American Journal of Food and Nutrition, 2019, Vol. 7, No. 4, 142-157
Available online at http://pubs.sciepub.com/ajfn/7/4/5
Published by Science and Education Publishing
DOI:10.12691/ajfn-7-4-5

Wild Plant Food Resources as Component of Dietary Diversity, Nutrition and Livelihood Security of Native Farming Communities of Uttarakhand Hills in North-western India: Some Policy Considerations for Promoting Their Sustainable Use

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Received November 01, 2019; Revised December 05, 2019; Accepted December 18, 2019

Abstract Wild foods provide a greater dietary diversity to native communities of Uttarakhand hills in north-western India who rely on them. The wild plant resources supplement their diets which often are based on a narrow range of rainfed staples in traditional hill farming landscapes. The importance of wild plant food resources is exemplified mainly by their free and easy accessibility and nutritional richness, especially vitamins and micronutrients. The present study documents major factors responsible for lack of use of wild plant food resources as component of household dietary diversity negatively impacting community nutrition and health, prioritizing wild food plants for research and marketing interventions in specific agro-ecologies of Uttarakhand hills, and policy inputs for consideration of planners and policy makers for wild plant food resources conservation and their sustainable use. A strong policy support and political will for documentation and promoting LEK; preservation of natural habitats and CPRs; research on sustainable harvesting of wild plant resources for food and livelihood security, and developing nutrition composition database of wild plant resources aimed at facilitating cross-sectoral advocacy campaigns, etc., have been emphasized.

Keywords: *wild plant food resources, household dietary diversity, sustainable harvesting, and marketing, agrobiodiversity management policy*

Cite This Article: Ranjana Singh, and Ishwari Singh Bisht, "Wild Plant Food Resources as Component of Dietary Diversity, Nutrition and Livelihood Security of Native Farming Communities of Uttarakhand Hills in North-western India: Some Policy Considerations for Promoting Their Sustainable Use." *American Journal of Food and Nutrition*, vol. 7, no. 4 (2019): 142-157. doi: 10.12691/ajfn-7-4-5.

1. Introduction

Since the time of colonization, indigenous communities have witnessed a drastic decline in the health and integrity of indigenous cultures, ecosystems, social structures and knowledge systems which are integral to our ability to respond to our own needs for adequate amounts of healthy indigenous foods. Indigenous foods, including wild food resources, provide a restorative framework for health and community development and reconciling past social and environmental injustices in an approach that people of all cultures can relate to (www.indigenousfoodsystems.org).

Today, food security has come to depend on a small handful of widely cultivated species. Over 50 per cent of the world's daily requirement of proteins and calories comes from three crops-wheat, maize and rice [1]; 12 species contribute 80 per cent of total dietary intake. By contrast, wild foods provide a greater dietary diversity to those who rely on them. Ethnobotanical surveys of wild plants indicate that more than 7000 species have been used for human food at some stage in human history [2,3]. Some indigenous communities use over 200 [4]; in India, 600 plant species are known to have food value [5]; DeFoliart [6] records 1000 species of edible insects used worldwide. Some 1069 species of wild fungi consumed worldwide are important sources of protein and income [7]. Bushmeat and fish provide 20 per cent of protein in at least 60 developing countries [8].

Wild plants and animals, historically the sole dietary components for hunter-gatherer and forager cultures, remain the key to many agricultural communities even today. The mean use of 90-100 wild species by agricultural and forager communities per location has been reported from 36 studies in 22 countries of Asia and

Africa [9]. Aggregate country estimates can reach 300-800 species (e.g. India, Ethiopia, Kenya). The mean use of wild species is 120 per community for indigenous communities in both industrialized and developing countries. However, access to these sources of food is now declining as natural habitats come under increasing pressure from development, conservation-exclusions and agricultural expansion. Despite their value, wild foods are excluded from official statistics on economic values of natural resources. It is clear that wild plants and animals continue to form a significant proportion of the global food basket, and while a variety of social and ecological drivers are acting to reduce wild food use, their importance may be set to grow as pressures on agricultural productivity increase [9].

Additionally, wild plants in particular have diverse uses. In Nepal, 80 per cent of 62 wild food plants have multiple uses [10]. Tanzanian Batemi agro-pastoralists use species as food (31 species), thirst quenchers (six species), for chewing (seven species), as flavourants (two species) and for honey beer (one species). A further 35 wild edible plants are cultivated [11]. In the Mekong Delta and Central Vietnamese Highlands, several wild food species are used as medicine and livestock feed; one-fifth are used as all three [12].

Wild edible plants and wild harvested foods have been an integral part of human diet since time immemorial with nearly 75,000 species of plants believed to be edible [13,14,15,16]. It is estimated that humans have domesticated about 200 species as food crops but around 30 only contribute 95% of the world's plant food intake [17,18]. However, despite the primary reliance of agricultural communities on conventional crop plants, the tradition of eating wild plants has never disappeared in rural communities [19,20,21,22]. FAO in its state of food insecurity in the world report estimated that around one billion people use wild plants in their diet [23].

Wild vegetables play an important role in the diet of inhabitants of different parts of the world. Among the wild vegetables of South Africa are *Chenopodium album*, *Sonchus asper*, *Solanum nigrum* and *Urtica urens* [24]. The leaves of these plants were analysed for their nutritive value, anti-nutritive components and polyphenolic contents. Wide interspecific variations were recorded in protein contents, fibre, mineral and phenolic contents of their leaves. These values were found to be comparable with or higher than those of commonly used vegetables such as spinach, lettuce and cabbage. In terms of anti-nutritional principles, all the vegetables had comparatively lower concentrations of phytate, alkaloids and saponins. Considering the amount of available mineral elements in the vegetables, these plants could be valuable and important contributors to the diets of the people in South Africa.

Twenty one wild harvested leafy vegetables from six villages of Nanda Devi Biosphere Reserve buffer zone in Uttarakhand state [25]. Irrespective of social or economic status in the study villages, the farmer households had enough knowledge about availability and use of these wild leafy vegetables. The traditional knowledge, however, is eroding fast due to changing social values and non- participation of younger generation in collection and processing of such wild food resources.

An ethnobotanical investigation was carried out in the interior of Kendrapara district, Odisha, to explore the potential use of edible plants by local inhabitants [26]. The study documented 86 edible plant species belonging to 51 families. Amaranthaceae, Dioscoreaceae and Caesalpiniaceae were the most important botanical families. Of the reported species trees and herbs make up the highest proportion of the edible species. Within the edible plant parts, leaves and fruits contributed maximum (about 75%) and the remainders were edible tubers, flowers and seeds. The study demonstrated that there is an urgent need for documentation of traditional knowledge related to the intangible cultural heritage concerning traditional plant uses. The utilization and cultivation of these vegetables should be promoted to maintain the dietary needs of the households in Odisha. The study provided a baseline data that may be helpful for prioritization of conservation through sustainable use and management of these resources.

In Uttarakhand hills, rural farming communities still gather and consume many edible wild harvested plant resources [27]. Rural communities use these food plants to supplement their diets which often are based on a narrow range of rainfed staples in traditional hill farming. It is commonly reported that consumption of these plants is particularly vital at times of food shortage because they enhance livelihoods, survival strategies and support household economies. Their importance is exemplified by free and easy accessibility and nutritional richness especially vitamins and micronutrients. Therefore, they play a significant role in the livelihoods of rural communities in Uttarakhand hills through improved household incomes, and food and nutritional security.

In traditional small-scale crop-livestock mixed-farming systems in Uttarakhand hills, the agroforestry and forestry based wild harvested plant resources supplement household food choices and ensures dietary diversity and better nutrition. Wild gathered tubers, fruits, seeds, twigs, leaves and flowers of several plants still form minor but important food components of the rural communities. However, provision of and access to these sources of food is declining as natural habitats come under increasing pressure from developmental activities, poor management and conservation-exclusions. The climate change and recurrent droughts are adversely affecting availability of the wild food resources. Further, the 'nutrition transition' and inflow of purchased foods are also negatively impacting the value of wild harvested foods.

Research on wild harvested foods in traditional agro-ecologies from forestry/agroforestry systems has so far received limited attention but it is a matter of great concern from various researchers now. It has been stressed that the conservation and promotion of sustainable utilization of wild and neglected food plants requires various actions including inventorying, *in situ* conservation of wild economic species and their promotion and commercialization. Similarly, many values from these plants remain undocumented because their products are used locally without being reflected in local, national or international markets. Therefore, systematic documentation of indigenous knowledge regarding the identity and use of wild harvested foods by rural communities has become an urgent concern because both biological resources and

indigenous knowledge are diminishing with habitat destruction and a growing disinterest among the younger generation in the community.

In view of above, the present study sought to identify some policy inputs for consideration of planners and policy makers in relation to food, nutrition, health, livelihood security and sustainability of wild plant food resources. Information on 335 wild plant species used in agricultural systems of Uttarakhand hills have already been documented [28,29]. In the present communication, the following three aspects have been specifically deliberated in detail:

- Major factors responsible for lack of use of wild plant food resources as component of household dietary diversity and its impact on community nutrition and health.
- Prioritizing wild food plants for research and marketing interventions in specific agro-ecologies of Uttarakhand hills.
- Policy inputs for consideration of planners and policy makers for wild plant food resources conservation and their sustainable use.

2. Research Methodology

The target study sites for the present study comprise 20 representative agrobiodiversity rich niche habitats of three major hill agro-ecologies of Uttarakhand state, i) crop-livestock mixed-farming landscapes (10 sites); ii) high mountainous valleys/meadows (5 sites), and iii) river valleys (5 sites) as indicated in Table 1, Figure 1.

Table 1. Niche sites in different agro-ecologies of Uttarakhand hills for documenting wild harvested food resources

Representative agro-ecology	No. of sites	Niche locations
1. Traditional rain-fed farming areas (crop-livestock mix-farming)	10	Berinag (Pithoragarh), Lohaghat (Champawat), Devidhura (Champawat), Tarikhet (Almora), Sama (Bageshwar), Ramgarh (Nainital), Okhalkanda (Nainital), Ranichauri (Tehri), Gwaldam (Chamoli), Bharsar (Pauri)
2. Mountainous regions-alpine meadows/ bugyals (nomadic pastorelists)	5	Johar (Pithoragarh) and Darma (Pithoragarh) valley in Kumaon region; Niti and Mana (Chamoli district), and Har-ki-doon (Uttarkashi), in Garhwal region of Uttarakhand hills
3. River valleys (improved farming)	5	Purola (Uttarkashi), Someshwar (Almora), Garur (Bageshwar), Ramganga (Almora) and Saryu (Pithoragarh)

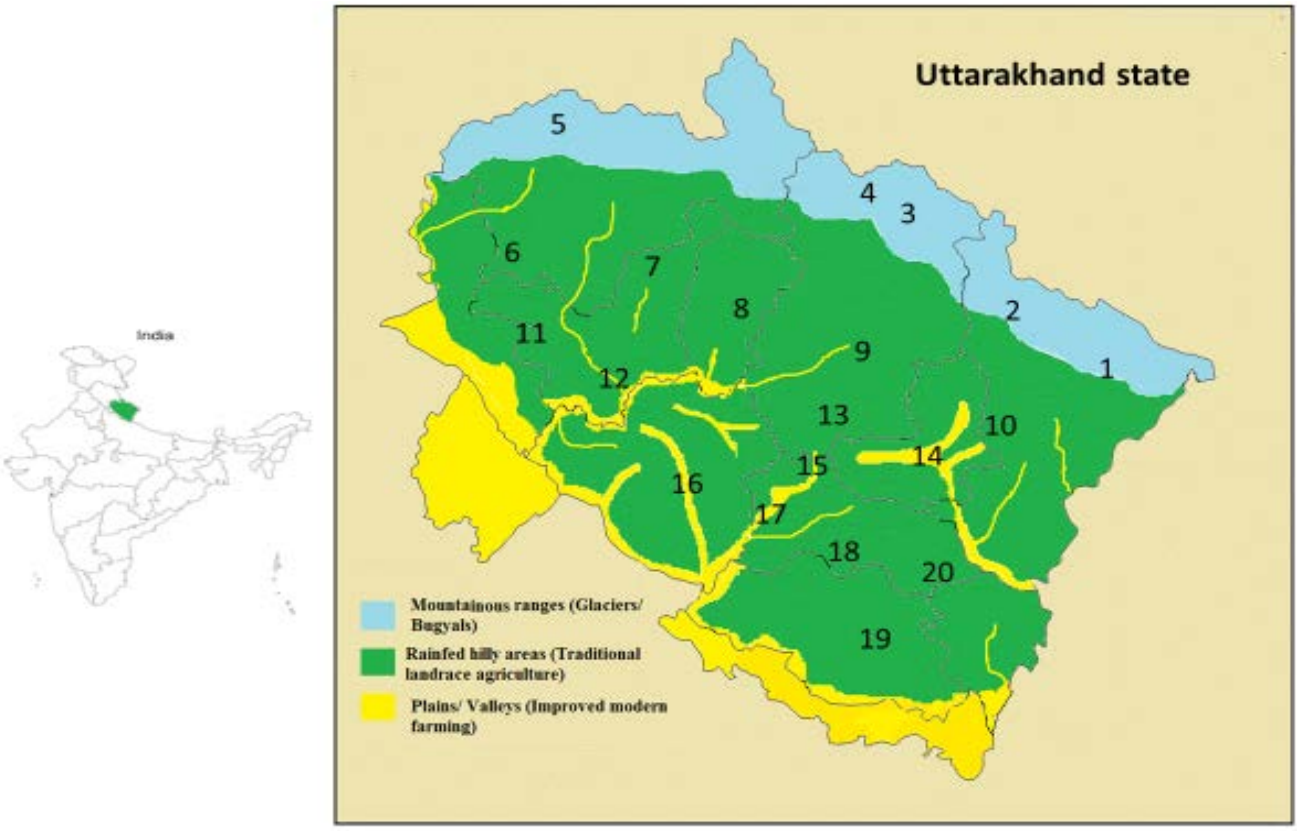

Figure 1. Twenty niche sites representing three major agro-ecologies of Uttarakhand state; predominant traditional rainfed farming landscapes with crop-livestock mixed farming (10 sites), high mountainous ranges adjoining Tibet (5 sites) and interspersed river valleys with improved agriculture (5 sites)

Data were collected through semi-structured interviews using a checklist of open ended questions during 2017-18. Since the data documented will be mainly indigenous knowledge pertaining to wild edible plant identity and use, the free listing technique was used. In this technique, the respondents were asked to mention any plant that comes to their mind until they could not mention any more species. It is generally agreed that normally people remember plants which are important to them. Field guided walks to the farm lands, grazing lands, other open habitats and nearby forestry areas were led by the respondents to identify/collect the plants listed during the interview. One Focus Group Discussion (FGD) meeting each was held in all agrobiodiversity rich niche target sites to authenticate the data in questionnaires and capture additional responses.

The participatory interviews were done separately for men and women farmers of different age groups for local ecological knowledge (LEK) on wild harvested foods. Children (<15 yrs) were also interviewed for LEK. Average 10-15 farmer households were interviewed per niche site.

Major characteristics of the agro-ecological habitats (Figure 1) and the three important representative farming situations (Figure 2) in Uttarakhand state are detailed below as described by Bisht et al. [29,30,31].

1. Small-scale crop-livestock mixed-farming systems representing about 70% cropped area under rainfed farming (Figure 2, A-B). The farming situations could be characterized by high household food production and dietary diversity. Only farmer-led traditional innovations were predominantly practiced. In the mixed crop-livestock farming system of the hills, there still exists a dynamic relationship among common property resources (CPRs), native crops and livestock. The livestock substantially contributes to household cash income whereas the surplus crop produce, if any, is sold locally and contributes very little to the household economy.

2. High elevation mountainous valleys adjoining Tibet with a mix of nomadic pastoralism, some arable land and wild harvesting including foraging and trading of medicinal herbs (Figure 2, C-D) from mountain meadows. Sheep and goat are the herded livestock. Level of household food production and dietary diversity is moderate to high with greater use of meat as source of protein. This system is representative of about 10% of the farming areas in hills of Uttarakhand. *Bhotia* tribes are the main inhabitants of the region. The agricultural economy of the valleys consists of subsistence and export (market) farming, as well as tending of livestock and harvesting of herbs for export (market) sale. In addition to cultivated herbs, many valley residents engage in medicinal herb foraging for income. Livestock grazing is practiced throughout the mountain valleys, although at rates significantly lower since the Indo-China conflict of 1962. Largely because the loss of trade with Tibet, demand for livestock and agriculture products as well as other professions linked to trade and agriculture including wool crafting and freight shepherding has dropped considerably.

3. A few interspersed river valleys where improved agriculture under assured irrigation is practiced and rice-wheat or rice-potato is the predominant cropping pattern (Figure 2, E-F). Household food production and dietary diversity is very low. The livestock herding particularly rearing of goats is minimal with limited contribution of livestock to overall cash income of the households. The river valleys represent about 10% of the cropped area in Uttarakhand hills. The famous Someshwar and Garur valleys, for example, consisting of many villages have huge paddy fields as long as one can see; the valleys are pretty famous with the locals for the ever-changing colours of the fields. Crossing through the valley would give an idea of how the daily life of a farmer is like in the hills; one would find more women working on the fields than men.

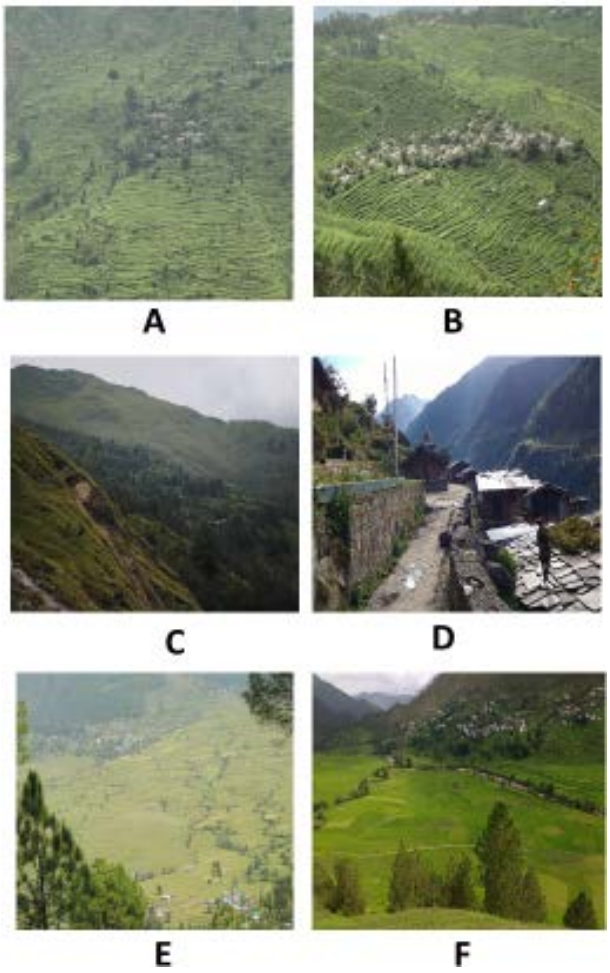

Figure 2. Representative agro-ecologies of Uttarakhand hills (A-B: Predominant traditional rainfed crop-livestock small scale mixed-farming landscapes; C-D: High mountainous valleys/alpine meadows; E-F: River valleys with improved agriculture)

The nutrition transition was clearly evident in farming situations of river valleys with the emergence of cash crop economies and impact of globalization in recent years. Enhanced use of improved crop varieties from formal seed system (FSS), synthetic fertilizers and pesticides is commonly seen in this farming system. About 70-80% cropped area was planted by a few improved cultivars of rice, wheat and potato bred by public sector institutions. Some farmers, however, still cultivate native landraces for their own household consumption. The produce of improved cultivars is generally sold in markets for cash income. Relatively reduced access to diverse indigenous food resources in farmer households has resulted in the replacement of diets of the hitherto diversified food resources

by energy-dense and nutrient-poor foods. With the nutrition transition resulting from increasing socio-economic change, the problems of overweight and underweight frequently co-exist. Socio-economic disparities and increased access to energy-dense foods are creating an "obesogenic" environment in river valley areas.

3. Results

• Major factors responsible for lack of use of wild plant food resources as component of household dietary diversity and its impact on community nutrition and health

Of the total 335 plant food species reported by Negi and Gaur [28] and further elaborated by Bisht et al. [29] from different agro-ecologies of Uttarakhand hills there has been substantial reduction in number of plant species presently being used in agricultural systems by native communities. A better use of wild plant resources in dietary diversity was reported by nomadic pastoralist communities of higher Himalayan ranges, followed by the predominant crop-livestock small scale mix-farming systems of mid-hills and river valleys (Table 2).

The major factors reported for lack of use of wild plant resources as presented in Table 3, are being described here:

i) Loss of traditional or local ecological knowledge (LEK): LEK is required for the identification, collection and preparation of wild foods. The distribution of LEK between individuals in a community is usually differentiated by gender, age or social role. In the present study, women score higher on food-related knowledge. Data from 20 niche sites, women above 40 years of age were able to describe the uses of 65 per cent of all edible species, while young men could only describe 15 per cent. Men and women also hold specialized LEK. While men had more knowledge of hunting and fishing, women had more knowledge of wild plant foods. LEK is also differentiated by age: children gather fruit for consumption by the whole community, and unsurprisingly those under 30 had the most knowledge of wild fruits.

A significant decline was recorded in LEK where communities rely increasingly on market-bought foods and move away from land-based livelihoods. It was observed that the grown-ups usually succumb to the culture of the society which regards the consumption, foraging and marketing of wild fruits as an inferior act.

In the low income communities of small-holder crop livestock farming systems and that of resource-dependent low income communities of higher Himalayan mountainous regions, LEK was found to be higher, and rate of knowledge acquisition rapid from a young age. This suggests that as communities become wealthier, knowledge becomes concentrated in fewer people with a sustained personal interest. However, where communities are local resource-dependent, their knowledge of species names and uses is likely to be shared among all community members engaged in daily tasks to meet family needs.

LEK decline (in terms of species names and uses) is associated with increasing disconnection and livelihood independence from agricultural and wild systems as a consequence of modern economic growth. It is, however, suggestive that as people become wealthier and more dependent on market bought foods, this particular level of LEK is no longer required on a daily basis to survive. At the same time, there may be less knowledge transmission between generations, or simply substitution for other forms of knowledge, particularly among younger generations as a result of the introduction of formal schooling, in which ecology as a science has been downgraded, and urban jobs.

The nutrition transition associated with modernization of diets poses challenges to public health in hill communities. The replacement of wild foods by market-bought products is linked to reduced dietary diversity, rising rates of chronic lifestyle-related conditions. Niche habitats where children use wild plant resources, level of malnutrition was reported to be low.

Table 2. Wild plant food resources reported and presently being used in agricultural systems

Wild plant food resources reported and presently being used as component of HH dietary diversity	Altitudinal range/distinct hill agro-ecology		
	<1000 m River valleys (5 niche sites; 50 HHs)	1000 – 2500 m Crop-livestock small scale mix-farming systems (10 niche sites; 150 HHs)	>2500 m (Mountain valleys, alpine meadows/ bugyals (5 niche sites; 70 HHs)
Total food plant species reported	52 (±7.3)	240 (±30.8)	69 (±10.1)
Plant food species presently being used as component of HH dietary diversity and livelihood security	13 (±2.2)	81 (±7.3)	52 (±6.9)
Percentage of total reported	25.0 (± 2.9)	33.8 (± 6.7)	75.4 (± 4.9)

Table 3. Prioritization of factors responsible for lack of use of wild plant food resources in agricultural systems of hill agro-ecologies

Factors responsible for lack of use	Agro-ecology/farming landscapes		
	Crop-livestock small scale mix-farming systems (10 niche sites; 150 HHs)	Mountain valleys, alpine meadows/ bugyals (5 niche sites; 70 HHs)	River valleys (5 niche sites; 50 HHs)
1. Loss of LEK	High	Moderate	High
2. Land use change and degradation including poor management of CPRs	High	Moderate	High
3. Climate change	High	High	High
4. Unsustainable harvesting	High	High	Low

ii) Land use change and degradation including poor management of common property resources (CPRs): Biodiversity in intensely managed CPRs and agroforestry systems has traditionally provided hill communities with the means to increase incomes, improve diets and increase labour productivity. Most of the wild food species used by local communities come from well managed CPRs and agroforestry systems rather than mature forests. Wild foods that accompanied CPRs are being lost, leading to decreased diversity and with it downgraded nutritional status, health and income, and the removal of a vital 'safety net' for the rural poor. Of the 20 niche habitats surveyed in the present study, poor management of CPRs and deforestation had led to a decline in wild food species. Efforts by the local communities to stem this loss by domesticating important species were often unsuccessful, as many species do not survive outside their natural forested habitat.

iii) Climate change: Wild food species offer a potentially critical role for buffering against food stress caused by a changing climate. The innate resilience of wild species to rapid climate change could, however, play an increasingly important role during periods of low agricultural productivity associated with climate events which often is lacking in exotic species. Forecasting the precise impacts of the changing climate on the availability of wild foods is difficult. Studying resilience and vulnerability in communities of three distinct farming agro-ecologies of Uttarakhand hills revealed that there was insufficient evidence to predict the impacts that climate change would have on both human foraging and the interlinked processes of local ecological knowledge (LEK) transmission, cultural continuity and land-based subsistence livelihood.

v) Unsustainable harvesting and changing dynamics: The Indian Himalayas including the Uttarakhand hills is one of the global hot-spots of biodiversity with areas of greater malnutrition and hunger, also placing pressure on biodiversity for food provision. In certain niche habitats, unsustainable harvests have led to declines in wild food species.

In the long term, over-harvesting of all species especially from alpine meadows/bugyals and higher mountain valleys will have a negative impact on wild food availability and thus on nutritional and livelihood security for those communities that rely on them. Unsustainable harvesting is regarded as a threat to wild flora in these habitats. Where species have traditionally been harvested sustainably, the entry of the market and the commercialization of species hitherto used exclusively for local subsistence can also result in over-harvesting. Unsustainable harvesting is a concern in the case of wild food resources of high elevation areas in Uttarakhand hills, more particularly "Jambu or Faran" (*Allium stracheyi syn. consanguineum* and *A. wallichii)* and "Gandhrain" (*Angelica glauca*), two important wild harvested commodities from alpine meadows/bugyals of Uttarakhand hills.

- **Prioritizing wild food plants for research and marketing interventions in specific agro-ecologies of Uttarakhand hills**

Table 4 and Table 5 lists important wild plant species of higher Himalayan ranges and mid-hills, respectively, which are widely used as component of native household diversity and some also has marketing potential as well.

Table 4. Important plant species used and marketed, as food and medicine, by nomadic pastoralists during from alpine meadows/ bugyals of Uttarakhand hills

S. No.	Plant species	Frequency of occurrence	Potential for market sale	Population status	Domestication potential
1.	*Allium humile* (High altitude alpine onion)	Common	Sold in local markets as *Jambu or Faran*.	Threatened	The plant material is mainly collected from the wild; the *Bhotia* tribes are trying its cultivation in high elevation areas of Uttarakhand.
2.	*A. przewalskianum (*Syn *A. rubellum var. parviflorum*, an Asian species of wild onion)	Rare	Sold as *Jambu* or *Faran* in local markets.	Threatened	The plant material wild harvested and also being cultivated by the *Bhotia* tribes in high elevation areas of Uttarakhand.
3.	*A. stracheyi* (*Jambu* or *Faran*)	Common	Pure material is costlier than Rs 1000 (USD 16) per kg but most often adulterated by flowers of other *Allium* species.	Threatened	This species of *Allium* is an exclusive Himalayan herb growing only in high altitudes and widely occurring in Uttarakhand hills. The plant material is mainly collected from wild but few ***Bhotia*** farmers are also trying its cultivation.
4.	*A. tuberosum* (Garlic chives, oriental garlic, Asian chives, Chinese chives, Chinese leek)	Rare	Has potential to be sold in local markets.	Threatened	Garlic chives have been widely cultivated by ***Bhotia*** tribes for centuries for its culinary value in high elevation areas of Uttarakhand.
5.	*A. victorialis* (Alpine Leek)	Rare	Has potential to be sold in local markets.	Threatened	Occurs both in wild and cultivated form.
6.	*A. wallichii* (Himalayan onion, *Jambu*)	Common	Sold in local markets as *Jambu* or *Faran*.	Threatened	A plant species native to India, Nepal, Sikkim, Bhutan, Myanmar, Tibet and parts of China. The plant material is mainly collected from wild but the *Bhotia* tribes are trying its cultivation in high elevation areas of Uttarakhand.
7.	*Angelica glauca* (Gandhrain)	Rare	Sold in local market at premium price	Threatened	Occurs in wild but has potential to be cultivated.

S. No.	Plant species	Frequency of occurrence	Potential for market sale	Population status	Domestication potential
8.	*Carum carvi* (Wild Caraway, Meridian fennel, Persian cumin)	Common	Sold in local markets at premium price	Least concern	Occurs wild in north-western Himalayan region and also widely cultivated now by *Bhotia* tribes.
9.	*Dendrobenthamia capitata* (Syn. *Cornus capitata;* Himalayan flowering dogwood, Himalayan strawberry-tree)	Rare	-	Threatened	-
10.	*Elaegnus parvifolia* (Autumn Olive, *Giwain* in Hindi)	Rare	-	Threatened	-
11.	*Fagopyrum dibotrys* (Perennial Buckwheat, *Ban ogal* in Hindi)	Common	-	Threatened	-
12.	*Fragaria nubicola* (Indian Strawberry)	Common	-	Threatened	-
13.	*Gautheria trichophylla* (Himalayan Strawberry)	Rare	-	Threatened	-
14.	*Hippophae rhamnoides* ssp. *salicifolia* (Sea-buck-thorn, *Chuk)*	Common	Has potential to be sold in local markets in different processed forms.	Vulnerable	Potential of domestication and genetic improvement owing to greater diversity and widespread distribution in cold arid region.
15.	*Holboellia latifolia* (Sausage vine; Gomphal)	Rare	-	Threatened	-
16.	*Juglans regia* (Walnut)	Common	Sold in local markets.	Threatened	-
17.	*Lonicera angustifolia* (Japanese Honeysuckle)	Rare	-	Threatened	-
18.	*Malus baccata* var. *himalaica* (*Ban-Mehal*, Siberian Crab Apple)	Rare	-	Threatened	Cultivated for diverse uses and as root stock to cultivated apple.
19.	*Oxyria digyna* (Mountain sorrel, wood sorrel, Alpine sorrel)	Rare	-	Threatened	-
20.	*Paeonia emodi* (Himalayan peony)	Rare	-	Critically endangered	-
21.	*Prunus cerasoides* (The wild Himalayan cherry or sour cherry)	Common	-	Least Concern	-
22.	*P. persica* (Ornamental Peach, Common Peach)	Rare	-	Threatened	-
23.	*Rheum emodi* (Himalayan rhubarb)	Common	-	Threatened	-
24.	*R. moorcroftianum* (Rhubarb)	Rare	-	Vulnerable	-
25.	*Ribes alpestre* **(**Asian Gooseberry**)**	Rare	-	Threatened	-
26.	*R. glaciale* (Ribes)	Rare	-	Threatened	
27.	*R. himalense* (Himalayan Gooseberry)	Rare	-	Threatened	-
28.	*Schisandra grandiflora* (Magnolia vine)	Rare	-	Threatened	-
29.	*Sorbus aucuparia* (Mountain Ash, European mountain ash)	Rare	-	Threatened	-
30.	*S. lanata* (Hairy Rowan)	Rare	-	Threatened	-
31.	*Taraxacum officinale* (The common dandelion)	Common	-	Threatened	-

Table 5. Important wild plant species used and marketed, as food and medicine, by farming communities from lower and mid hills of Uttarakhand

S. No.	Plant species	Frequency of occurrence	Potential for market sale	Population status	Domestication status/ potential
1.	*Adhatoda zeylanica* (Malabar nut, Adosa in Hindi)	Common	-	Threatened	-
2.	*Aegel marmelos* (Bael, Bengal quince, golden apple)	Rare	Fruits are sold in local markets.	Vulnerable	It occurs in dry, open forests on hills and plains. It is cultivated throughout India, It has a reputation in India for being able to grow in places that other trees cannot. It requires a pronounced dry season to give fruit. In lowever elevation areas of Uttarakhand wild stands of bael occur.
3.	*Amaranthus cruentus*	Common	Sold in local markets as vegetable and cereal grain.	Least Concern	Both wild and domesticated forms commonly occur in Uttarakhand hills.
4.	*Artocarpus lakoocha* (Monkey fruit, or Monkey Jack or barhar)	Rare	-	Threatened	-
5.	*Asparagus adscendens* (Satavar, shatavari, or shatamull)	Common	Because of its multiple uses, the demand for *Asparagus racemosus* is constantly on the rise.	Endangered in its natural habitat.	Wild populations can be easily cultivated.
6.	*Bauhinia variegata* (Mountain Ebony; *Kuiral*)	Common	The flowers and buds are sold in local market @ Rs. 50/kg.	Threatened	Important species for social forestry.
7.	*Celtis australis*	Common	-	Threatened	-
8.	*Cleome viscosa* (*Jakhia*; Asian spiderflower, Tickwood)	Common	Price of dried seeds in market is about Rs. 500-600/kg.	Threate3ned	Occurs in semi-domesticated form. Can be easily domesticated and improved.
9.	*Cordia dichotoma* (Bird lime tree, clammy cherry, Lasora in Hindi)	Rare	-	Threatened	-
10.	*Dillenia indica* (commonly known as elephant apple or chulta)	Rare	-	Threatened	-
11.	*Diospyros tomentosa*	Common	-	Threatened	-
12.	*Dioscorea bulbifera* (the air potato, air yam, bitter yam, cheeky yam, potato yam)	Common	Sold in local markets.	Threatened	It is widely cultivated and has escaped to become naturalized in many other regions.
13.	*D. deltoidei* (Yam)	Common	Sold in local markets.	Threatened	-
14.	*D. glabra* (*Tarur*, Yam)	Common	Sold in local markets on *Shivratri* day.	Threatened	-
15.	*D. pentaphylla* (Fiveleaf yam)	Rare	Sold in local markets.	Threatened	It is widely cultivated as a food crop and naturalized in many areas.
16.	*Diplazium esculentum* (a vegetable fern, *Lingura* or *Lungru*)	Common	The vegetable fern, *Diplazium esculentum*, is sold in local markets @ Rs. 60-70 (USD 1) per kg.	Least Concern	-
17.	*Ficus palmata* (*Bedu*, Punjab fig)	Common	Fig trees are rarely found in the forests, but grow around the villages, in wastelands, fields, etc. The fruits are liked very much by the people. They are also offered for sale.	Threatened	This fruit has a scope for cultivation and it should be extended. There exists considerable variation in the size and quality of the fruit among different trees. Good types should be selected for propagation.
18.	*Ficus racemosa* (Syn. *F. glomerata;* cluster fig tree, Indian fig tree or gular fig, *Timil*)	Common	Gular fruit are almost never sold commercially because of the fig wasps problem.	Endangered	A good tree for social forestry as considerable genetic diversity occurs due to its widespread distribution
19.	*Myrica esculenta* (*Kaphal*)	Common	The fruits are sold in local markets @ Rs. 60-70 (USD 1) per kg. A good source of livelihood security to farm households involved in its wild harvesting and market sale.	Endangered	A good tree for social forestry as considerable genetic diversity occurs due to widespread distribution in Uttarakhand hills.
20.	*Oreganum vulgare* (Bantulsi)	Common	The dried leaves fetching premium price in food industry.	Threatened	It occurs both in wild and cultivated forms.
21.	*Perilla frutescens* (Bhanjeera)	Common	Sold in local markets @ Rs. 100 per kg.	Threatened	It occurs both in wild and cultivated forms. In some wild stands in lower elevation areas it is invasive as well.

S. No.	Plant species	Frequency of occurrence	Potential for market sale	Population status	Domestication status/ potential
22.	*Pueraria tuberosa* (Kutzu)	Rare	-	Facing extinction in wild	-
23.	*Rorripa nasturtium-aquaticum* (Water cress)	Common	-	Threatened	Occurs both in wild and cultivated form.
24.	*Rosa sericea* (Himalayan rose)	Common	-	Threatened	-
25.	*Rubus biflorus* (Himalayan yellow berry)	Rare	-	Threatened	-
26.	*R. ellipticus* (Golden Himalayan raspberry, *Hisalu*)	Common	Sold in local markets in small quantities.	Threatened	-
27.	*R. macilentus* (Lean raspberry)	Rare	-	Threatened	-
28.	*R. niveus* (Kala Hisalu, Hill raspberry)	Common	-	Threatened	-
29.	*Schleichera oleosa* (Kusum tree, Ceylon oak)	Common	-	Threatened	-
30	*Semecarpus anacardium* (Marking nut, Belatak, Bela)	Common	-	Threatened	-
31.	*Syzizium cumini* (Black plum, Jamun)	Common	Sold in local markets at premium price.	Threatened	Occurs both in wild and cultivated form. Wild stands occur in the subhimalayan ranges in most forest types up to 1200m
32.	*Ziziphus mauritiana* (Chinese date, ber, Chinee/Chinkee apple, jujube, Indian plum)	Common	Sold in local markets in small quantities.	Threatened	It is widely cultivated but in Uttarakhand wild stands are Common throughout the subhimalayantracts up to 1200m

Table 6. Direct use values of wild plant foods either as contributions to household consumption or income from sale in niche target areas of three representative farming agro-ecologies of Uttarakhand (*in percentage terms*)

Farm household respondents from niche sites of different farming agro-ecologies	Contribution of wild harvested food resources to household cash income	Major wild plant resources for household cash income from market sale
1. Crop-livestock small scale mix-farming systems (10 niche sites; 150 HHs)	14 (± 1.58)	*Myrica esculenta* (**Kaphal**), *Diplazium esculentum* (**Lingura**, a vegetable fern), *Bauhinia variegata* (**Kuiral**, Mountain Ebony), Wild edible tubers (*Dioscorea* spp.)
2. Mountain valleys, alpine meadows/ bugyals (5 niche sites; 70 HHs)	34 (± 2.24)*	*Allium* spp. (**Jambu** or **Faran**), *Angelica glauca* (**Gandhrain**), *Carum carvi* (Caraway, **Kala Jeera**)
3. River valleys (5 niche sites; 50 HHs)	2 (± 0.84)	*Diplazium esculentum* (**Lingura,** a vegetable fern), Wild edible tubers (*Dioscorea* spp.)

* The cash income also includes the trade of *"**Keeda Jadi**"* (Tibetan *"**yartsa gunbu**"*, the caterpillar fungus, *Ophiocordyceps sinensis* syn. *Cordyceps sinensis*), foraged from alpine meadows/bugyals.

Table 7. Trend in market sale of a few important wild plant foods in local markets at a niche site in mid-hill areas under crop-livestock small-scale farming situations

S.No.	Plant species and market availability	Trend of market sale per season (quantity in kg)		Per cent increase in sale	Average cash income per household per annum involved in market sale (in Rs.)
		Average sale about a decade ago	**Present Sale (2017)**		
1.	*Diplazium esculentum* (March/April to September/October)	757.5 (±99.4)	4264.7 (± 650.1)	563.6 (± 36.2)	9000 (± 750.0)
2.	*Myrica esculenta* (April-June)	1062.5 (± 125.0)	4037.5 (± 647.3)	380.0 (± 22.6)	2631.25 (± 436.5)
3.	*Bauhinia variegata* (April-May)	572.5 (±11.06)	879.0 (± 109.1)	153.5 (± 34.5)	1662.5 (± 89.8)
4.	*Chenopodium album* (March - November)	355.0 (± 21.5)	1550.0 (± 79.0)	436.6 (± 65.0)	1712.5 (± 42.5)
5.	*Asparagus adscendens* (July- August)	237.5 (±17.7)	575.0 (± 35.3)	242.1 (± 11.3)	1875.0 (± 106.0)
6.	*Indigofera heterantha* (March- April)	225.0 (±35.4)	650.0 (± 70.7)	288.8 (± 35.4)	625.0 (± 35.4)
7.	*Dioscorea glabra* (February- March)	95.0 (±7.1)	212.5 (± 17.7)	223.7 (± 3.5)	287.5 (± 17.7)

Survey done in some local towns of Nainital district (Bhowali, Bhimtal, Garampani and Nainital) around ICAR-NBPGR Regional Station, Bhowali (Uttarakhand).

Figure 3. Some important wild plant resources of mid-hills as source of household cash income from market sale (A-C: *Myrica esculenta*, Kafal; D-E: *Diplazium esculentum*, Vegetable fern; F: *Rubus* spp.; G-H: *Bauhinia variegate*, Mountain ebony; I: *Oreganum vulgare*, Ban tulsi)

Figure 4. Some important wild plant resources of higher Himalayan region/alpine meadows as source of household cash income from market sale (A-D: *Allium* spp., sold as 'Jambu' or 'Faran', *A. stracheyi*, *A. wallichii* and *A. humile;* E-F: *Angelica glauca*, Gandhrain; G-H: *Carum carvi*, Caraway, Kala Jeera*)*

Table 6 lists the direct use values of wild plant foods either as contributions to household consumption or income from sale in niche target areas of three representative farming agro-ecologies of Uttarakhand hills. Contribution of wild plant food resources for household cash income was highest in higher mountainous agro-ecologies of nomadic pastoralists followed by traditional farming landscapes of mid-hills and lowest in river valleys where improved agriculture is practiced.

Table 7 lists the trend in market sale of a few important wild plant foods in local markets at a niche site in mid-hill areas representing crop-livestock small-scale farming situations. There has been substantial increase in market sale of plant food resources for urban consumers which is proving to be a better livelihood security choice for rural households engaged in their foraging and trading.

Figure 3 and Figure 4 depicts some important wild economic species of substantial marketing potentials of mid-hills and higher Himalayan ranges, respectively.

- **Policy considerations for wild food resources conservation and use**

In the participatory FGD meetings at different niche sites, a consensus opinion for a strong political will and state support was expressed for conservation and use of wild plant food resources. The planners and policy makers need to be made aware of the most important, but highly ignored, role of wild plant food resources for nutrition, health and livelihood security of native farming communities of Uttarakhand hills. The important action points to be included in state agro-biodiversity management policy are as follows:

Documenting LEK and traditional innovations: Use of wild plant resources in native food system of Uttarakhand hills has been the result of the treasures of knowledge possessed by local communities from long-evolved cultures and patterns of living in local ecosystems. Therefore, traditional food systems need to be documented so that policymakers know what is at stake by ruining an ecosystem, not only for the native peoples living there, but also for everyone. Armed with ancient traditional knowledge and a deep connection to their lands, local communities, and particularly local women needs to be encouraged for developing projects and building networks to revitalize local food capacity and strengthen indigenous food sovereignty. The indigenous knowledge and innovations, therefore, needs to be properly documented and made use for bringing sustainability in production systems.

Support for reviving CPRs and enhanced consumption of wild plant food resources: The rural communities under different farming agro-ecologies of Uttarakhand hills still gather and consume many edible wild plant food resources. Beside, nutritional security, the wild plant resources are helpful in enhancing livelihoods and supporting household economies of rural farming communities. The wild plant resources are considered especially rich source of vitamins and minerals. The access to and availability of these food resources are now declining due to degradation of their natural habitats from various developmental activities and in particular poor management of CPRs. The contribution of wild plant food resources to total food and nutritional security of native communities has been undervalued. It has now been well recognized that wild food resources are vital for nutrition and health of hill communities beside just source of food and income. The sustainable harvesting of wild economic species therefore requires a strong policy support by ensuring its continued availability to local communities. We also need to combine and enhance the efforts to conserving biodiversity and preserving traditional food systems and farming practices.

The predominant hill agro-ecology, crop-livestock mix farming system, could be characterized by greater household food production and dietary diversity. Household crop production and consumption decisions are, however, linked. In past, there existed a dynamic relationship among CPRs, native crops, and livestock. Livestock traditionally contributed substantially to rural livelihoods, employment, and poverty relief. The most common livestock species in mixed-crop farming are goats, cattle, buffaloes, and poultry. They integrate with and complement crop production, embody savings, and provide a reserve against risks. While crops provide feed and fodder, livestock provide meat, milk, and milk products for subsistence and as a source of cash income. Livestock also supply draught power to till the land and provide power for other agricultural operations such as threshing and to a limited extent transport. Livestock are, therefore, considered integral to the sustainability of the farming communities in Uttarakhand hills.

CPRs are important sources of livelihood to rural households. Poor management of CPRs leads to declining fodder resources for livestock in crop–livestock mixed farming and declining sources of wild food resources for rural farmer households. The dynamic relationship among crops, livestock, and CPRs is increasingly breaking down now. As, there is substantial shortfall in herded livestock over the past 2-3 decades, there is general ignorance among rural small-holder households for farming leading to permanent outmigration. Reviving CPRs, being source of wild plant food resources will also help sustain the livestock for their feed and fodder requirements and making traditional hill farming economically viable.

Documenting nutritional value of wild foods: Malnutrition is a major health burden in many Uttarakhand hill communities/households and the recognition that nutritional security and biodiversity are linked is fundamental for enlisting policy support to secure wild food use and preserve habitats for wild edible species. Comprehensive food composition data is a critical first step. This is especially important for communities most vulnerable to malnutrition. However, understanding of wild foods' micro- and macro-nutritional properties currently lags behind that of cultivated species.

The energy density of wild plant food resources have been reported low but they are important sources of micronutrients. Several wild edible plants are sources of important micronutrients, Fe, Ca, P, Na, K, Zn etc. Many wild plants have edible parts that are commonly consumed and are critical suppliers of vitamins A, B_2, C, antioxidants, especially during seasonal lean periods. Many backyard plants and plants in agroforestry systems (CPRs) are important for ensuring year-round nutritional security in the face of possible food shortages, often used as famine foods. They are often superior in energy and micronutrient content compared with those from many cultivated species.

Promoting research for sustainable harvesting and advocacy activities for cross-sectoral collaboration: There is need to promote research-oriented activities on wild plant food resources conservation and use. Research on sustainable harvesting of wild plant resources from natural habitats, post-harvest processing for add-value interventions, domestication initiatives of wild economic species having marketing potential, etc. needs to be strengthened. Beside research-oriented activities, advocacy is an important thrust area of local institutional collaboration. There is a strong need to enhance the knowledge base of policy and decision makers at the local, regional and national level across agriculture, food, and public health sectors on traditional food and nutrition. Continuous policy advocacy activities in the form of workshops, round-table discussions, stakeholders' meetings, etc. need to be organized in order to educate various functionaries across different sectors. There is also a need to re-assess existing food and nutrition-related health and agriculture policy at local, regional and national level, harmonize such policies and develop cross-sectoral implementation strategies that would positively impact on food security, nutrition and health of the native communities. Developing the wild food composition database, as stated above, will be vital for effective advocacy tools and critical for policy and programme development across agriculture, food, nutrition and health sectors.

4. Discussion

The number of wild plant food species reported from different agro-ecologies of Uttarakhand hills and presently being used in household dietary diversity and livelihood security are listed in Table 2. There has been substantial lack of use of wild plant resources in agricultural system. A number of important drivers of change for wild food availability and use have been reported [9]. While some clearly increase or decrease the use of wild foods, the impact of others is ambiguous and context-dependent. Some important drivers of change of use of wild plant resources in context of the present study are listed in Table 3. The importance of understanding current trends for wild plant resources use is underscored by the recognition that food insecurity, in particular, is not an issue among local communities in Uttarakhand hills. For instance, food insecurity in three representative hill agro-ecologies was relatively more in households of crop-livestock small-scale mix farming situations followed by nomadic pastoralists of higher Himalayan ranges, and least in households of river valleys [30,31]. There appears to be no direct relationship between food insecurity and wild plant food resources used. The *interaction* between drivers, however, deserves attention. Links among LEK and sociocultural factors (including gender roles, wealth, education, social status), wild plant food availability and economic incentives, eco-nutrition, etc., in combination could lead to either an increase or decrease in wild food use.

Wild foods have long been used by farmers, as 'hidden harvests', and have supplemented their dietary diversity and household income [2,29,32,33]. Many wild plant resources in Uttarakhand hills are important as famine foods, ensuring year-round nutritional security in the face of possible food shortages. Many wild food resources are rich in micronutrients [28,29]. Many wild backyard plants and plants in agroforestry systems (CPRs) have edible parts that are commonly consumed and are critical suppliers of vitamins A, B2, C, antioxidants, especially during seasonal lean periods. It is interesting to note that 70-80% wild plant resources in Uttarakhand hills are mostly used as fruits and vegetables. Fruits and vegetables is known to lower risk of several oxidative stresses, including cardiovascular diseases, cancer and stroke and such health benefits are mainly ascribed to phytochemicals such as polyphenols, carotenoids and vitamins. Of these phytochemicals, polyphenols are largely recognized as anti-inflammatory, antiviral, antimicrobial and antioxidant agents [34].

Loss of LEK has been observed in all agro-ecologies of Uttarakhand hills. It was interesting to note that in low income communities of small-holder crop livestock farming systems and that of resource-dependent low-income communities of higher Himalayan mountainous regions, LEK was found to be higher and rate of knowledge acquisition rapid from a young age. This suggests that as communities become wealthier, knowledge becomes concentrated in fewer people with a sustained personal interest. A strong inverse correlation has also been reported by Pilgrim et al. [35] between ecological knowledge and income levels. Understanding ecological knowledge loss is important to understanding the declining capacities of communities undergoing economic development to manage their natural resources and the future of ecosystem diversity in the light of current patterns of economic growth [35].

Data from the 20 niche sites, women above 40 years of age were able to describe the uses of about 70 per cent of all edible species, while young men could only describe 15-20 per cent. Similar findings have been reported from a study from Nepal [10]. Men and women might also hold specialized LEK. LEK is also differentiated by age [10]. The distribution of LEK between individuals in a community has been reported to be differentiated by gender, age or social role [9].

A significant decline was recorded in LEK where communities rely increasingly on market-bought foods and move away from land-based livelihoods [35,36]. In certain farming landscapes, it was observed that the grown-ups usually succumb to the culture of the society where foraging, consumption and marketing of wild fruits is regarded as an inferior act. Further, the LEK decline (in terms of species names and uses) is associated with increasing disconnection and livelihood independence from agricultural and wild systems as a consequence of modern economic growth [35].

The nutrition transition associated with modernization of diets poses challenges to public health in hill communities (Bisht, 2019). The replacement of wild foods by market-bought products is linked to reduced dietary diversity, rising rates of chronic lifestyle-related conditions such as obesity and type II diabetes, poor intake of micronutrients and malnutrition. Traditional species become undervalued and underused as exotic ones become available. Yet, the importance of wild foods to nutritional security means that they are not necessarily replaced by market-bought foods providing the same amount of calories. When more people depend solely on market-bought (cultivated foods), consuming wild foods will be marginalized [9]. LEK is likely to be substituted by

modern environmental knowledge about global warming, energy saving techniques and organic foods for example. This global knowledge is, of course, essential but should not replace that of our local ecosystems [9].

As Uttarakhand hills have a strong food culture, traditional food systems can persist, and wild foods are still prevalent enough to be considered an important part of local diets particularly in crop-livestock mix farming systems and pastoralist communities of higher Himalayan ranges.

The nutrition transition is driven by a changing climate as well as large-scale cultural changes and is expected to produce significant negative effects to physical and mental health at community level. Niche habitats where children use wild edible fruits and vegetables, level of malnutrition was low and the benefits of consuming traditional wild foods were clearly evident. Though wild foods have played a critical role several traditional farming area across the globe including circumpolar communities, public health policy generally operate within a model of food security that discounts the traditional food practices of native communities [9,37,38].

In traditional farming systems of Uttarakhand hills, the agroforestry and forestry based wild plant resources supplement household food choices and ensures dietary diversity and better nutrition [29,39]. Wild gathered tubers, fruits, seeds, twigs, leaves and flowers of several plants still form minor but important food components of the rural communities. However, availability and access to these foods is declining as natural habitats are under constant pressure from developmental activities, poor management and conservation-exclusions. The climate change and recurrent droughts are adversely affecting availability of the wild food resources. Further, the 'nutrition transition' and inflow of purchased foods are also negatively impacting the value of wild harvested foods.

It has been observed that most wild harvested plant products are consumed directly within the farmer households, hence it is often difficult to capture the quantity and diversity of the harvest at local or national level [32]. Table 4 – Table 7, however**,** confirm that some wild edible plant foods might contribute substantially to the household dietary diversity and economy once fully tapped.

It may be emphasized that 'malnutrition is a major health burden in developing countries and use of wild plant foods can be enlisted as policy support to secure wild food use and preserve habitats for wild edible species [9]. Comprehensive food composition is therefore critical especially for communities most vulnerable to malnutrition [25,40]. We, however, have limited understanding of micro- and macro-nutritional properties of wild foods as compared to cultivated species. Several wild edible plants are sources of important micronutrients, Fe, Ca, P, Na, K, Zn, etc. (Negi and Gaur, 1994; Bisht et al., 2017).

The wild fruits are gaining increased attention now as potential food supplement or cheaper alternative of commercial fruits across the world. Evidences of the health benefits of wild edible fruits, in addition to established role in nutrition are available. In general, enough information is available on the antioxidant potential of fruits of different species.

There is no comprehensive estimate of the economic value of wild foods [9]. Quantitative analyses face methodological difficulties. Further, the trade of wild foods is often informal or occurs at local markets and is, therefore, missed by conventional accounting mechanisms [41]. Data presented in Table 7 provide encouraging results as a few prioritized species of a niche habitat in Uttarakhand hills contributing substantially to livelihood and nutritional security of local households who are involved in their foraging and marketing.

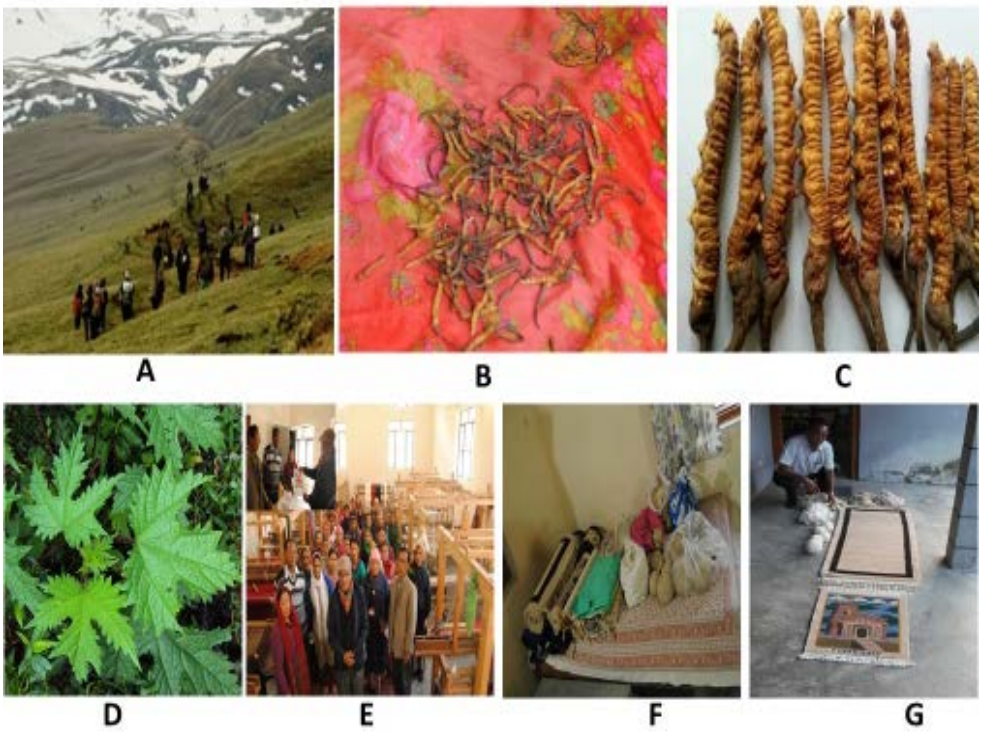

Figure 5. A-C: Foraging of "*Keeda Jadi*", a caterpillar fungus, *Ophiocordyceps sinensis* (syn. *Cordyceps sinensis*) from mountain meadows/bugyals and sold at premium price, often illegally smuggled to China/Tibet for medicinal uses; D-E: *Girardinia diversifolia*, Himalayan nettle, the fibre is very flexible and has high tenacity, allowing it to be used in a multitude of applications ranging from clothing and bags to floor mats and rope

Decline in management of CPRs including expansion of intensive agriculture and urbanization have significant implications for the availability of wild foods, the commercialization of agriculture- an important driver of land use change-potentially implies decreased reliance on wild foods. Agricultural and land use policy, infrastructure development and widened access to markets all drive land use change and are implicated in declines of wild species [42,43,44].

The 20 niche habitats surveyed in the present study, poor management of CPRs and deforestation had led to a decline in wild food species as most of the wild food species used by local communities come from well managed CPRs and agroforestry systems rather than mature forests. Lack of sustainable intensification, therefore, calls for a biodiversity-focused strategy in food, public health and poverty-alleviation policies [9].

The Indian Himalayas including the Uttarakhand hills is one of the global hot-spots of biodiversity with areas of greater malnutrition and hunger, also placing pressure on biodiversity for food provision. In certain niche habitats, unsustainable harvests have led to declines in wild food species. Unsustainable harvesting is a concern in the case of wild food resources of high elevation areas in Uttarakhand hills, more particularly "Jambu or Faran" (*Allium stracheyi* and *A. wallichii*) and "Gandhrain" (*Angelica glauca*), two important wild harvested commodities from alpine meadows/bugyals of Uttarakhand hills. The treasure nature has given us for medical purposes, but that does not justify the use of uneven means for any selfish motives.

The illegal use and trade of "***Keeda Jadi***" (being considered as a Herbal Viagra) can also be cited here as example here which is adversely affecting sustainable harvesting and trading of important wild resources of higher Himalayan ranges (Figure 5, A-C). ***Keeda Jadi*** is a fungus which grows as a parasite on the larvae of a particular kind of caterpillar. The caterpillar fungus *Ophiocordyceps sinensis* (syn. *Cordyceps sinensis*) is one of the entomogenous Ascomycetes and parasitizes the larvae of Lepidoptera to form the well-known traditional Tibetan medicine "***yartsa gunbu***" or, in traditional Chinese medicine, "***DongChongXiaCao***" ("winter worm-summer grass"). The fungus evolves in the living larva, which kills and mummifies the larva and then develops as a stalk-like fruiting figure. Caterpillars take 5 years to grow underground in Alpine grass and shrub lands before finally pupating (from larva) and are attacked by the fungus while feeding on roots. It finally takes the shape of 5-15 centimeter columnar mushroom out of the forehead of the caterpillar. It is mostly found in alpine meadows/bugyals of higher Himalayan ranges of Uttarakhand (Johar and Darma valley in district Pithoragarh, and parts of Chamoli district), and also in Darchula in Mahakali zone of the adjoining Nepal. As per Indian government rules, locals are allowed to gather *Keeda Jadi*, but not to trade it outside India.

In the global market, *Keeda Jadi* is worth Rs 18 lakhs (~25,000 USD) for a kilogram which is around 3500 to 4500 pieces of the fungus. In India, every year families in some regions of rural Uttarakhand hills, both Kumaon and Garhwal region, along with their children plod up in hills of Himalayas at the altitude of 3500 to 5000 meters to collect the *Keeda Jadi*.

Their high value also leads to the conflict among villages and illegal trade, as in India it is not legalized. This rare fungus is only found when summer sets in and snow (glacier) melts at higher altitudes of Kumaon region and exposes mummified caterpillars. People have started using uneven means to collect *Keeda Jadi*. Sometimes, forests are put on fire to melt the snow. Such unnatural practices are causing damage to the environment and precious species also. The government should take necessary steps to preserve these endangered caterpillar fungi. It has great demand in China where it is used for medical purposes since the 14th century. It is only found in the Himalayas and the areas of Tibetan Plateau. It is in demand for its energy booster and aphrodisiac qualities. In the 1990s, some Chinese athletes gave credit of their success to *Keeda Jadi* which increased its demand in the Chinese market. We must agree that we share the treasure nature has given us for medical purposes, but that does not justify the use of uneven means for any selfish motives. Situations like this also highlight the rural life of people of Uttarakhand who sometimes take up uneven means for their sustenance.

Further, industrial uses needs to be streamlined for some wild species, for example the Himalayan Nettle, *Girardinia diversifolia*, the fibre is very flexible and has high tenacity, allowing it to be used in a multitude of applications ranging from clothing and bags to floor mats and rope (Figure 5, D-G). Preservation of natural habitats and sustained availability of such wild plant resources needs to be ensured for community level to generate off-farm employment opportunities.

5. Conclusion

Wild plant food resources form a significant portion of the dietary diversity of the farmer households of Uttarakhand hills. However, the contribution of wild harvested foods to total food and nutritional security is under-researched. Constant efforts to increase agricultural production and enhance economic development have threatened the continued contribution of wild species to food and nutritional security. Unsustainable harvesting of some wild economic species is also threatening their continued availability for livelihood and nutritional security of local communities. Use of wild food resources is part of culture and traditions of hill communities of Uttarakhand and is part of their living link with the land. Decline in traditional ways of life is interlinked with decreased wild food use. Wild food species, therefore, provide more than just food and income to hill communities. Policies on conservation, food-security and agriculture, therefore, need to be integrated to recognize and preserve the importance of wild foods. Traditional food revitalization projects aimed at increasing the consumption of wild foods, in order to provide health and cultural benefits to traditional communities otherwise subject to the nutrition transition is considered a necessity. The efforts to conserve biodiversity and preserve traditional food systems and farming practices, therefore, need to be combined and enhanced. Documentation and promoting LEK; preservation of natural habitats; research on sustainable harvesting of wild plant resources for food

and livelihood security; nutrition composition database, etc., however, require a strong political will and policy support. It is a well-recognized fact now that wild species and intra-species biodiversity have key roles in global nutrition security. The wild foods still provide substantial health and economic benefits to those who depend on them globally.

Acknowledgements

The farmer households from different niche traditional farming sites of Uttarakhand hills deserve our special thanks for interacting with the researchers and sharing the valuable information they possess on wild plant resources and local agro-ecology. Thanks are also due to the Jawaharlal Nehru University, New Delhi for supporting the case study on "Indigenous land and food systems in Uttarakhand: a case study on use of wild foods in agricultural systems", under DST Network Programme on Traditional Knowledge Systems in the Indian Himalayan region that helped and motivated the researchers to take up the studies further.

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