

# The Extraction of Forestry Resources for Household Food Security in Leh Himalaya, India

## Abstract

Food resources extracted from forestry landscapes enhance the quality of diets, improve health care, and ensure income diversification for local communities in developing countries. This paper explores the diversity, seasonality, distribution, mode of use, frequency of use, and reliance of forestry food resources on livelihoods in the Leh Himalaya. Data were collected from 185 sample families that were selected from five blocks and nine villages using a multi-stage random sampling procedure. Descriptive statistics were applied to the data analysis. Results revealed that 37 forestry food resources were harvested from 27 herbs, 3 shrubs, and 3 trees belonging to 28 genera and 19 families, and consumed as vegetables (15), fruits (5), dye or flavour (4), pot herb (4), salad (3), beverage (2), sauce (2), condiment (1), oil seeds (1), flatbread (1), sour (1), and *tantur* (1). Over 63.18% of sample households extracted and utilised all the forestry food resources extremely often for cash earnings and sustenance during the peak period. Forestry food resources constitute a key source of food, nutrition, health care, subsistence, cash income, and safety nets. This study gives insights to promote the conservation of forestry foods, develop management strategies that could be harmonised with rural development, poverty alleviation, food security, and livelihood sustainability for rural communities in Leh Himalaya, and accordingly design useful policy implications.

**Keywords:** Forestry resources, wild edibles, food security, livelihoods, Leh, Himalaya, India.

## 1. Introduction

The indigenous communities in the Leh area of Ladakh consume forestry resources to enhance the quality of their diets and sell or trade them to diversify household income [1]. The rural landscapes provide a rich and diverse wealth of nutritious forestry food resources, including vegetables, fruits, dyes or flavours, pot herbs, salads, beverages, sauces, condiments, oil seeds, sour, etc., that contribute to local diets [2]. The forestry food resources collected from forestry interventions in Leh are widely consumed by rural households to supplement and enrich their diets with vitamins, minerals, fats, starch, and other ingredients. Uses of forestry food resources as a diet supplement or as a coping mechanism in times of food shortages provide an important safety net for rural people. Forestry food resources are also an indispensable source of health care systems for poor people in rural areas. The consumption of these forestry foods reduces the risk of several ailments like diabetes, heart disease, cancer, neurodegenerative disorders, etc. [3]. Additionally, the collection of forestry food resources is a potential source of income for vulnerable people in rural areas. Although the share of forestry food income in total household income was low, poorer households experiencing shocks derived higher income shares from these food

### Comment [Ma1]: Strengths

**Clear Objective:** The abstract effectively outlines the objective of the study, which is to explore the diversity and usage of forestry food resources in the Leh Himalaya and their impact on local communities.

**Concise Results:** The abstract presents concise results, detailing the number of forestry food resources harvested and their various uses, providing readers with a quick understanding of the study's findings.

**Relevance:** The abstract highlights the significance of forestry food resources in enhancing food security, nutrition, and livelihoods, which is relevant to broader discussions on rural development and sustainability.

### Weaknesses

**Lack of Methodological Detail:** The abstract mentions the use of a multi-stage random sampling procedure but does not provide specific details on the methodology, making it difficult to assess the study's rigor.

**Vague Statistical Information:** The abstract refers to descriptive statistics without specifying the types of statistics used or the key findings from the analysis, limiting the clarity of the results.

**Insufficient Context:** There is limited context regarding the implications of the study's findings or how they contribute to the existing literature on forestry resources and food security.

### Suggestions

**Include Methodological Details:** Provide a brief description of the sampling process and data analysis methods to enhance the transparency and credibility of the study.

**Specify Key Findings:** Include specific quantitative findings or statistics to give readers a clearer understanding of the study's results and their significance.

**Highlight Implications:** Emphasize the potential implications of the study for policy and practice, particularly in the context of rural development and conservation strategies.

resources[4]. The urban markets carry forestry foods regularly, making it possible that those without easy access to forestry resources may be able to include them in their diets. Forestry foods are often sold unprocessed, although it has long been tradition to process them—especially fruits—to make value-added goods like beverages, jams, and other confections. Although forestry foods are collected primarily by women, they are consumed by both men and women across all age groups.

In order to provide affordable food for human consumption and livelihood subsistence, it is crucial to explore, document, preserve, and promote forestry food resources [5]. The benefits of these forestry food resources encourage us to use wise management strategies to protect these resources so that they can continue to be a sustainable source of food for future generations[6]. Developing forestry policies and management plans requires a thorough understanding of the food resources gathered from forestry plantations and the households who harvest them[7]. More information is specifically required on the extent to which forestry foods contribute to local diets and nutrition, as well as the identification of the households and communities that benefit most from these contributions. Knowledge of forestry food resources can help alleviate food insecurity and serve as an affordable alternative in developing plans for the rural poor's food security[8]. In recent times, the increasing dependence of rural populations on food resources derived from forestry has led to a surge in scientific curiosity among scholars, policymakers, and development professionals operating in developing nations. Despite this, empirical study on the traditional wisdom and people's reliance on forestry resources for food and nutrition security is scarce, with a few notable exceptions. In light of these facts, the purpose of this study was to compile vital data regarding the diversity, seasonality, distribution, mode of use, frequency of use, and reliance of forestry food resources on **livelihoods**.

## 2. Materials and Methods

### 2.1 Description of study area

Leh district (Fig. 1) is one of the coldest and highest inhabited regions in the world, with 112 inhabited villages and one uninhabited village at an altitude ranging from 2900 to 5900 metres[9]. With an area of 45110 sq. km, it is likely the largest district in the nation. The district is located at an elevation of between 2300 and 5000 metres above sea level, approximately between 32- and 36-degrees north latitude and 75- and 80-degrees east longitude. The district is bordered to the west by Pakistan-occupied Kashmir, to the east and north by China, and to the south by the Laquan Spite of Himachal Pradesh. The district is located 474 km from Manali (HP) and 434 miles from Srinagar. Geographically, the district is entirely mountainous, featuring three parallel Himalayan mountains. The district is divided into nine (9) blocks: Leh, Chuchot, Panamic, Saspol, Khru, Nyoma, Durbok, and Nubra. The Leh district is cut off from the rest of the nation for half of the year due to excessive early precipitation (snow) caused by its high altitude and geographic location. Since the Zojila and Rotang passes are closed due to severe winter

#### Comment [Ma2]: Strengths

**Comprehensive Overview:** The introduction provides a broad overview of the importance of forestry resources for indigenous communities in the Leh area, highlighting their role in diet enhancement, income diversification, and health care.

**Highlighting Benefits:** The text effectively outlines the multiple benefits of forestry food resources, including nutritional value, health benefits, and income generation for vulnerable populations.

**Emphasis on Sustainability:** The introduction underscores the need for sustainable management and conservation of forestry resources, which aligns well with global priorities for environmental and food security.

**Identifies Knowledge Gaps:** The introduction acknowledges the lack of empirical studies on the subject, which sets the stage for the study and highlights its relevance and necessity.

#### Weaknesses

**Lack of Specificity:** While the introduction discusses the importance of forestry resources, it lacks specificity regarding the types of forestry interventions and the specific communities involved in the study area.

**Redundancy:** Some points are repeated, such as the health benefits of forestry resources and their role in income generation, which could be streamlined to enhance readability.

**Lack of Structure:** The introduction could benefit from a clearer structure and organization, as it currently presents information in a somewhat scattered manner.

**Insufficient Context:** The introduction provides limited context regarding the broader socio-economic and environmental challenges faced by the indigenous communities in the Leh area, which are crucial for understanding the study's significance.

**Weak Link to Study Objectives:** The transition from the background information to the study objectives is weak, making it difficult for the reader to understand how the study aims to address the identified gaps.

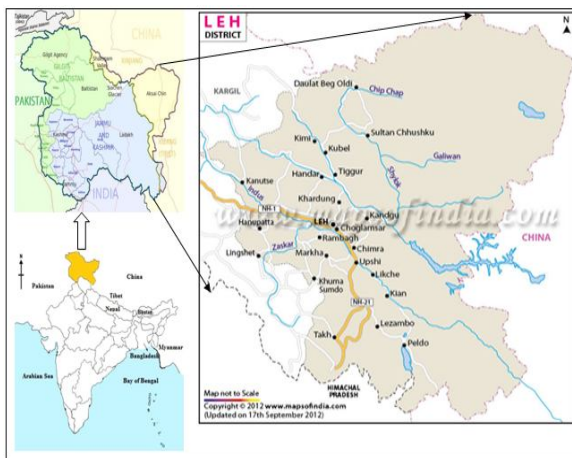
#### Suggestions

**Increase Specificity:** Provide more specific details about the types of forestry interventions and the particular indigenous communities involved in the study to enhance the introduction's relevance and clarity.

**Streamline Content:** Eliminate redundant points and organize the introduction more logically, moving from general background information to the specific research problem and objectives.

... [1]

snowfall, the area continues to be inaccessible from both Srinagar and Himachal Pradesh. The human population of Leh district is 117232 [10]. The density of population is 3 people per sq. km. One of the areas on Earth with the lowest population density is the Leh district. The population is divided into 76.70% rural areas and roughly 23.30% semi-urban areas. The working population is mostly employed in domestic industry, employment in agriculture, and other occupations. The district's principal development organization was established in September 1995 and is known as the Ladakh Autonomous Hill Development Council.



**Fig. 1.** Location map of the study area

## 2.2 Sampling technique and Sample

The present study was conducted in the Leh district of Ladakh Union Territory. A multi-stage random sampling technique [11] was used to select the villages and the respondents. The first stage was the random sampling of five (5) blocks, namely, Leh, NyomaChochot, Panamic, and Khaltsi of Leh district. The second stage involved random sampling of ten (10) villages, viz., Saboo from Leh Block, Chumathang and Mud from Nyoma Block, Stakna and Nang from Chochot Block, Lakjung and Panamic from Panamic Block, and Dha, Lamayuru, and Nurla from Khaltsi Block. In the third stage, a total of 185 households were selected from the sample villages with a 15 percent sampling intensity employing a simple random sampling technique for the field study. The respondents interviewed were either household heads or eldest members. The summary of the sample selection process is given in the flow chart, as detailed below in Fig. 2.

**Comment [Ma3]:** Short Comment on Strengths, Weaknesses, and Suggestions

### Strengths

**Comprehensive Geographic Overview:** The introduction provides a detailed description of the geographic, climatic, and demographic characteristics of the Leh district, which sets a clear context for the study.

**Relevance to the Study:** By highlighting the unique geographical and climatic conditions of Leh, the introduction effectively explains the challenges and opportunities for forestry resource utilization in this region.

**Inclusion of Socioeconomic Factors:** The discussion of the district's population density, rural-urban distribution, and employment patterns adds depth to the introduction, linking the geographic and climatic context to the socioeconomic realities of the inhabitants.

### Weaknesses

**Repetitive Information:** Some information, such as the elevation range and geographic location of the district, is repeated unnecessarily, which can make the text less engaging and more difficult to read.

**Lack of Connection to Research Objective:** The introduction could more explicitly connect the geographic and demographic information to the specific research objective of the study, which is to explore forestry resource utilization for food security and livelihoods.

**Absence of Current Data:** The demographic data cited (e.g., population numbers) may not be up-to-date, which could affect the relevance and accuracy of the information provided.

### Suggestions

**Streamline Content:** Remove repetitive elements and focus on presenting the information in a concise and engaging manner. For example, the elevation range and geographic location could be combined into a single sentence.

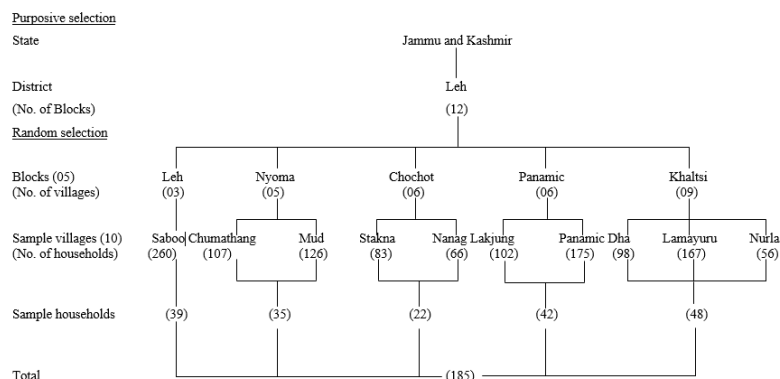
**Example:** "Leh district, one of the coldest and highest inhabited regions globally, spans an elevation of 2900 to 5900 meters, between 32-36°N latitude and 75-80°E longitude."

**Strengthen the Connection to Research Objectives:** Clearly link the geographic and demographic details to the study's focus on forestry resources and their impact on local livelihoods.

**Example:** "Given its challenging climatic conditions and low population density, understanding the role of forestry resources in the Leh district is crucial for developing sustainable livelihood strategies."

**Update Data Sources:** Ensure that all demographic and geographic data are current and accurately referenced, enhancing the credibility of the manuscript.

... [2]



**Fig. 2.** Sampling procedure

### 2.3 Data collection

The current study used both qualitative and quantitative methodologies to accomplish its research goals. Primary field surveys as well as secondary sources were used to gather data. Structured interviews with specific respondents and non-participant observations were utilized as primary sources [12]. Secondary sources included documentation from several governmental and non-governmental organizations, literature from journals, records from the forest department, records from the village, the internet, earlier studies, annual reports, and other relevant materials. The primary data were collected at the household level, whereas the secondary data were collected at the block, village, and household/individual level.

#### 2.3.1 Structured interview

The primary data were collected through the personal interviews of the respondents through a well-structured, pre-tested interview schedule at the household level. The interview schedule for the household survey was prepared on the basis of the literature referred to, a reconnaissance survey of the study area, discussion with local people, and consultation with the experts. The interview schedule so prepared was employed to collect information on forestry food resources, including species name, family, vernacular name, common name, plant habit, parts used, mode of use, frequency of use, seasonality, and livelihood importance. The data, thus generated through these approaches, was used in exploring the reliance on forestry resources for food and nutrition security among the rural communities to put forth strategies to keep pace with current development and future challenges in the locality.

#### 2.3.2 Non-participant observation

The basis for the qualitative analysis was firsthand observation and conversation with the respondents. The use of this technique made it possible to interact with the respondents directly, observe their behaviour in a realistic setting, and research the situation-based characteristics of behaviour.

### 2.4 Data analysis

To summarize the forestry resources that were extracted for food security, data pertaining to the species name, family, parts used, frequency of use, seasonality, livelihood importance and mode of use were recorded. We used simple descriptive statistics like frequency (f), percentage (%), average (x), standard error, and range to analyze the data [13]. The numerical data and text information were presented either as tables or graphs.

### 3. Results

The food plants constituted 33 (19.76%) species of the total useful forestry plant flora belonging to 28 genera and 19 families, mostly extracted and consumed for food and livelihood security (Table 1). Among food plants, vegetables comprised 15 (37.50%), fruit 5 (12.50%), dye or flavor 4 (10.0%), pot herb 4 (10%), salad 3 (7.50%), beverage 2 (5.0%), *chutney* (sauce) 2 (5.0%), condiment 1 (2.50%), oil seeds 1 (2.50%), *paratha* (flatbread) 1 (2.50%), sour 1 (2.50%), and *tantur* (local dish) 1 (2.50%) (Table 2). All the forestry food resources were extracted and consumed by over 63.18% of sample households very frequently for subsistence and cash income during the peak period (Table 2). The plant parts consumed as food were leaves (11), whole plants (10), shoots (8), fruits (4), flowers (3), and oilseed (1) (Fig. 3). Among food plants, the maximum (27) species were herbs, while shrubs and trees comprised 3 species each (Fig. 4). The family Asteraceae (6) had the highest representation, followed by Polygonaceae (4), Chenopodiaceae (3), Lamiaceae (3), Rosaceae (2), Brassicaceae (2), Amaranthaceae (1), Amaryllidaceae (1), Boraginaceae (1), Braericeae (1), Capparidaceae (1), Crassulaceae (1), Elaeagnaceae (1), Ephedraceae (1), Gentianaceae (1), Liliaceae (1), Orobanchaceae (1), Salicaceae (1) and Urticaceae (1) (Fig. 5).

**Table 1.a:** Extraction of Forestry resources for food security in the sample households (N=185)

Species	Family	Local name	Part used	Mode of use
<i>Allium humile</i> Schrenk.	Amaryllidaceae	Skotche	Whole plants	Plants fresh as well as dried are used as condiment.
<i>Amaranthus spinosus</i> Willd.	Amaranthaceae	Chulai	Tender shoots/leaves	Used as vegetable. Young leaves dried and stored for winter.
<i>Anaohalistriplinervis (sims)</i> Clark var.	Asteraceae	Yakto	Buds	Young buds are edible, generally eaten by children as salads.
<i>Anaphalistriplinervis</i> Clarke var.	Asteraceae	Yakto	Young buds	Edible as vegetable, usually the buds are eaten as salad.
<i>Arnabtaguttata</i> Bunge.	Boraginaceae	Demok	Roots	Roots yields edible fat-soluble red dye which is used by locals for coloring dishes.
<i>Capparis spinosa</i> Linn.	Capparidaceae	Kabra	Leaves	Flowers- edible. Young leaves are eaten as vegetable.
<i>Capsellaelcptica</i> C.A.M.	Braericeae	Shangshoo	Whole plant	The tender leaves are generally plucked during early summer and cooked as vegetable.
<i>Chenopodium glaucum</i> Linn.	Chenopodiaceae	Kupaid	Leaves	Leaves are eaten as a potherb.
<i>Chenopodium album</i> Linn.	Chenopodiaceae	Neung	Whole plants	The whole herbs are properly boiled and used as vegetable. Also used for making paratha (flatbread) etc. either fresh or dehydrated for prolong winter use by locals.
<i>Chenopodiumfoliosum</i> Asch.	Chenopodiaceae	Sangsti	Young leaves/	The young leaves and tender shoots are used as potherb by the locals.

**Comment [Ma4]:** Short Comment on Strengths, Weaknesses, and Suggestions

**Strengths**  
**Comprehensive Methodology:** The study employs a robust combination of qualitative and quantitative methods, including structured interviews and non-participant observations, which enhances the reliability and depth of the data collected.

**Diverse Data Sources:** Utilizing both primary data (e.g., interviews, observations) and secondary data (e.g., governmental records, literature) provides a well-rounded view of the forestry resources and their impact on livelihoods.

**Detailed Data Collection:** The structured interview schedule covers various aspects of forestry resources, including species, usage, and seasonality, allowing for a thorough exploration of their role in food security and livelihoods.

**Clear Data Analysis Methods:** The use of descriptive statistics to summarize the data ensures clarity and provides a straightforward interpretation of the results.

**Weaknesses**

**Lack of Detail on Sampling:** The methodology does not specify how respondents were selected for interviews or observations, which could impact the representativeness and reliability of the data.

**Insufficient Description of Observation Method:** The non-participant observation section lacks detail on how observations were conducted and recorded, which may affect the transparency and replicability of the qualitative analysis.

**Limited Explanation of Data Integration:** The process of integrating qualitative and quantitative data into a cohesive analysis is not well explained, which may hinder the understanding of how the data types complement each other.

**Suggestions**

**Clarify Sampling Procedures:** Provide more information on the sampling methods used for selecting respondents and observations, including any criteria or randomization techniques employed.

**Example:** "Respondents for structured interviews were selected using a stratified random sampling method to ensure representation from different demographic groups within the study area."  
**Detail Observation Techniques:** Elaborate on the non-participant observation methods, including how observations were documented and any criteria used to guide the observations.

**Example:** "Non-participant observations were systematically recorded using field notes, focusing on specific behaviors related to the use of forestry resources."

**Explain Data Integration:** Describe how qualitative observations and quantitative data were integrated and analyzed together to draw conclusions. ... [3]

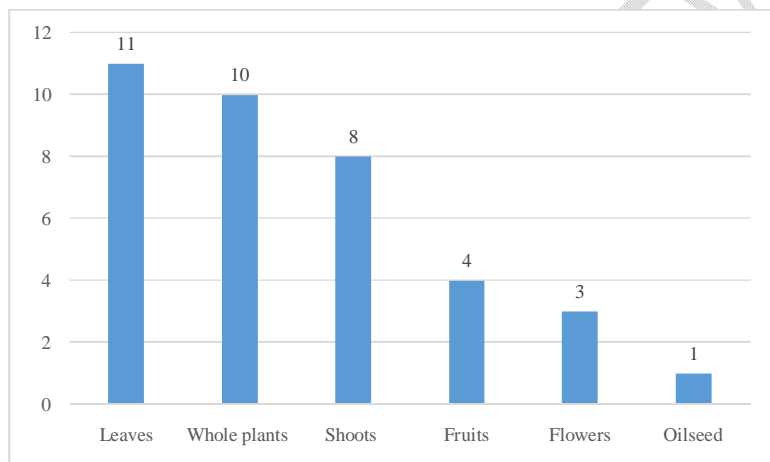
<i>Christoleacrassifolia</i> Camb.	Brassicaceae	Sanak	tender shoots Shoots	The tender shoots are consumed as vegetable by the local.
<i>Elshotzjadensa</i> Benth.	Lamiaceae	Philongtso	Leaves	The tender leaves are eaten as raw or after making <i>chutney</i> (sauce) or flavors in local dishes.
<i>Ephedra gerardiana</i> Wall.ex.stapf.	Ephedraceae	Chappat	Fruits	Fruits-edible
<i>Eremurushimalaicus</i> Baker.	Liliaceae	Nyamgtso	Young flowers	Young flower buds are edible.
<i>Erigeron multiradiatus</i> Benth.	Asteraceae	Durang-phang	Whole plants	Leaves and the tender shoots are eaten as potherb.

**Table 1.b:**Extraction of Forestry resources for food security in the sample households (N=185)

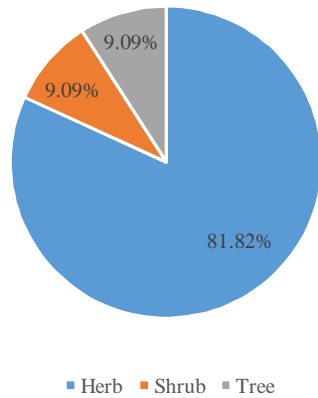
Species	Family	Local name	Part used	Mode of use
<i>Erigeron multiradiatus</i> Benth.	Asteraceae	Phang	Leaves	Leaves are cooked as a vegetable.
<i>Fagopyrumtataricum</i> Linn.)Gaertn.	Polygonaceae	Dayat	Whole plants	Dried leaves are eaten as vegetable.
<i>Fagopyrumtataricum</i> Linn.	Polygonaceae	Dayat	Leaves	The leaves are consumed as vegetable after drying.
<i>Gentiana humilis</i> Steven ex Bunge.	Gentianaceae	Nylo	Whole plants	Young flowers/ buds are edible.
<i>Hippophaerhamnoides</i> Linn.	Elaeagnaceae	Tesmarma	Fruits, seeds/ leaves	Fruits are edible. Popular Leh berry juice is extracted from fruit pulps.
<i>Lactucascariola</i> Linn.	Asteraceae	Khala	Whole plant	Young plants are eaten as vegetable.
<i>Lepidiumlatifolium</i> Royle.	Brassicaceae	Gyerdut	Young Leaves	Young leaves are used as salad.
<i>Malus x domestica</i> Borkh	Rosaceae	Kushoo	Fruit	Fruit-edible.
<i>Nepatalongibracteata</i> Benth	Lamiaceae	Prianku	Whole plants	Aromatic oil of strong fragrance is extracted from the species and used by the local <i>amchi</i> (medicinal practitioners).
<i>Nepetafloccosa</i> Benth.	Lamiaceae	Shamalo	Leaves/ shoots	The dried leaves and shoots are aromatic and used to add flavor in local dishes.
<i>Orobanchaehansii</i> A.Kern	Orobanchacea	Broom-Rape	Shoots	The tender shoots are used in making soup.
<i>Polygonumaviculare</i> Linn.	Polygonaceae	Chhiankar	Leaves	The tender leaves are cooked as pot herb.
<i>Prunusarmeniaca</i> L.	Rosaceae	Chule	Fruits	Fruits/ oil seeds- edible.
<i>Reheumtibeticum</i> Maxim.ex Hk.f.	Polygonaceae	Lachu	leaves	Small leaf stalk contains vitamin C and is eaten raw.
<i>Rhodiola heterodonta</i> Boiss	Crassulaceae	Shrolo	Leaves	The tender parts are to make a local delicious dish <i>Tantur</i> .
<i>Salix daphnoides</i> Vill.	Salicaceae	Shoa	Leaves	The tree leaves are used to make local tea.
<i>Taraxacum officinale</i> Wiggers.	Asteraceae	Han	Whole plants	Very nutritious wild edible plant used as vegetable in far flung areas.
<i>Urticahyperborea</i> Jacq. ex, Wedd.	Urticaceae	Zazot	Whole plants	Young leaves are dried and cooked as vegetable during winter.
<i>Elaeaganus angustifolia</i> L.	Elagenaeeae	Sersing	Fruit	Fruit- edible.

**Table 2:** Consumption status, frequency of use, livelihood significance and seasonality of forestry food resources in the sample households (N=185)

Forestry resource	food type (%)	Households consuming (%)	No. of species consumed (%)	Frequency of use	Livelihood significance	Seasonality (Peak/ lean)
Vegetables	185 (100.00)	15 (37.50%)	Very frequently	Subsistence, cash income	Peak, lean	
Fruits	185 (100.00)	5 (12.50%)	Very frequently	Subsistence, cash income	Peak	
Dye or flavour	122 (65.94)	4 (10.0%)	Frequently	Subsistence	Peak, lean	
Pot herb	135 (72.97)	4 (10%)	Frequently	Subsistence, cash income	Peak	
Salad	141 (76.21)	3 (7.50%)	Frequently	Subsistence, cash income	Peak	
Beverage	163 (88.11)	2 (5.0%)	Frequently	Subsistence	Peak, lean	
Chutney (sauce)	152 (82.16)	2 (5.0%)	Frequently	Subsistence	Peak	
Condiment	145 (78.37)	1 (2.50%)	Frequently	Subsistence, cash income	Peak, lean	
Oil seeds	126 (68.11)	1 (2.50%)	Occasionally	Subsistence, cash income	Peak, lean	
Paratha (flatbread)	118 (63.18)	1 (2.50%)	Occasionally	Subsistence	Peak, lean	
Sour	137 (74.05)	1 (2.50%)	Occasionally	Subsistence	Peak, lean	
Tanur (local dish)	129 (69.73)	1 (2.50%)	Occasionally	Subsistence	Peak, lean	



**Fig. 3.** Plant parts used as forestry food resources



**Fig. 4.** Life forms of forestry food resources



**Fig. 5.** Family-wise distribution of forestry food resources

#### 4. Discussion

The diversity of edible forestry resources consumed reflected the rich biodiversity of the rural landscape. Edible forestry resources form the main component of the food basket of the local people in the district. Food security is an acute concern for most families in the district; hence, all families in the villages collect and consume a great variety of forestry food resources on a regular basis. Forestry food resources (Fig. 6) contribute in two ways to food security, i.e., direct consumption of forestry food resources next to grains and selling the resources to buy grains in times of shortage [14]. Although the diet of the poor local people is seriously deficient in carbohydrates, protein, fats, sugar, vitamins, minerals, etc., forestry food resources are important sources for meeting their daily diet

**Comment [Ma5]:** Short Comment on Strengths, Weaknesses, and Suggestions

**Strengths**  
**Detailed Data Presentation:** The results provide a comprehensive breakdown of the various food plants, including their species, family, parts used, and modes of use. This detailed presentation offers valuable insights into the diversity and applications of forestry resources.

**Clear Statistical Summary:** The use of tables and figures to summarize the frequency of use, livelihood significance, and seasonality of different food resources enhances the clarity and accessibility of the data.

**Thorough Documentation:** The inclusion of specific examples and data on plant parts used and their functions demonstrates a thorough documentation of how forestry resources contribute to local diets and livelihoods.

**Weaknesses**  
**Lack of Contextual Analysis:** The results section provides data but lacks an in-depth analysis of how these findings relate to broader issues like food security, sustainability, or local cultural practices.

**Potential Data Overlap:** There is some redundancy in presenting similar data across multiple tables and figures, which might make it difficult to integrate the findings into a cohesive narrative.

**Insufficient Explanation of Seasonal Variations:** While seasonality is mentioned, there is limited explanation about how seasonal changes affect the availability and consumption of these resources.

**Suggestions**  
**Enhance Contextual Analysis:** Provide a discussion on how the findings relate to broader themes such as food security, livelihood sustainability, and environmental impacts. This will help to frame the data within a larger context.

**Example:** "Discuss how the seasonal variations in food resource availability impact household food security and income stability."

**Streamline Data Presentation:** Consider consolidating similar data from tables and figures to reduce redundancy and enhance the readability of the results.

**Example:** "Combine overlapping data points from multiple tables into a single summary table to avoid repetition and improve clarity."

**Expand on Seasonal Impact:** Offer a more detailed analysis of how the seasonal availability of food resources influences their usage and importance in different periods.

**Example:** "Elaborate on how the peak and lean seasons affect the accessibility of different food resources and their role in household diets and income."

requirements. Although the largest proportion of forestry food resources are consumed at home, low income and meagre returns from farm products have compelled many families to trade some parts of the edible forestry products in the local daily markets. The market value of edible forestry products is not regulated, and vendors generally get trivial earnings not remunerative to their labour used. The sale of forestry food resources contributes considerable cash income to the household annual income, which is mostly used to buy grains; the products are therefore the most important safety net or key coping strategy to combat food shortages. Forest foods have gained global attention due to their contribution to household livelihoods, food security, poverty reduction, and biodiversity conservation [15, 7]. Forestry food resources fulfil the health and nutritional needs of about 80% of the population of developing countries [16]. Overall, edible forestry resources are an indispensable source of diet, food, nutrition, health care, and livelihood in different parts of the world [17]. The diversity of edible forestry food resources offers variety in diets and contributes to household food security [18]. Some edible forestry food products are even reported to be more nutritious than conventionally eaten crops [19]. Besides food and nutrition, the utilization of edible forestry food products as coping strategies during scarcity is prevalent, particularly in developing countries where food insecurity is acute [20].



6.a. Collection of Sea buckthorn fruits



6.b. Beverage processing from Sea buckthorn fruits



6.c. Local woman selling dried wild vegetables



6.d. *Capsella elliptica* (Shangshoo) consumed as vegetable

**Fig. 6.** Forestry food resources of rural communities in **Leh**

## 5. Conclusion

The extraction of forestry resources is a vital source of food, financial income, sustenance, and a safety net for the rural residents of Leh Himalaya. To satisfy rural residents' dietary demands, the vast portion of foods produced by forestry landscapes are consumed for subsistence, with very little being sold for profit. Besides this, forestry food resources are also consumed by the local people as herbal medicine for health care. The supply of forestry foods is expected to decrease in the near future due to current unsustainable extraction, increased market demand on forestry food resources, loss of forestry landscapes from conversion to agriculture, and rapid population growth. Therefore, maintaining a pace with present growth and addressing future difficulties requires the sustainable management of forestry resources and conservation through forestry access regulation. The monetary revenue generated is substantial to support household livelihoods, even though the economic value of forestry foods is not comparable to the labours expended in the endeavor. Therefore, future interventions that can offset conservation efforts and encourage livelihood diversification for the poorest people include value-adding of economically and culturally significant forestry food resources and entrepreneurship in micro-enterprises of forestry food products. The present findings on forestry food resources and rural food security linkage suggest that forestry food resources should be given due focus in policy implications to harmonize food security, livelihood improvement, and poverty alleviation, besides forestry conservation in the Leh Himalaya.

## References

1. Fatima S, Bhat GM, Islam MA, Rather TA, Rashid M, Dar MUD. Traditional agroforestry systems practiced in Leh district of Ladakh union territory, India. *The Pharma Innovation Journal*, 2022;SP-11(9):2946-2952.
2. Bhat GM, Fatima S, Masoodi TH, Islam MA, Rather TA, Pala NA, Rashid M, Dar MUD. Livelihood dependency on agroforestry systems in the Trans Himalayan region of Ladakh. *Indian Journal of Agroforestry*. 2022;24(2):103-110.
3. Shah Khan FA, Islam MA, Gangoo SA, Gattoo AA, Mughal AH, Maqbool S, Atta U. Health care and livelihood support through medicinal plants in indigenous communities of Leh district in Ladakh. *Journal of Pharmacognosy and Phytochemistry*, 2018;7(6):1888-1893.
4. Malik AR, Namgyal D, Bhat GM, Sofi PA, Islam MA, Baba JA, Mugloo JA. Integrated approach of sustainable agroforestry development in cold arid deserts region of Indian Himalaya. In: Kumar, M, Pala, N.A. and Bhat, JA. (eds), *Diversity and Dynamics in Forest Ecosystems*, Apple Academic Press Inc., Palm Bay, USA, 2022;195-214.

### Comment [Ma6]: Short Comment on Strengths, Weaknesses, and Suggestions

#### Strengths

**Comprehensive Overview:** The section effectively highlights the importance of edible forestry resources in maintaining food security and meeting nutritional needs, particularly in the context of food shortages and low income.

**Clear Connection to Food Security:** It clearly establishes the dual role of forestry resources in both direct consumption and as a means to generate income, contributing significantly to household food security.

**Global and Local Relevance:** The discussion links local practices to broader global issues, emphasizing the role of forestry foods in poverty reduction, biodiversity conservation, and nutritional health.

#### Weaknesses

**Limited Detail on Nutritional Impact:** While the text mentions that forestry foods help meet daily diet requirements, it lacks specific details on how these foods compare nutritionally to other food sources.

**Insufficient Economic Analysis:** There is a brief mention of the low market value of these products, but there is no in-depth analysis of the economic impact on households or how it influences their overall food security.

**Lack of Specific Examples:** The section could benefit from more detailed examples or case studies illustrating how specific forestry resources are used and their impact on local diets and economies.

#### Suggestions

**Expand on Nutritional Benefits:** Provide more detailed information on the nutritional composition of key forestry food resources and how they address deficiencies in local diets.

**Example:** "Include data or studies comparing the nutritional value of forestry foods to conventional crops to highlight their contribution to addressing dietary deficiencies."

**Incorporate Economic Analysis:** Offer a more detailed examination of the economic implications of selling forestry food resources, including potential income generation and its impact on food security.

**Example:** "Analyze how the income from selling forestry products influences household purchasing power and access to other food items."

**Add Case Studies or Examples:** Include specific examples or case studies of how particular forestry foods are utilized in the community and their effects on food security and livelihoods.

**Example:** "Provide case studies showing how different forestry resources are processed and marketed, and their role in local food systems." By addressing these points, the section can provide a more detailed and nuanced understanding ... [5]

5. Abdullah MR, Rahman MM, Hossain HA, Jalil MA. Diversity of minor fruit species in two tribal communities of Sadarupazila, Khagrachari. Bangladesh. *International Journal of Forestry, Ecology and Environment*, 2020;1(2):28-34. DOI: <https://doi.org/10.18801/ijfee.010220.04>.
6. Biswas SC, Majumdar M, Das S, Misra TK. Diversity of wild edible minor fruits used by the ethnic communities of Tripura, India. *Indian Journal of Traditional Knowledge*, 2018;17(2):282-289.
7. Steel EA, Bwembelo L, Mulani A, Siamutondo ALM, Banda P, Gumbo D, Moombe K, Ickowitz A. Wild foods from forests: Quantities collected across Zambia. *People and Nature*, 2022;4:1159–1175. DOI: <https://doi.org/10.1002/pan3.10367>
8. Ickowitz A, Bwembelo L, Mulani A, Siamutondo ALM, Banda P, Gumbo D, Moombe K, Steel EA. Collection and consumption of wild forest fruits in Zambia. *InfoBrief* Published by CIFOR and FAO, 2021. Retrieved from <http://www.fao.org/3/cb4724en/cb4724en.pdf>
9. Anonymous. Directorate of Economics and Statistics, District Statistics and Evaluation Office, Leh, Jammu and Kashmir, 2011.
10. Census of India, A - 5 State Primary Census Abstract – 2011, Government of India, 2011.
11. Ray GL, Mondol S. *Research Methods in Social Sciences and Extension Education*. Kalyani Publishers, New Delhi, 2011;66-76.
12. Mangal SK, Mangal S. *Research Methodology in Behavioural Science*. PHI Learning Private Limited. Delhi, India, 2020.
13. Snedecor GW, Cochran WG. *Statistical Methods*. Iowa State University Press, Ames, Iowa-50010, 1967.
14. Islam MA, Quli SMS. Non-timber forest products (NTFPs) supporting food security in tribal Jharkhand. *Jharkhand Journal of Development and Management Studies*, 2016;14(1):6855-6864.
15. Islam MA, Ali A, Ansari AM. The dependence of tribal livelihoods on forest fruits in rural Jharkhand, India. *Journal of Experimental Biology and Agricultural Sciences*, 2020;8(5):576–585. DOI: [http://dx.doi.org/10.18006/2020.8\(5\).576.585](http://dx.doi.org/10.18006/2020.8(5).576.585)
16. Nweze NJ, Igbokwe EM. Non-timber forest products in rural economies of Southern Nigeria. *Journal of Non-Timber Forest Products*, 2000;7(3/4):145-155.
17. Hazarika TK, Marak S. Wild edible fruits of Meghalaya, North-East India: an unexplored potential for nutritional security and economic prosperity. *Acta Horticulture*, 2019;1241(104):717-727. DOI: <https://doi.org/10.17660/ActaHortic.2019.1241.104>.
18. Muzaffer M, Lutfi B, Ugur C. Survey of wild food plants for human consumption in villages of Catak (Van-Turkey). *Indian Journal of Traditional Knowledge*, 2016;15(2):183-191.

19. Slathia PS, Paul N, Gupta SK, Sharma BC, Kumar R, Kher SK. Traditional uses of under-utilized tree species in sub-tropical rainfed areas of Kathua, Jammu & Kashmir. *Indian Journal of Traditional Knowledge*, 2017;16(1):164-169.
20. Zulu D, Ellis RH, Culham A. Collection, consumption, and sale of lusala (*Dioscorea hirtiflora*)—A wild yam—By rural households in Southern Province, Zambia. *Ethnic Botany*, 2019;73:47–63.

UNDER PEER REVIEW

## Strengths

**Comprehensive Overview:** The introduction provides a broad overview of the importance of forestry resources for indigenous communities in the Leh area, highlighting their role in diet enhancement, income diversification, and health care.

**Highlighting Benefits:** The text effectively outlines the multiple benefits of forestry food resources, including nutritional value, health benefits, and income generation for vulnerable populations.

**Emphasis on Sustainability:** The introduction underscores the need for sustainable management and conservation of forestry resources, which aligns well with global priorities for environmental and food security.

**Identifies Knowledge Gaps:** The introduction acknowledges the lack of empirical studies on the subject, which sets the stage for the study and highlights its relevance and necessity.

## Weaknesses

**Lack of Specificity:** While the introduction discusses the importance of forestry resources, it lacks specificity regarding the types of forestry interventions and the specific communities involved in the study area.

**Redundancy:** Some points are repeated, such as the health benefits of forestry resources and their role in income generation, which could be streamlined to enhance readability.

**Lack of Structure:** The introduction could benefit from a clearer structure and organization, as it currently presents information in a somewhat scattered manner.

**Insufficient Context:** The introduction provides limited context regarding the broader socio-economic and environmental challenges faced by the indigenous communities in the Leh area, which are crucial for understanding the study's significance.

**Weak Link to Study Objectives:** The transition from the background information to the study objectives is weak, making it difficult for the reader to understand how the study aims to address the identified gaps.

## Suggestions

**Increase Specificity:** Provide more specific details about the types of forestry interventions and the particular

**Streamline Content:** Eliminate redundant points and organize the introduction more logically, moving from general background information to the specific research problem and objectives.

**Provide Context:** Include more context regarding the socio-economic and environmental challenges faced by the communities in the Leh area to highlight the study's importance and relevance.

**Strengthen Transition:** Improve the transition between the background information and the study objectives by clearly articulating how the study addresses the identified gaps and contributes to the existing literature.

**Highlight Study Objectives:** Clearly state the study's objectives and research questions, making it easier for readers to understand the study's focus and scope.

**Incorporate Recent References:** Update the introduction with recent studies and references to reflect the current state of knowledge in the field and to emphasize the novelty of the research.

**Use Clear and Concise Language:** Ensure the language used in the introduction is clear and concise to facilitate better understanding and engagement from the reader.

By addressing these suggestions, the introduction can provide a stronger foundation for the study, enhancing its clarity, relevance, and impact on the scientific community.

Page 3: [2] Comment [Ma3]

Microsoft account

8/13/2024 3:22:00 PM

Short Comment on Strengths, Weaknesses, and Suggestions

Strengths

**Comprehensive Geographic Overview:** The introduction provides a detailed description of the geographic, climatic, and demographic characteristics of the Leh district, which sets a clear context for the study.

**Relevance to the Study:** By highlighting the unique geographical and climatic conditions of Leh, the introduction effectively explains the challenges and opportunities for forestry resource utilization in this region.

**Inclusion of Socioeconomic Factors:** The discussion of the district's population density, rural-urban distribution, and employment patterns adds depth to the introduction, linking the geographic and climatic context to the socioeconomic realities of the inhabitants.

## Weaknesses

**Repetitive Information:** Some information, such as the elevation range and geographic location of the district, is repeated unnecessarily, which can make the text less engaging and more difficult to read.

**Lack of Connection to Research Objective:** The introduction could more explicitly connect the geographic and demographic information to the specific research objective of the study, which is to explore forestry resource utilization for food security and livelihoods.

**Absence of Current Data:** The demographic data cited (e.g., population numbers) may not be up-to-date, which could affect the relevance and accuracy of the information provided.

## Suggestions

**Streamline Content:** Remove repetitive elements and focus on presenting the information in a concise and engaging manner. For example, the elevation range and geographic location could be combined into a single sentence.

**Example:** "Leh district, one of the coldest and highest inhabited regions globally, spans an elevation of 2900 to 5900 meters, between 32-36°N latitude and 75-80°E longitude."

**Strengthen the Connection to Research Objectives:** Clearly link the geographic and demographic details to the study's focus on forestry resources and their impact on local livelihoods.

**Example:** "Given its challenging climatic conditions and low population density, understanding the role of forestry resources in the Leh district is crucial for developing sustainable livelihood strategies."

**Update Data Sources:** Ensure that all demographic and geographic data are current and accurately referenced, enhancing the credibility of the manuscript.

**Incorporate a Visual Element:** Consider including a map or figure of the Leh district to visually support the descriptive text and provide readers with a clearer understanding of the region's geography.

By addressing these points, the introduction can provide a stronger foundation for the study and better engage readers in the research's significance.

**Comprehensive Methodology:** The study employs a robust combination of qualitative and quantitative methods, including structured interviews and non-participant observations, which enhances the reliability and depth of the data collected.

**Diverse Data Sources:** Utilizing both primary data (e.g., interviews, observations) and secondary data (e.g., governmental records, literature) provides a well-rounded view of the forestry resources and their impact on livelihoods.

**Detailed Data Collection:** The structured interview schedule covers various aspects of forestry resources, including species, usage, and seasonality, allowing for a thorough exploration of their role in food security and livelihoods.

**Clear Data Analysis Methods:** The use of descriptive statistics to summarize the data ensures clarity and provides a straightforward interpretation of the results.

## Weaknesses

**Lack of Detail on Sampling:** The methodology does not specify how respondents were selected for interviews or observations, which could impact the representativeness and reliability of the data.

**Insufficient Description of Observation Method:** The non-participant observation section lacks detail on how observations were conducted and recorded, which may affect the transparency and replicability of the qualitative analysis.

**Limited Explanation of Data Integration:** The process of integrating qualitative and quantitative data into a cohesive analysis is not well explained, which may hinder the understanding of how the data types complement each other.

## Suggestions

**Clarify Sampling Procedures:** Provide more information on the sampling methods used for selecting respondents and observations, including any criteria or randomization techniques employed.

**Example:** "Respondents for structured interviews were selected using a stratified random sampling method to ensure representation from different demographic groups within the study area."

**Detail Observation Techniques:** Elaborate on the non-participant observation methods, including how observations were documented and any criteria used to guide the observations.

Example: "Non-participant observations were systematically recorded using field notes, focusing on specific behaviors related to the use of forestry resources."

Explain Data Integration: Describe how qualitative observations and quantitative data were integrated and analyzed together to draw conclusions.

Example: "Qualitative data from observations were compared with quantitative findings to identify patterns and validate the reported uses of forestry resources."

Include Limitations: Address any potential limitations of the data collection methods, such as biases in interviews or observations, and how these were mitigated.

Example: "To minimize potential biases in interviews, respondents were assured of confidentiality, and multiple interviewers were used to provide diverse perspectives."

By addressing these points, the methodology section can be enhanced to provide a clearer, more comprehensive account of how data were collected and analyzed, improving the overall robustness of the study.

Short Comment on Strengths, Weaknesses, and Suggestions

### Strengths

Detailed Data Presentation: The results provide a comprehensive breakdown of the various food plants, including their species, family, parts used, and modes of use. This detailed presentation offers valuable insights into the diversity and applications of forestry resources.

Clear Statistical Summary: The use of tables and figures to summarize the frequency of use, livelihood significance, and seasonality of different food resources enhances the clarity and accessibility of the data.

Thorough Documentation: The inclusion of specific examples and data on plant parts used and their functions demonstrates a thorough documentation of how forestry resources contribute to local diets and livelihoods.

### Weaknesses

Lack of Contextual Analysis: The results section provides data but lacks an in-depth analysis of how these findings relate to broader issues like food security, sustainability, or local cultural practices.

Potential Data Overlap: There is some redundancy in presenting similar data across multiple tables and figures, which might make it difficult to integrate the findings into a cohesive narrative.

Insufficient Explanation of Seasonal Variations: While seasonality is mentioned, there is limited explanation about how seasonal changes affect the availability and consumption of these resources.

### Suggestions

Enhance Contextual Analysis: Provide a discussion on how the findings relate to broader themes such as food security, livelihood sustainability, and environmental impacts. This will help to frame the data within a larger context.

Example: "Discuss how the seasonal variations in food resource availability impact household food security and income stability."

Streamline Data Presentation: Consider consolidating similar data from tables and figures to reduce redundancy and enhance the readability of the results.

Example: "Combine overlapping data points from multiple tables into a single summary table to avoid repetition and improve clarity."

Expand on Seasonal Impact: Offer a more detailed analysis of how the seasonal availability of food resources influences their usage and importance in different periods.

Example: "Elaborate on how the peak and lean seasons affect the accessibility of different food resources and their role in household diets and income."

By addressing these points, the results section can be refined to provide a more integrated and insightful analysis of the data.

Page 10: [5] Comment [Ma6]

Microsoft account

8/13/2024 3:26:00 PM

Short Comment on Strengths, Weaknesses, and Suggestions

### Strengths

Comprehensive Overview: The section effectively highlights the importance of edible forestry resources in maintaining food security and meeting nutritional needs, particularly in the context of food shortages and low income.

Clear Connection to Food Security: It clearly establishes the dual role of forestry resources in both direct consumption and as a means to generate income, contributing significantly to household food security.

Global and Local Relevance: The discussion links local practices to broader global issues, emphasizing the role of forestry foods in poverty reduction, biodiversity conservation, and nutritional health.

## Weaknesses

**Limited Detail on Nutritional Impact:** While the text mentions that forestry foods help meet daily diet requirements, it lacks specific details on how these foods compare nutritionally to other food sources.

**Insufficient Economic Analysis:** There is a brief mention of the low market value of these products, but there is no in-depth analysis of the economic impact on households or how it influences their overall food security.

**Lack of Specific Examples:** The section could benefit from more detailed examples or case studies illustrating how specific forestry resources are used and their impact on local diets and economies.

## Suggestions

**Expand on Nutritional Benefits:** Provide more detailed information on the nutritional composition of key forestry food resources and how they address deficiencies in local diets.

**Example:** "Include data or studies comparing the nutritional value of forestry foods to conventional crops to highlight their contribution to addressing dietary deficiencies."

**Incorporate Economic Analysis:** Offer a more detailed examination of the economic implications of selling forestry food resources, including potential income generation and its impact on food security.

**Example:** "Analyze how the income from selling forestry products influences household purchasing power and access to other food items."

**Add Case Studies or Examples:** Include specific examples or case studies of how particular forestry foods are utilized in the community and their effects on food security and livelihoods.

**Example:** "Provide case studies showing how different forestry resources are processed and marketed, and their role in local food systems."

By addressing these points, the section can provide a more detailed and nuanced understanding of the role of edible forestry resources in supporting food security and livelihoods.