

Figure 4 depicts the spatial distribution of relief zones forYarsa-Gambu growing in the Gori Ganga Watershed and registered inTable 2, which accounts for about 1133.68 km^2 (51.73%) areas between3000 to 5000 m relief zones. The spatial distribution of YarsaGambu growing areas (Bugyals) are presented in Figure 5, and there are 168 villages in the Gori Ganga watershed where near about 50% (85) villages are directly and indirectly connected with the trade of herbs as well as Yarsa-Gambuwhich is registered in Table 4 and geographically distribution in Figure 7.

Table 2: Growing Area of Yarsa-Gambu in different Altitudinal Zones of the Gori Ganga Watershed *(based on Cartosat-1 satellite, DEM).*

Relief zones	Yarsa-Gambu growing area in km^2	Relief zone
3000-3500	196.42	High relief zones
3500-4000	262.57	
4000-4500	321.95	
4500-5000	352.74	
Total area	1133.68 (Total study Area- 2191.63 km^2)	
in percentage	51.73%	

B. Climatic Regions of Gori Ganga Watershed

Climatic conditions are determined by altitudes, slope, and aspects. The altitudinal differences coupled with varied physiographic divisions, contribute to climate variations in the GoriGanga watershed. Climatically, the Gori Ganga watershed is very complex. The climate of the watershed varies from the sub-tropical (valley regions) to the alpine (highlands), which is divided into five different climate regions. These are:

i) Sub-Tropical Region (below 1200m)
ii) Cool Temperate Region (1200-2100m)
iii) Cold Temperate Region (2100-2500m)
iv) Alpine Region (2500-4500m)
v) Snow Cover Area (>4500m)

Figure 6 depicts the spatial distribution of climatic regions of the Gori Ganga watershed, and Table 3 presents the distribution of the area under these regions. A brief account of each climatic region is given in the following paragraph.

5.2.1 Alpine Region as a Suitable Climatic Zone for Growing YarsaGambu

This region has 19 grasslands locally known as Bugyals and is very important for growing herbs, as well as very costliest YarsaGambu in Gori Ganga watershed, which extends between 2500-4500 m altitude zones. In the summer average temperature is 5^0-10^0 C, and the area of this region is about 807.67 km^2 which accounts for about 36.85% area of the total watershed.

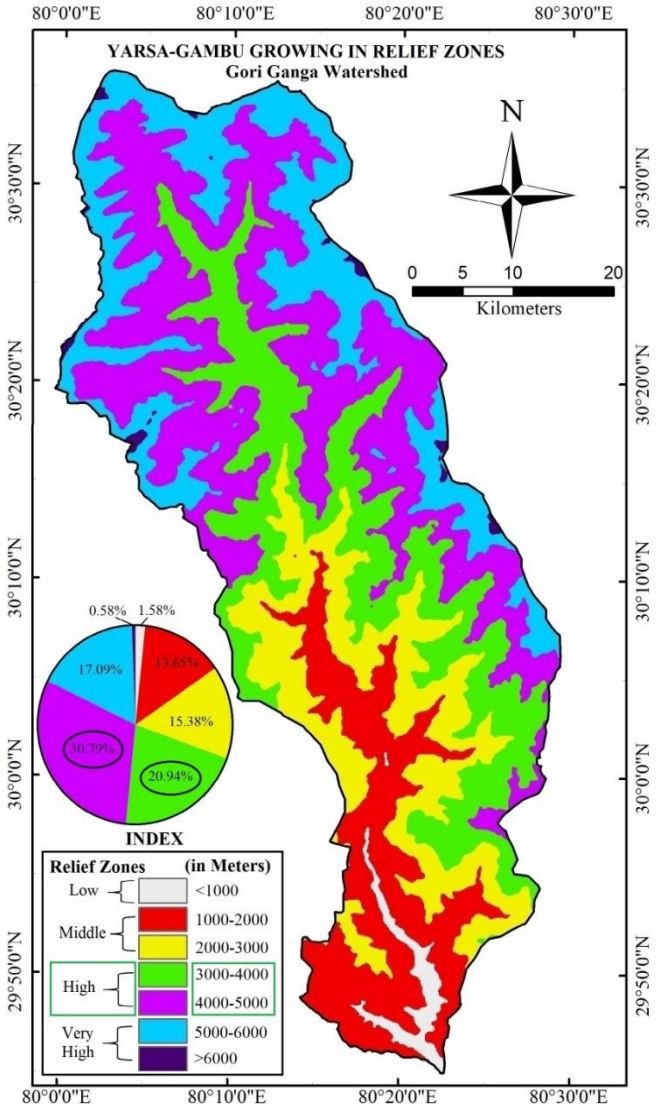

Figure 4: Yarsa-Gambu growing relief zones in the Gori Ganga Watershed *(Based on Cartosat-1 satellite, DEM).*

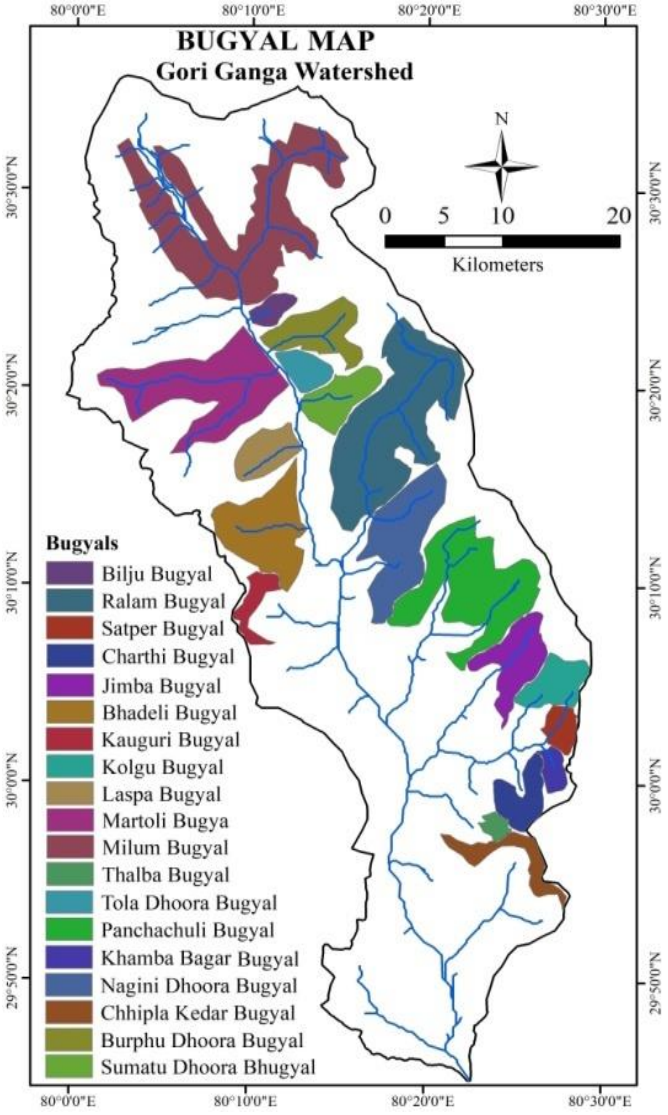

Figure 5: Yarsa-Gambu growing Bugyals in the Gori Ganga watershed *(based on field survey and GPS).*

Table 3: Distribution of area under climatic regions of the Gori Ganga watershed (*based on Cartosat-1 Satellite data).*

Climatic Region	Height in meters	Area		Cumulative Area	
		In km^2	In %	In km^2	In %
Sub Tropical Region	<1200	74	3.38	74	3.38
Cool Temperate Region	1200-2100	190.65	8.70	264.65	12.08
Cold Temperate Region	2100-2500	600.65	27.41	865.3	39.49
Alpine Region	2500-4500	807.67	36.85	1672.97	76.34
Snow Cover Area	>4500	518.55	23.66	2191.52	100

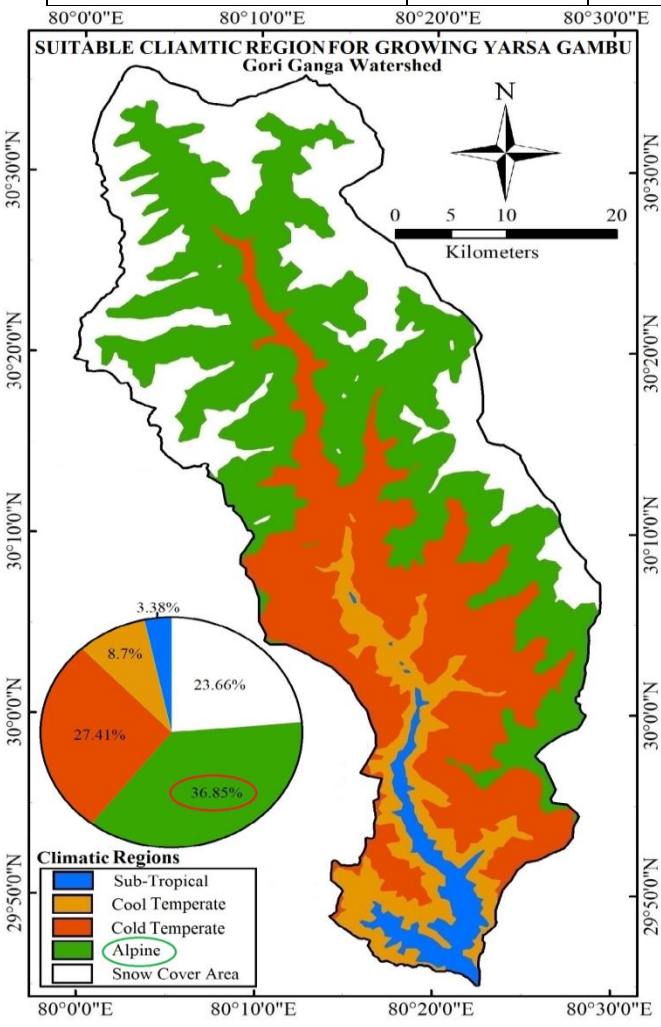

Figure 6: Climatic region of Yarra-Gambugrowing in the study area *(Based on Cartosat-1 satellite, DEM).*

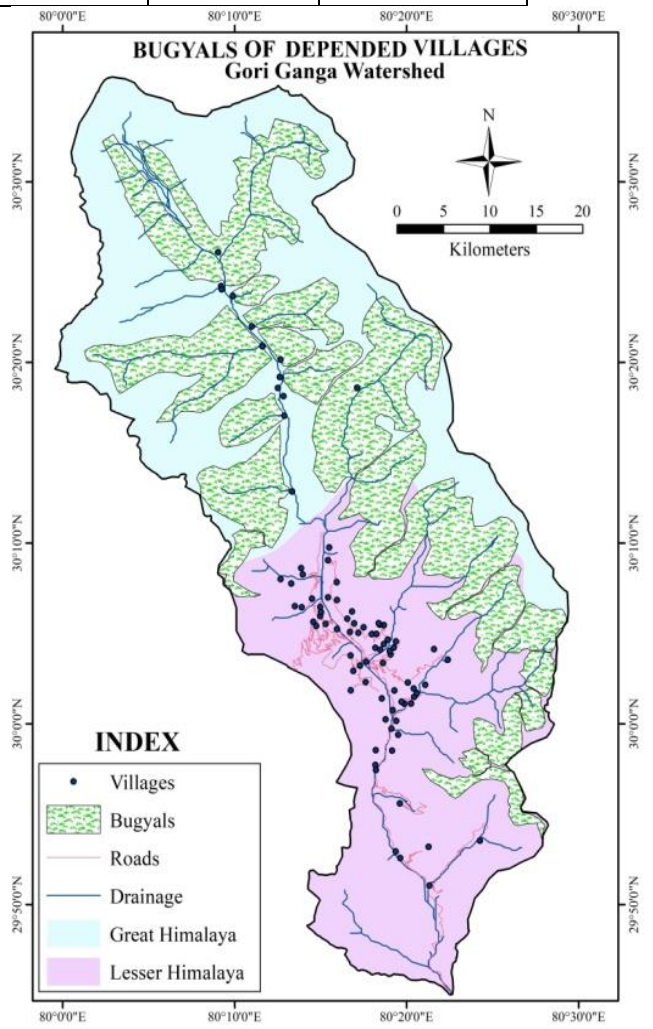

Figure 7: Geographical distribution of villages dependent on Bugyals in the Gori Ganga watershed *(Based on field survey).*

C. Yarsa-Gambu as a source of livelihood for villagers

Risk factors during collectionYarsa-Gambu are found in the high altitude of the Gori Ganga region; maximum villagers walk through the dangerous mountain trails to reach there. The footpaths are highly risky and very narrow, and also prone to landslides. People walk for 2-3 days to reach there then they are staying in Extreme cold, raining, snowfall during May-June worsen the condition. A number of people die due to excessive cold; high altitude sickness is the most common one; Photophobia is a common problem of Yarsa-Gambu hunters just after a snowfall, sometimes avalanche causes a disaster that usually seen there and falling from sloppy hill also a contributory factor for death. Some people go there along with the family, and sometimes infants die due to excessive cold.

a) Benefits of Yarsa-Gambu in Study Area

There are some drastic changes and impacts of Yarsa-Gambu on villager's economies of 85 villages in the Gori Ganga watershed which geographical locations are presented in Figure 7 and registered in Table 4. The seasonal migration of some villagers is decreasing because of the collection of Yarsa-Gambu. Now they are moving or making the concrete houses instead of traditional wood and stone houses from the earning of Yarsa-Gambu. Another positive change which is reflecting in field of education, from last 5-7 year education of girls was not proper, and the dropout rate of girl's education in comparison to boys was too high from schools. At present, the trend is changing day by day. The young girls and boys are going for education in adjacent towns and cities e.g. Pithoragarh, Almora,

Haldwani, Dehradun, and Delhi, etc.Yarsa-Gambu is one of the biggest sources of cash income for the livelihood of the villagers of Gori Ganga Watershed. This source of cash income to rural livelihood through the collection and trade of Yarsa-Gambuhas caused a far-reaching transformation of economic and social conditions in the last 5-7 years. Yarsa-Gambu provides cash income for education, health care, especially motorcycles, transportation, and consumer goods activities such as trade as well as community activities.

Every year, this herb is collected during May-July and sold to the business people directly in order to sustain the livelihood in rural areas.Usually, Yarsa-Gambu is collected in large quantity before it attains the maturity. The first reason is that it is sold based on its weight. It attains the highest weight just before the maturity due to the compactness of the inner tissue.Yarsa-Gambu is said to be the most expensive herb in the world today, a kilogram of it fetching more than 650000 money in the international market.

Table 4: List of Yarsa-Gambu collector villages in the Gori Ganga watershed *(based on field survey).*

S. N.	Village Name	Geographical Location		S. N.	Village Name	Geographical Location	
		Latitude (N)	Longitude (E)			Latitude (N)	Longitude (E)
1	Baram	29^{0}51’02.49’’	80^{0}21’18.96’’	44	DhaulaDhunga	30^{0}06’12.63’’	80^{0}16’49.71’’
2	Kanar	29^{0}53’31.50’’	80^{0}24’15.66’’	45	JaraJibli	29^{0}55’35.23’’	80^{0}19’36.47’’
3	Metali	29^{0}53’10.85’’	80^{0}21’16.32’’	46	Bangapani	29^{0}57’26.65’’	80^{0}18’12.71’’
4	Chami	29^{0}52’33.83’’	80^{0}19’37.47’’	47	Tomik	30^{0}04’07.38’’	80^{0}21’35.37’’
5	Lumti	29^{0}52’55.74’’	80^{0}19’21.57’’	48	Nirtoli	30^{0}02’16.33’’	80^{0}20’04.31’’
6	Bindi	30^{0}01’56.74’’	80^{0}20’24.43’’	49	Walthi	30^{0}03’21.92’’	80^{0}18’37.07’’
7	Bona	30^{0}03’32.33’’	80^{0}22’23.32’’	50	Madkote	30^{0}03’26.25’’	80^{0}17’38.87’’
8	Mavani	29^{0}57’43.06’’	80^{0}18’10.64’’	51	Dunamani	30^{0}01’23.58’’	80^{0}18’33.45’’
9	Darma	29^{0}58’31.88’’	80^{0}18’12.06’’	52	Josha	30^{0}02’18.10’’	80^{0}17’37.07’’
10	Seeling	29^{0}58’30.43’’	80^{0}19’09.03’’	53	Gandhi Nagar	30^{0}01’51.20’’	80^{0}16’45.35’’
11	Imla	30^{0}02’55.17’’	80^{0}16’54.16’’	54	Khartoli	29^{0}59’23.00’’	80^{0}19’30.47’’
12	Sera	29^{0}59’43.58’’	80^{0}19’06.61’’	55	Sai-Polo	30^{0}08’36.98’’	80^{0}13’36.98’’
13	Sirtola	30^{0}00’09.26’’	80^{0}19’23.75’’	56	Bhatkura	30^{0}05’01.73’’	80^{0}17’11.46’’
14	Alam	30^{0}00’14.59’’	80^{0}18’46.18’’	57	Uchhaiti	30^{0}05’33.21’’	80^{0}16’56.53’’
15	Dobri	30^{0}04’05.26’’	80^{0}18’28.04’’	58	Sera Ghat	30^{0}00’45.41’’	80^{0}19’11.62’’
16	Lodi	30^{0}01’06.96’’	80^{0}20’06.96’’	59	MulyanPani	30^{0}01’13.05’’	80^{0}19’41.89’’
17	Bata	30^{0}01’50.30’’	80^{0}19’17.28’’	60	Bali Bagar	30^{0}01’28.92’’	80^{0}20’26.19’’
18	Tanga	30^{0}01’06.70’’	80^{0}19’51.37’’	61	Bhikuriya	30^{0}01’41.55’’	80^{0}20’35.52’’
19	Waiga	30^{0}04’24.72’’	80^{0}18’40.56’’	62	Dheelam	30^{0}06’50.75’’	80^{0}15’57.27’’
20	Sana	30^{0}04’38.74’’	80^{0}18’54.60’’	63	Kulthum	30^{0}06’59.73’’	80^{0}15’25.27’’
21	Wadni	30^{0}04’58.22’’	80^{0}18’14.01’’	64	Syalthing	30^{0}05’25.67’’	80^{0}18’25.67’’
22	Okhali	30^{0}05’27.12’’	80^{0}18’40.64’’	65	Chulkote	30^{0}04’57.02’’	80^{0}17’58.57’’
23	Ringu	30^{0}05’33.55’’	80^{0}18’22.56’’	66	Bogdyar	30^{0}12’50.83’’	80^{0}13’20.45’’
24	Buinee	30^{0}09’03.04’’	80^{0}15’25.43’’	67	Darkote	30^{0}05’57.42’’	80^{0}14’58.21’’
25	Paton	30^{0}09’45.37’’	80^{0}15’30.10’’	68	Dhuratoli	30^{0}05’20.15’’	80^{0}17’29.42’’
26	Lang	30^{0}07’50.05’’	80^{0}15’56.43’’	69	LariPyankti	30^{0}06’30.13’’	80^{0}13’29.93’’
27	Quiry	30^{0}07’45.65’’	80^{0}13’17.90’’	70	Dadabisa	30^{0}05’14.49’’	80^{0}15’57.07’’
28	Darati	30^{0}05’31.29’’	80^{0}15’17.56’’	71	Dummar	30^{0}06’11.19’’	80^{0}15’01.23’’
29	Phapa	30^{0}05’48.70’’	80^{0}16’32.70’’	72	TallaDummar	30^{0}06’27.35’’	80^{0}14’58.70’’
30	Jimia	30^{0}08’00.10’’	80^{0}12’40.26’’	73	Basantkote	30^{0}05’04.59’’	80^{0}16’42.49’’
31	Sain	30^{0}08’15.33’’	80^{0}13’57.97’’	74	Milam	30^{0}26’05.85’’	80^{0}09’02.66’’
32	Dhapa	30^{0}06’55.21’’	80^{0}14’29.80’’	75	Ralam	30^{0}18’35.31’’	80^{0}17’07.18’’
33	Synnar	30^{0}06’26.60’’	80^{0}13’53.85’’	76	Panchhu	30^{0}24’12.80’’	80^{0}09’12.72’’
34	Suring	30^{0}05’38.25’’	80^{0}14’34.25’’	77	Ghanghar	30^{0}24’01.80’’	80^{0}09’14.61’
35	Ranth	30^{0}05’24.31’’	80^{0}14’44.73’’	78	Bilju	30^{0}23’41.01’’	80^{0}09’53.87’’
36	Dolma	30^{0}03’49.87’’	80^{0}19’03.78’’	79	Burphu	30^{0}21’59.22’’	80^{0}10’59.99’’
37	Timphu	30^{0}04’00.75’’	80^{0}19’01.14’’	80	Martoli	30^{0}20’52.98’’	80^{0}11’37.21’’
38	Tola	30^{0}20’09.17’’	80^{0}12’40.53’’	81	Dharikhet	30^{0}04’12.75’’	80^{0}19’14.86’’
39	Gaila	30^{0}04’33.33’’	80^{0}19’22.44’’	82	Old Rilkot	30^{0}19’11.28’’	80^{0}12’37.35’’
40	Golma	30^{0}03’12.86’’	80^{0}17’17.34’’	83	Rilkote	30^{0}18’34.84’’	80^{0}12’31.10’’

41	Chona	$30^0$03’46.56’’	$80^0$16’44.61’’	84	Sumatu	$30^0$18’07.19’’	$80^0$12’50.80’’
42	Narki	$30^0$04’12.22’’	$80^0$18’10.49’’	85	Laspa	$30^0$17’02.22’’	$80^0$12’53.40’’
43	Golpha	$30^0$02’09.22’’	$80^0$21’04.39’’				

VI. Impact of Anthropogenic Activities in Yarsa-Gambu and Himalayan Region

The residents of the higher Himalayan region of Gori Ganga watershed villagers (the most interior villages of district Pithoragarh) in Uttarakhand are extracting of Yarsa-Gambu. A large number of families depend on it for livelihood. That is the fact of anthropogenic activities going to be adverse for Yarsa-Gambu in the alpine and sub-alpine region of the watershed. Table 5 depicts were depending village name with relatedBugyals which is presenting in Figure 7. There is Panchachuli is the biggest dependency Bugyalof, about 21 villages then Milam Bugyal is second because there are about 11 villages that are directly dependent, and many other villagers have their seasonal house in Milam Village. A large number of tourists are traveling in Milam Glacier and Bugyals also. The example of herbal extraction in different Bugyals are presented in Plate 3; Plate 4 presented example of highly stressed on the environment in the alpine region, an example of heavy anthropogenic disturbances in the different alpine regions are presented in Plate 5 and example of developing many colonies by using plastic tents during collecting herbs in the different alpine zones of the Gori Ganga watershed is presented on Plate 6.

Table 5: Bugyals of dependent villages in the Gori Ganga watershed *(based on field survey)*.

S.N.	Bugyal	Villages depended on Bugyals
1	ChhiplaKedar	Baram, Kanar, Metali, Chami, Lumti, JaraJibli, Bangapani, Mavani, Darma, Seeling, Khartoli, Dharchula
2	Thalba	Sirtola, Ghangli, Sera
3	Charthi	Lodi, Ghangli, Tanga, Bata, MulyanPani, Bali Bagar, Bhikuriya, Seraghat, Alam, Dharchula
4	KhambaBagar	Golfa, Tanga, Dharchula, Bata
5	Satper	Golfa, Bona, Dharchula, Nirtoli
6	Kolgu	Golfa, Dharchula
7	Jimba	Bona, Tomik, Nirtoli
8	Panchachuli	Walthi, Madkote, Dunamani, Josha, Gandhinagar, Imla, Golma, Chona, Narki, Dobari, Waiga, Sana, Chulkote, Wadni, Okhli, Syalthing, Ringu, Dolma, Timphu, Dharikhet, Gaila,
9	NaginiDhoora	Basantkote, Bhatkura, Uchhaiti, Dhuratoli, Deelam, Kulthum,
10	Ralam	Buinee, Paton, Lang
11	Milam	Madkote, Dadabisa, Darati, Dhapa, Synnar, Suring, Ranth, Milam, Panchhu, large number Tourists,
12	SumatuDhoora	Sumatu, Milam, Tola, Burphu, Bilju
13	TolaDhoora	Tola, Ghanghar, Bilju, Sumatu, Burphu, Martoli
14	BurphuDhoora	Burphu, Bilju, Laspa, Sumatu, Tola
15	Bilju	Bilju, Laspa, Sumatu, Tola
16	Laspa	Laspa, Rilkote, Old Rilkote, Tola
17	Martoli	Martoli, Tola
18	Bhadeli	Quiry, Jimia, Sain, Polu, LariPyankti
19	Kauguri	Quiry, Jimia, Sain, Polu, LariPyankti, Synnar,

VII. ORIGIN OF PROBLEMS FROM HARVESTING YARSA-GAMBU

The increasing of population in Bugyal is the origin of problems in the alpine zones. People are creating too many disturbances in this region during the collecting of Yarsa-Gambu. Problems are as follows:

- Social relations between villagers and villages are spoiling because of its illegal trade and collection, and nobody applied government rule for harvesting Yarsa-Gambu.
- Population of those 85 villages in Table 3 is fully dependent on Yarsa-Gambu. They are moving from their traditional occupation of goat, sheep, and horse shepherding in Gori Ganga watershed.
- Large amount of population load in alpine region in the season time (May to July every year) is created so many disturbing like air temperature and ground pollution in

whole alpine and the sub-alpine region now the Bugyals are covered by any kind of mini to large plastic wastage. People used too many kinds of PaanMashala, candies, and biscuits, which is plastic coated cover and after use, they throw open earth surface. There are adversely impacting the growth of Yarsa-Gambu and the snow cover region.

Plate 3: Herbal species extraction in different Bugyals of the Gori Ganga watershed: (A) at CharthiBugyal in 2013 and (B) at PanchachuliBugyal in 2019.

Plate 4: Highly stressed on the environment in the alpine region in the Gori Ganga watershed: (A) at the KhambaBagarBugyal in 2013 and (B) at the CharthiBugyal in 2013.

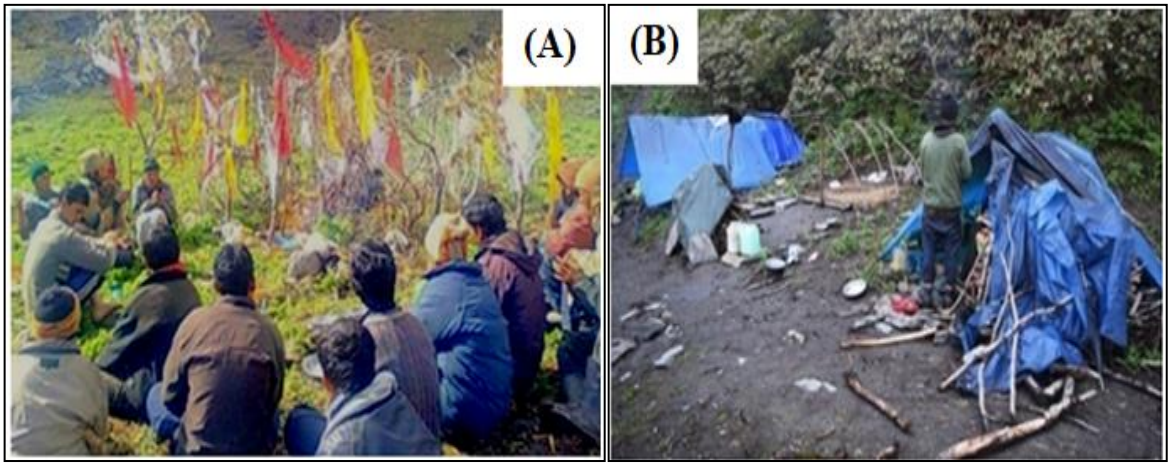

Plate 5: Heavy anthropogenic disturbances in the different alpine zones of the Gori Ganga watershed: (A) felling and burning of trees at the CharthiBugyal in 2013 and (B) felling trees and shrubs for making temporary shelter in the ThalbaBugyal in 2019.

Plate 6: Developing many colonies by using plastic tents during May to July/August every year for collecting herbs in the different alpine zones of the Gori Ganga watershed: (A) at JimbaBugyal in 2013, (B) at KhambaBagar in 2019.

- People are felling and burning of trees and shrubs for cooking and heating, including the open burning of biomass, forest and open area burning and firing the Bugyals region of Gori Ganga.
- Live larva survives on earth surface it is affected by a large number of a crowd because peoples are walking the whole region of Yarsa-Gambu and larva is going to die after collapsing under peoples foot. That is affected to production and extraction of Yarsa-Gambu.

VIII. RECOMMENDATIONS/SUGGESTIONS

The dependency of the rural communities is on Yarsa-Gambu and long-term availability such as precious resources. For continued harvesting of caterpillar fungus needs some sustainable management steps for conservation following aspects:

A. The sustainability of current collecting practices remains undocumented; however, ecological concerns include, among others, the impact of harvesting on caterpillar fungus reproduction in nature, the improper disposal of waste, and the removal of top soil during collection. Occasionally, deliberate fire is set to promote vegetation in spring, which ultimately kills both the host and fungal spores. Habitat destruction by the uprooting of grasses during foraging, break-down of immature Cordycepsstroma, and prevention of spore dispersal are the main issues while harvesting natural Cordyceps.

B. Moreover, proper harvesting plans, policies, adaptation, and their mitigation measures should be carefully planned, formulated, and strictly adopted for harvesting Cordyceps resources.

C. There is a dire need to formulate immediate plans and produce definite maps of potential areas for expansion of the caterpillar fungus, which may help to understand how harvesting areas cross social or cultural boundaries or various tenure regimes.

IX. CONCLUSIONS

Yarsa-Gambu is one of the rarest fungal species in the whole world, known as the mysterious "*Half-Caterpillar-Half-Mushroom*". This fungus was especially used from since ancient times to the present time for as various medicinal purposes in China and South Asian countries. Present study advocates that, there is a wide price gap in forest departments and outside funding agencies, so villagers are like to sell and supplied it is illegally. The social relations and customs are also affecting for the collection of Yarsa-Gambu. The villagers are not much aware of its conservation priorities. The economic boom is easily seen in villages where the villagers are collecting Yarsa-Gambu. The current Yaarsa-Gambu harvesting pressure on caterpillar fungus is unprecedented. There should be a proper understanding between collectors, forest departments, and other agencies for the proper harvesting and conservation of this species, while it is not extracted sustainably in a planned way in the study areas. Awareness and scientific knowledge are very necessary for the future prospects regarding conserving Yarsa-Gambu.

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