

RESEARCH ARTICLE

Traditional Land and Food Systems: A Case of Uttarakhand State in North-western Indian Himalayas

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Like most of India, agriculture is one of the significant sectors of the economy of Uttarakhand state. About 86% of the state consists of hills, traditionally growing diverse crops as polycultures and sustaining about 50% of its population. As the contribution of agricultural biodiversity for food and nutritional security of native farming communities is often undervalued, the present communication succinctly documents the important features of traditional small-holder farming of Uttarakhand hills. About 70-80% of the native people living in rural areas depend on farming for their livelihoods, with the majority relying on small scale crop-livestock systems, including those that are integrated with long haul pastoral systems. The integration of crop and livestock production systems increases the diversity, along with environmental sustainability, of both sectors. At the same time it provides opportunities for increasing overall production and economics of farming. Being rich in agricultural biodiversity and food culture, use of locally available traditional food resources including wild harvested food resources in agricultural systems should be part of frontline strategies for nutrition interventions in Uttarakhand hills. The revitalization of local food systems is believed to be an imperative starting point in the local, regional and national framework of agrobiodiversity conservation, dietary diversification and food sovereignty in the Himalayan highlands. The present communication also suggests the need of a proactive alliance between local communities and their key allies across agriculture, food, and public health sectors in collaboratively creating a research and advocacy agenda in support of agrobiodiversity and the revival of local food systems and landscapes within the broader framework of indigenous food sovereignty.

Key Words: Community nutrition and health, Indigenous food sovereignty, Native food culture, Traditional hill farming

Introduction

Work on land tenure and traditional food systems are important for native farming communities and indigenous people world over. Indigenous food systems help people to realize the importance of maintaining their connections with nature and their own cultures, and between heart and mind, to reaffirm identity (Woodley *et al.*, 2009). Where people identify themselves with their culture and natural environment, knowledge and use of traditional food systems to improve health builds community support and engagement for holistic health and well-being. Kuhnlein *et al.* (2009) asserts that “the dimensions of nature and culture that define a food system of an indigenous culture contribute to the whole health picture of the individual and the community-not only physical health but also the emotional, mental and spiritual aspects of health, healing and protection from disease”. Those living in their rural homelands depend on traditional food systems rooted in historical continuity in their regions, where food is harvested with traditional

knowledge from the natural environment, and prepared and served in local cultural settings. This is also an important aspect of cultural collectives of individuals and community – in recognizing continuity from the past, into the present and towards the future (Woodley *et al.*, 2009).

Security of tenure, which is crucial to native communities’ cultural identity and well-being, can be enhanced through recognition of customary tenure rules and practices. Common property regimes provide a basis for shared identity and livelihoods, and have been found to contribute to the health status of communities (Woodley *et al.*, 2009). Indigenous Peoples’ organizations are, however, concerned that various types of development activities have had negative impacts on native indigenous communities’ traditional food and agro-ecosystems. Such impacts can only be avoided if development programmes are carried out with the free, prior and informed consent (FPIC) of the native communities with traditional rights to the lands, territories or resources concerned. Indigenous

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Peoples are often insufficiently aware of their rights, particularly those related to Intellectual Property Rights (IPR) and Access and Benefit-Sharing (ABS) as laid down in various UN treaties and conventions.

It is a well-accepted fact that crop diversity and wild-harvested plants and animals have made and continue to make appreciable contributions to human diets (Heywood, 2013). However, detailed evidence of their importance in terms of energy intake, micronutrient intake and dietary diversification is scarce and correlating agricultural biodiversity with human nutrition is generally difficult for a number of reasons including human diversity (DeClerck *et al.*, 2011).

Further, the exploitation of agricultural biodiversity has provided enormous nutrition and health benefits but overexploitation of some resources and extensive habitat loss has negatively impacted dietary diversity, nutrition and health of some groups of society (Nakhauka, 2009). We are now faced with attempting to assess these impacts, learn lessons and seek a sustainable way forward (IAASTD, 2009). New approaches have been explored which aim to integrate environmental and human health, focusing especially on the many interactions between agriculture, ecology and human nutrition (Blasbalg *et al.*, 2011; Heywood, 2013).

It is a well-known fact that despite the success of the agricultural revolution in providing enough food to feed the world, today we are faced with issues of over- and undernutrition – both forms of malnutrition. More than a billion people today are underfed and suffering from acute malnutrition thus making them more disease-prone, while much of the developed world is at the same time facing a crisis of obesity caused by overnutrition, a condition that is increasingly aggravated by an unhealthy lifestyle, leading to diet-related diseases, such as cardiovascular disease, hypertension, cancer, diabetes, etc. This tendency is not confined to the developed world but is also spreading to countries undergoing rapid societal transition – so-called development-driven obesity (Heywood, 2013). Worldwide 30 per cent more people are now obese than those who are underfed. The causes of these nutritional challenges are many and complex as are possible solutions.

Salient findings of a few exploratory case studies on native crop landrace diversity, experiential knowledge of farmer households in identification and use of wild harvested foods in agricultural systems, and potential of

native biodiversity in addressing the food-based approach to community health and nutrition are highlighted in the present communication with regard to hilly areas of Uttarakhand state in north-western India where biodiverse traditional subsistence farming is still predominantly practiced.

The salient findings of the case study on wild harvested foods in agricultural systems are discussed in great detail in this communication as it forms an important but undervalued component of local food culture in Uttarakhand hills.

The aim of these exploratory case studies has been to build scientific credibility of local food systems, to use this information to improve the health of the people directly involved, and to share the findings to influence policies at the local and national levels. We also discuss how policies can be influenced to benefit native communities use their food systems, particularly by increasing access to the range of biodiversity available in overall framework of indigenous food sovereignty.

The studies on the potential of local food systems in addressing community health and nutrition will showcase how best the problem of malnutrition and food-related diseases can be addressed by reviving the native food culture. The need of a proactive alliance among diverse stakeholders collaboratively creating a research and advocacy agenda in support of agrobiodiversity and the revival of local food systems and landscapes within the broader framework of indigenous food sovereignty will be explored and advocated. Food sovereignty has yet not been formally adopted in the state policy of India in general and Uttarakhand hills in particular.

Representative Farming Situations in Uttarakhand Himalaya

Like most of India, agriculture is one of the significant sectors of the economy of Uttarakhand state. About 86% of the state consists of hills but most of the crop lands are in plains, the *Terai* and *Bhabar* region, where improved agriculture is practiced (Figure 1). On the other hand, the hilly areas of Uttarakhand state (parts of north-western Himalayas) traditionally grow diverse crops as polycultures. The crops include coarse cereals (minor millets-finger millet, barnyard millet, foxtail millet, little millet, prosomillet), rice, wheat, barley, pulses (horse gram, black gram, black-seeded local soybean, lentil, cowpea, rice bean), oilseeds (mustard, sesame), several



Fig. 1. Major agro-ecological regions in Uttarakhand (Site 1-3 are niche sites for representative farming situations)

underutilized crops (amaranths, buckwheat, chenopods, tubers, yams, cucurbits, minor leafy vegetables, perilla and others), numerous medicinal herbs, etc. Most of these native crops and their traditional landraces form the “functional foods” to hill farming communities with nutraceutical properties and high nutritional value.

The subsistence harvests and uses of *wild* resources by native communities have been another important feature of traditional hill farming. Fruits such as apples, oranges, pears, peaches, plums, and citrus are also grown and important to the food processing industry in certain areas. Livestock (buffalo, cattle, goats, sheep, and poultry) are integral to hill farming and contribute substantially to rural economy.

In Uttarakhand hills there exists a self-contained food system, specific to different farming situations and communities which are deeply rooted in local traditions and culture. However, the forces of globalization and the vulnerabilities arising from poverty, discrimination and marginalization in some sections of farmer households in the hill communities are increasingly affecting the native food culture. Limited access to diverse food resources is affecting the nutrition and health of native communities causing malnutrition among children and women.

The traditional hill agriculture is highly knowledge-based and farmer-led innovations are predominantly practiced. All farmer led innovations are socio-economic

and are not of a technical nature. The driving forces for emergence of the farmer led innovation paradigm are constraints to crop and livestock production.

Non-availability of quality seed of native crop varieties, lack of human resource (farm labourers), poor market infrastructure for native crops, high land fragmentation, and the changing climate, especially greater frequency and severity of droughts during the past two decades or so, have been the major constraints to traditional rainfed agriculture of Uttarakhand hills. Further, poor management of common property resources (CPRs) leads to declining fodder resources for livestock in crop-livestock small-scale mixed farming and declining sources of wild harvested foods. The dynamic relationship among crops, livestock and CPRs is increasingly breaking down now.

During the exploratory surveys in parts of Uttarakhand hills we encountered the following three predominant representative farming situations (Fig. 1; Photo Plates 1-3):

1. Small-scale crop-livestock mixed-farming systems representing about 70% cropped area under rainfed farming (Plate 1). 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 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 cash income.
2. High elevation mountainous areas adjoining Tibet with a mix of nomadic pastoralism, some arable land and wild harvesting including foraging and trading of medicinal herbs (Plate 2). Sheep and goat are the herded livestock. Level of household food production and dietary diversity is moderate to high. This system is representative of about 10% of the farming areas in hills of Uttarakhand. *Bhotia* and *Shoka* tribes are the main inhabitants of the region. The agricultural economy of the mountainous 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

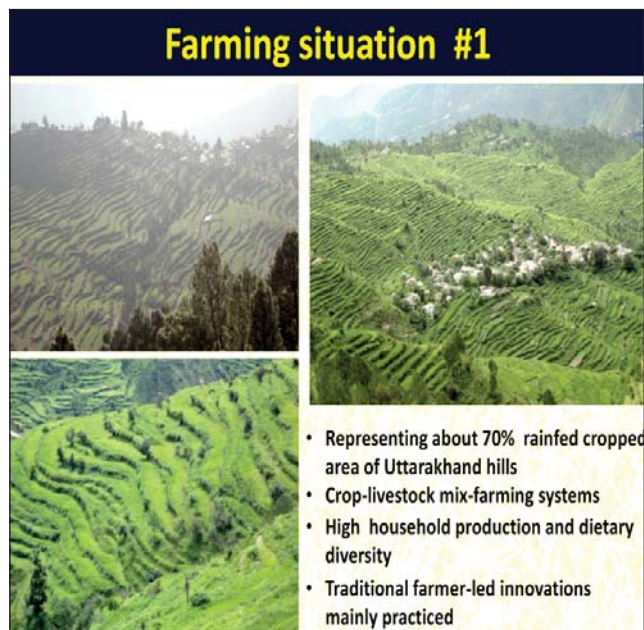


Plate-1

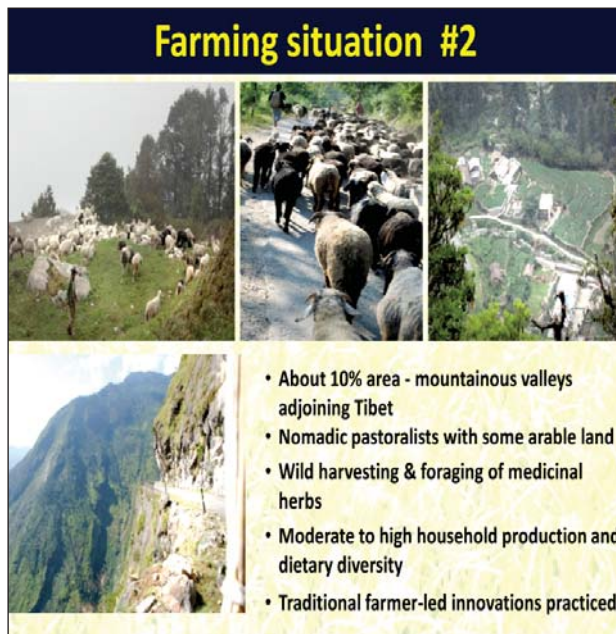


Plate-2



Plate-3

Plate-1 to 3: Representative farming situations in Uttarakhand hills (Sites 1-3)

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.

Important crops include naked (hull-less) barley, tatar buckwheat (*Fagopyrum tataricum*), potato and many minor tubers, yams, leafy vegetables, and others. Consumption of meat (sheep and goat) is high in nomadic pastoralist societies. Cultivation and foraging of medicinal and other herbs, for export purposes in past and now for local and distant national markets viz. 'Jambu' or 'Faran'

(*Allium stracheyi*); ‘Gandhrain’ (*Angelica glauca*); ‘Kala jeera’ (*Carum carvi*); ‘Chuk’, Sea-buckthorn (*Hippophae rhamnoides* ssp. *salicifolia*), etc. are common and a major economy for local communities.

Allium spp., *Dendrobenthamia capitata*, *Elaeagnus parvifolia*, *Epilobium royleanum*, *Fagopyrum dibotrys*, *Fragaria nubicola*, *Gautheria trichophylla*, *Holboellia latifolia*, *Lonicera angustifolia*, *Malus baccata* var. *himalaica*, *Oxyria digyna*, *Paeonia emodi*, *Podophyllum haxandrum*, *Prunus* spp., *Rheum* spp., *Ribes* spp., *Schisandra grandiflora*, *Sorbus aucuparia*, *Taraxacum officinale*, *Viburnum* spp., etc. are other wild plant food resources of nomadic pastoralists commonly occurring in alpine and mountainous meadows/bugyals.

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 (Plate 3). 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 local 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.

A nutrition transition is 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 mainly 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 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.

There existed a dynamic relationship among CPRs, crops and livestock of the mixed farming system in past in the hills. The same is now under increasing pressure from different sources. The livestock production systems are becoming quite dynamic in certain areas and households with accessibility to road networks and a market for milk. Farmers are being provided with a strong incentive to keep livestock; not just to fulfil the traditional role of providing draught power, milk, meat, and manure for households; but also to generate cash income through the sale of milk and meat. In certain areas, there has been a shift in management practices, with linkages to CPRs beginning to break down.

The small-scale crop-livestock traditional farming practices of the Uttarakhand hills, therefore, holds a promise for food and nutritional security of farmer households. The general ignorance of the nature and use of nutrient-rich indigenous and traditional food resources over the years has resulted in these foods being left out of most nutritional strategies put in place to address food security and nutrition problems of the local population. Awareness about enhanced use of minor millets, native pulses/legumes, leafy and underutilized vegetables, native tubers and yams, minor fruits, wild harvested foods, animal food products, etc. in daily diets, as “functional foods”, can help address community health and nutrition in Uttarakhand hills.

Materials and Methods

Case Study on Farmer Household Production and Dietary Diversification

An exploratory case study, comparing the food production and dietary diversity of three representative farming situations of Uttarakhand hills, was conducted during 2015-16. The main representative target site was an agrobiodiversity rich niche village cluster in Tarikhet block of Almora district in Uttarakhand state (Fig. 1, Site 1). The study site comprised about 14 villages, 1000 farmer households and 1000 ha cropped area. The target site represented the crop-livestock small-scale mixed-farming, it being the predominant farming system of the Uttarakhand hills. The two other representative

niche habitats for documenting information on household production and dietary diversity included, i) high elevation mountainous areas where long-haul pastoral/nomadic livestock herding is practiced together with crop husbandry and cultivation, foraging and trading of medicinal herbs (Fig. 1, Site 2), and ii) river valleys where improved agriculture and crop monoculture is practiced (Fig. 1, Site 3). Information was documented from about 100 households in each of these two niche target sites representing a cluster of about 8-10 villages spread over 50-60 km² area.

A participatory approach was adopted for documenting information on household production and dietary diversity. Information on crop diversity, livestock diversity, food production and consumption diversity, and associated indigenous knowledge (IK) was documented. Consequent upon complete documentation of the community seed and livestock breed management systems; household production and dietary diversity; food and nutrition transition, etc., the farmer households expressed their opinion, in location-specific FGDs, on advantages/disadvantages of the existing farming systems; the pattern of change in production and dietary diversity over the years; the status of the existing indigenous knowledge in the community regarding biodiversity management and role of native diversity, including wild harvested foods in agricultural systems, in food and nutritional security of farmer households; and the way forward showcasing the potential of local food in eradicating malnutrition and addressing the nutritional security of farmer households.

The household production and dietary diversity scores were measured as per FAO (2011) and Sibhatu *et al.* (2015) with minor modifications.

An exploratory study was also conducted to relate the household production and dietary diversity with the nutrition and health of the above three *niche* target sites on the following health indicators, 1) Infant mortality rate, 2) Maternal mortality rate, 3) Level of malnutrition among children under five years, 4) Malnutrition among women of reproductive age, 5) Level of obesity among adults, 6) Level of coexistence of obesity in the adults and malnutrition in the children, 7) Formal education about malnutrition among women, 8) Incidence of communicable diseases (*e.g.* tuberculosis), and 9) Incidence of food-related non-communicable diseases (*e.g.* hypertension and diabetes).

Case Study on Wild Harvested Foods in Agricultural Systems

Data were collected through semi-structured interviews using a checklist of open ended questions. Since the data required 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. Data were documented from about 20 representative niche sites of three farming situations, i) traditional rain-fed farming areas (crop-livestock mix-farming, 10 niche sites), ii) mountainous regions-alpine meadows/*bugyals* (nomadic pastoralists, 5 sites), and 3) river valleys (improved farming, 5 sites) of Uttarakhand hills (Plate 1-3). Average 10-15 farmer households were interviewed per niche site.

Results

Farmer Household Production and Dietary Diversity

A comparative study on production and dietary diversity as well as certain health indicators (Table 1 and Table 2) was performed under three different representative farming situations in Uttarakhand hills. It is evident from Table 1 that farmer household production and dietary diversity is more where traditional small scale crop-livestock mixed-farming is practiced followed by mountainous areas with a mix of nomadic pastoralism, crop husbandry, and wild harvesting and foraging of medicinal herbs, and river valleys where improved agriculture is practiced. With relatively greater per capita household income, the farmer households of river valleys has enhanced access to energy-dense foods low in nutrition leading to both malnutrition and obesity.

It is also evident from Table 2 that the problem of under-nutrition and obesity co-exist even in Himalayan highlands. With the nutrition transition resulting from increasing socio-economic change, the problems of overweight and underweight frequently co-exist even within the same village and even within the same household. Socio-economic disparities and increased access to energy-dense foods are creating an “obesogenic” environment particularly in river valleys as recorded in the present exploratory case study. In the present study we noticed that malnutrition is not always the result of food scarcity, it can also be caused by foods that are poor in essential nutrients. Lack of access to nutrient-rich food has in turn led to nutritional deformities (like stunting), which increases the likelihood of obesity later in life.

Wild Harvested Plant Food Resources in Agricultural Systems

A total of about 335 plant species have been recorded in different plant families of Angiosperms, and also Gymnosperms and Pteridophytes. A total of 97 families of dicotyledons and 12 families of monocotyledons, in Angiosperms; three families of Gymnosperms, and one family of Pteridophytes (Ferns) were represented

(Table 3). Rosaceae (25), Polygonaceae (15), Fabaceae, (12), Asteraceae (11), Lamiaceae (10), Liliaceae (10), Urticaceae (10), Amaryllidaceae (Alliaceae, 8), Amaranthaceae (8), Caesalpinaceae (7), Rutaceae (7), etc. were the families with greater species representation among angiosperms.

Domestication programmes are being initiated by Uttarakhand state to bring many wild species, mainly the local herbs into farming systems. Examples of important plant species for domestication interventions include, *Allium humile*, *A. stracheyi*, *A. wallichii*, *Asendra butyracea*, *Malus baccata* var. *himalaica*, *Sorbus lanata*, *S. cuspidata*, *Fragaria nubicola*, *Rubus macilentus*, *R. ellipticus*/ *R. biflorus*, *R. nutans*, *Hippophae rhamnoides* spp. *salicifolia*, *Rosa sericea*/ *R. macrophylla*, *Cleome viscosa* and others. These species can help provide livelihood support, health and nutritional benefits to local communities.

The 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

Table 1. Production and consumption pattern of major food groups in households (HH) of three different niche target sites of Uttarakhand state

Household characteristics	Agrobiodiversity rich niche site where traditional small scale crop-livestock mix-farming is practiced * (<i>Niche</i> site 1)	Niche site with nomadic pastoralism and some arable land** (<i>Niche</i> site 2)	Niche site where improved agriculture is practiced*** (<i>Niche</i> site 3)
Average per capita cash income/ annum (Rs.)/ HH (excluding home consumption of local agricultural produce)	33,259	36,425	52,124
Per cent contribution of livestock to HH cash income (without taking home consumption products into account)	29.60	34.60	5.50
Production diversity (no. of crop/livestock species produced/reared)	32.06	28.70	14.20
Food crop production diversity (no. of food crop species produced)	27.78	19.70	13.30
Food variety score (no. of food items consumed)	22.13	18.50	9.30
Food variety score only with respect to purchased foods (no. of food items consumed)	14.07	9.30	6.50
Dietary diversity score (no. of food groups consumed)	6.43	5.60	4.30
Dietary diversity score of healthy foods (no. of healthy food groups consumed)	5.49	4.50	3.40
Dietary diversity score only with respect to purchased foods (no. of healthy food groups consumed)	2.24	1.80	2.20
Food purchased from market, % of total food	29.37	21.32	18.30
Dietary diversity of wild harvested food	31.24	25.50	7.50

* The main target study site in Tarikhet block of Almora district; ** Higher Himalayan ranges (Johar valley in Pithoragarh district where nomadic pastoralism is practiced, the herded livestock includes sheep and goats); *** Someshwar valley in Almora and adjoining Garur valley in Bageshwar district

Table 2. Comparison of some health indicators of households of three different niche target sites of Uttarakhand state (last two decades)

Health indicator	Niche site 1	Niche site 2	Niche site 3	Uttarakhand state
1. Infant mortality rate	Nil	Nil	Nil	38 /1000 (SRS 2011), 32/1000 (SRS 2013) 43/1000 (AHS 2011)
2. Maternal mortality rate	Nil	Nil	Nil	292/100000 (SRS 2010-12) 188/100000 (AHS 2011)
3. Level of malnutrition among children under five years*	Low (2%)	Low (2%)	Moderate (10%)	High (~40-50%)
4. Malnutrition among women of reproductive age**	Low (3%)	Low (4%)	Moderate (12%)	High (~40-50%)
5. Level of obesity among adults	Low (3%)	Low (5%)	Moderate (14%)	Data not available
6. Level of coexistence of obesity in the adults and malnutrition in the children	Low (2%)	Low (4%)	Moderate (8%)	Data not available
7. Formal education about malnutrition among women	Low	Low	Low	Low
8. Incidence of communicable diseases (e.g. tuberculosis)	Nil	Nil	Nil	170/100000 (State level health reports)
9. Incidence of non-communicable diseases				
● Hypertension	Low (2%)	Low (2%)	Moderate (7%)	8%
● Diabetes	Low (1%)	Low (2%)	Moderate (5%)	5.7%
				(MHFW-NPCDCS Survey 2010)

Niche site 1: Agro-biodiversity rich niche site where traditional small scale crop-livestock mix-farming is practiced

Niche site 2: Mountainous regions with nomadic pastoralism, some arable land and medicinal herb foraging

Niche site 3: River valleys where improved agriculture is practiced

*Based on three child malnutrition indicators, stunting, wasting and underweight

** Based on the concept of nutritional anaemia among women of reproductive age

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.

Though several studies have found that wild foods are important sources of micronutrients, their energy-density is generally low with a few exceptions. 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, B₂, 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.

The Economic Value of Wild Foods

There is no comprehensive estimate of the economic value of wild foods. Quantitative analyses face methodological difficulties. First, case studies using different valuation

methods and diverse scales are rarely comparable. Second, sale of wild products is very limited, often illegal, and therefore under-reported. Trade is often informal or occurs at local markets and is, therefore, missed by conventional accounting mechanisms.

While exact estimates of the economic value or volumes involved is difficult, what is not in dispute is that trade in and use of wild foods provide an important supplement to general incomes and are especially critical during economic hardship. In Table 4, we summarize findings from economic valuations of direct use values for wild foods in selected agro-ecologies/farming situations of Uttarakhand hills. From the limited data available, during exploratory surveys for some important species, it is clear that wild plants can provide Rs. 5,000–5,00,000 per households in specific agro-ecologies/niche areas.

An important aspect of wild food use is the relative importance of wild foods to poorer households. The conventional understanding holds that poorer households depend more on wild foods. However, detailed analyses on limited exploratory data do not show simple correlations between wealth and resource use. A range of context-specific social and economic factors (e.g. price, individual or cultural preference, and wealth) are

Table 3. Number of plant species used as wild harvested foods in Uttarakhand hills

Family	No. of species	Family	No. of species	Family	No. of species
Dicotyledons					
Acanthaceae	3	Fagaceae	2	Saurauiaceae	1
Amaranthaceae	8	Flacourteaceae	2	Saxifragaceae	2
Anacardiaceae	4	Gentianaceae	1	Schisandraceae	2
Annonaceae	1	Geraniaceae	1	Scrophulariaceae	2
Apiaceae	3	Grossulariaceae	3	Simaroubaceae	1
Apocynaceae	2	Hippocastanaceae	1	Solanaceae	3
Asclepiadaceae	5	Hydrocotylaceae	1	Sterculiaceae	1
Asteraceae	11	Juglandaceae	1	Taxaceae	1
Balsaminaceae	4	Lamiaceae	10	Tiliaceae	2
Begoniaceae	1	Lardizablaceae	1	Ulmaceae	4
Berberidaceae	1	Lauraceae	3	Urticaceae	10
Bignoniaceae	1	Loranthaceae	3	Verbenaceae	5
Bombacaceae	1	Lythraceae	1	Violaceae	4
Boraginaceae	1	Malvaceae	4	Vitaceae	3
Brassicaceae	6	Menispermaceae	2	Zygophyllaceae	1
Buxaceae	1	Molluginaceae	1	Total	286
Cactaceae	1	Moraceae	5	Monocotyledons	
Caesalpinaceae	7	Moringaceae	1	Amaryllidaceae (Alliaceae)	8
Campanulaceae	1	Myricaceae	1	Araceae	5
Cannabinaceae	1	Myrsinaceae	3	Comellinaceae	2
Capparidaceae	1	Myrtaceae	1	Cyperaceae	3
Capparifoliaceae	1	Nyctageneceae	1	Dioscoraceae	5
Caryophyllaceae	3	Olacaceae	2	Hypoxidaceae	1
Celastraceae	2	Oleaceae	1	Liliaceae	10
Chenopodiaceae	3	Onagraceae	2	Orchidaceae	2
Combretaceae	3	Oxalidaceae	1	Palmae	3
Convolvulaceae	2	Paeoniaceae	1	Poaceae	2
Coriariaceae	1	Phytolaccaceae	2	Smilacaceae	1
Cornaceae	2	Podophylaceae	1	Zingiberaceae	2
Corylaceae	1	Polygonaceae	15	Total	44
Crassulaceae	1	Portulacaceae	1	Gymnosperms	
Cucurbitaceae	5	Punicaceae	1	Ephedraceae	1
Dillaneaceae	1	Ranunculaceae	1	Pinaceae	2
Dipsacaceae	1	Rhamnaceae	4	Taxaceae	1
Dipterocarpaceae	1	Rosaceae	25	Total	4
Ebenaceae	1	Rubiaceae	5	Pteridophytes (Ferns)	
Ehretiaceae	4	Rutaceae	7	Dryopteridaceae	1
Eleagnaceae	3	Sambucaceae	3		
Ericaceae	4	Sapindaceae	1		
Euphorbiaceae	5	Sapotaceae	1		
Fabaceae	12	Sauraceae	1		

G. Total: 335

also relevant. In some households, consumption of wild foods increases with wealth and depends less on natural abundance than on socio-economic factors.

Drivers of Change in Wild Food Availability and Use

There are a number of important drivers for wild food availability and use. While some clearly increase or

decrease the use of wild foods, the impact of others is ambiguous and context-dependent. The importance of understanding current trends for wild foods is underscored by the recognition that food insecurity is a particular problem among local communities. For instance, food insecurity was relatively more in households of crop-livestock small-scale mix farming situations followed

by nomadic pastoralists and least in households of river valleys. The interaction between drivers also deserves attention. In assessing links between local knowledge and socio-cultural continuity, we found that cultural identity and agrobiodiversity are strongly associated: ‘culture and ecosystems co-evolve’. Thus, a biophysical driver (e.g. climate change) has knock-on effects on a cultural parameter (e.g. local knowledge), and the effect of the two combined could lead to either an increase or decrease in wild food use.

(a) *Wild foods in a changing climate*

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 situations of Uttarakhand hills (Figure 1; Plate 1-3) 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.

Wild food species offer a potentially critical role for buffering against food stress caused by a changing climate. Nevertheless, the innate resilience of wild species to rapid climate change, which is often lacking in exotic species, means that they could play an increasingly important role during periods of low agricultural productivity associated with climate events.

(b) *Land Use change and degradation*

Decline in management of CPRs including expansion of intensive agriculture in river valleys and enhanced cash crop economies in some areas, limit the capacity of ecosystems to sustain food production and maintain the habitats of wild food species. Changes in land use

and agriculture expansion/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 in Uttarakhand hills.

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. In about 20 niche habitats (Table 4) surveyed in the present exploratory 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.

Lack of sustainable intensification, will further threaten naturally biodiverse landscapes. This calls for a biodiversity-focused strategy in food, public health and poverty-alleviation policies.

(c) *Unsustainable harvesting and changing dynamics*

The Indian Himalayas including the Uttarakhand hills although one of the global hot-spots of biodiversity, have areas of greater malnutrition and hunger, which

Table 4. Direct use values of wild foods either as contributions to household consumption or income from sale in niche target areas of three representative farming situations (in percentage terms)

Farm household respondents from niche sites of different farming situations	Wild harvested foods (plant species used of the total reported in parentheses)	Other foods	Contribution of wild harvested food resources to household cash income	Major wild plant resources for household cash income from market sale
Crop-livestock small scale mix-farming systems (10 niche sites; 150 households)	8 (70)	92	14	<i>Myrica esculenta</i> (Kaphal); <i>Diplazium esculentum</i> (Lingura , a vegetable fern); <i>Bauhinia variegata</i> (Kuiral , Mountain Ebony)
Mountain valleys, alpine meadows/bugyals (5 niche sites; 70 households)	16 (40)	84	34	<i>Allium</i> spp. (Jambu or Faran); <i>Angelica glauca</i> (Gandhrain); <i>Carum carvi</i> (Kala Jeera)
River valleys (5 niche sites; 50 households)	2 (20)	98	1.5	<i>Diplazium esculentum</i> (Lingura , a vegetable fern)

also places 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.

(d) Loss of local ecological knowledge

Local ecological knowledge is required for the identification and collection of species for preparation of foods with wild species. The distribution of LEK between individuals in a community is usually differentiated by gender, age or social role. In present exploratory case study, women scored higher on food-related knowledge. Data from about 20 niche sites, revealed that 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 held specialized LEK. While men had more knowledge of hunting and fishing, women had more knowledge of wild food plants. LEK was also differentiated by age: children gathered 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 relied increasingly on market-bought foods having moved away from land-based livelihoods. It is thus possible that as young adults leave land-based livelihoods, knowledge transmission to younger generations will be diminished. In other cases, individuals' preferences change as they grow and thus, their stock of LEK changes, even if they remain within their community. It was observed that the grown-ups usually succumb to the culture of the society which regards the consumption of

wild fruits as an inferior act. As climate change alters habitats, so knock-on effects are expected on LEK is feared.

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. Our study reveals that LEK, a primary factor responsible for successful resource management, declines in association with economic growth. Therefore, in addition to the depletion of goods and services, the capacity of local communities to manage what environmental assets remain will decline in the future in association with economic growth. Hence time and money could be saved if the knowledge, experiences, and capacities of local peoples were protected and used in resource management efforts today.

(e) Socio-economic change and the expansion of markets

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 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.

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 traditionally played a critical role in native communities, public health policy generally

operate within a model of food security that discounts the traditional food practices of the hill communities.

State of Food Sovereignty Movement in Uttarakhand

There is limited awareness about indigenous food sovereignty among farming communities of Uttarakhand hills. Indigenous food sovereignty is poorly understood conceptually by farmer households. The self-contained indigenous food systems are, however, largely dependent on landrace cultivation of native/naturalized crops, rearing of native livestock breeds and harvesting wild foods for subsistence from nearby agro-forestry/forestry areas. Ecological food provisions maximises the contribution of ecosystems and improves resilience and adaptation of production and harvesting systems, especially important in the face of climate change.

Discussion

There has been a resurgence of interest in agricultural biodiversity within traditional food systems and the possible role these resources could play in ongoing efforts to steer populations away from carbohydrate and energy rich foods that are typical of simplified diets to more diversified diets that engender household food and nutrition security. In spite of nutrition transition trend in many other parts of Uttarakhand, it is widely acknowledged that in the representative target region rich in crop and livestock diversity and use of wild harvested foods, food traditions are still prevailing in the life of rural households to a greater extent. It is indeed heartening that the traditional food habits are still playing a significant role in contemporary food habits of the target communities, and the possibility of reversing the trends in favour of dietary diversification from dietary simplification look promising. It was found that the root cause of both malnutrition and over-nutrition/obesity is inadequate or improper nutrients. Consumption of an appropriate portion of food rich in essential nutrients can eliminate both pandemics.

The exploratory study of the household production and dietary diversity of different representative farming situations in Uttarakhand state clearly indicated that high production and dietary diversity is linked with better community health and nutrition. Growing a range of local crops supplemented by wild-harvested foods help provide much diversity in the diet in traditional farming areas. It may also be emphasized that better and balanced nutrition in the human diet depends not just on growing

a diversity of crops but on the diversity within the crops (Mouille *et al.*, 2010). The micronutrient superiority of landrace cultivars complemented with wild harvested food resources in traditional hill farming has been revealed by the present exploratory research findings. The past researches have shown substantial inter-varietal differences (Kennedy and Burlingame, 2003; Burlingame *et al.*, 2009; Litaladio *et al.*, 2010). Intake of one variety rather than another can be the difference between micronutrient deficiency and micronutrient adequacy in traditional farming. Unfortunately, we lack detailed information about such diversity within most crops at the cultivar level and the role it plays in nutrition because of the general neglect by researchers/professionals (Burlingame *et al.*, 2009) and much of the evidence is anecdotal.

Coates *et al.* (2007) suggest dietary diversity, typically measured in the form of a count of food groups or food group frequency, as a proxy indicator for nutrient adequacy. Adequate human nutrition thus involves regular intake of a wide range of nutrients, some of which must be consumed on a frequent basis, even if in small quantities. The micronutrient superiority of some lesser-known cultivars and wild varieties over other has been confirmed by certain recent researches (Heywood, 2013).

We believe that the trend in nutrition transition can be slowed down and certain approaches are needed to move the nutrition transition in a more positive direction. Among the suggested public health promotion strategies, policies and intervention approaches (Smith, 2013) are:

- Holistic integrated food and nutrition interventions.
- Addressing under- and over-nutrition simultaneously.
- Involving communities in planning interventions using a bottom-up rather than top-down approach.
- Focusing on diversification of diets rather than a reliance on fortified foods and supplementation where possible.

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. Within the larger society in which they live, despite the wealth of knowledge rural indigenous people have of their local environment and food system, they often face vulnerabilities derived from extreme poverty, discrimination and marginalization. It has been rightly argued that the emerging concept of food sovereignty emphasizes farmers' access to land, seeds, and water while focusing on local autonomy, local markets, local production-consumption cycles, energy and technological sovereignty, and community level farmer-to-farmer networks (Altieri, 2009).

The case study on household production and dietary diversity will set the stage for the future research to demonstrate how these local foods contribute to food security, nutrition and health. Our long-term objectives will be to address scientific issues, public health, and policy, with the goal of influencing local, national and international policies for environmental protection of indigenous peoples' land and food resources. In this way, communities can be encouraged to strengthen their use of local food and sustain knowledge of their local food systems for essential contributions to cultural protection, well-being and health. Local biodiversity should be recognized as a significant contribution to a sustainable agriculture–food–nutrition strategy alongside improvements in agricultural productivity and agronomic practice, nutritional enhancement of crops, industrial fortification, vitamin supplementation and other nutrition–agriculture interventions (Heywood, 2013).

Uttarakhand hills are primarily an agriculture-based society with a rich native food culture and traditions. The native food culture affects the holistic health of native communities individually and in community and cultural collectives - in recognizing continuity from the past, into the present and towards the future (Woodley *et al.*, 2009; Kuhnlein *et al.*, 2009). Indigenous people never separated food from medicine, depending upon which part of the plant is used, the season of the year and physiological condition of the person using the crop, the same plant can be consumed as food or medicine (Kuhnlein *et al.*, 2009). Further sustainability of the environment happened to be one of the critical issues in the food acquisition and consumption of indigenous communities' world over (Demi, 2016). Industrial agriculture on the other hand is premised on a business model through neoliberal policies. The current WTO policy has worsened the plight of small-holder farmers,

creating backlogs of unemployment in the Global South and widening the poverty gap between the rich and the poor in most countries.

One of the commonest criticisms of advocating a greater use of local agricultural biodiversity in the form of traditional crops, underutilized species and wild-harvested species to address under- or malnutrition is precisely that it is local and it is assumed therefore will have little impact on the global picture. Yet, at least 20 per cent of the world food supply comes from traditional multiple cropping systems, most of them small farm units often of 2 ha or less (Altieri, 2009). There is ample evidence on the ground that local biodiversity and ecosystem services play an essential role in the lives of communities throughout the developing world, by providing a social safety net for food, medicine, fibre, fuel wood etc. that can act as route out of poverty and a source of income generation, prevent people falling further into poverty or in extreme cases as an emergency lifeline through the provision of 'famine food' (Roe *et al.*, 2010) [Not cited in References]. It can also play a major part in addressing issues of malnutrition (Heywood, 2013).

With rich native food culture and more than 80% area under traditional farming, except a few river valleys, Uttarakhand state offers hospitable conditions for indigenous food sovereignty movement. Unlike food security, the food sovereignty has to be a process coming from the bottom up – from the peasant, from the communities (Schiavoni, 2015, 2017).

The native food culture of Uttarakhand hills can be discussed here in greater detail based on local IK in context of food viz. spirituality, food security, harvesting regulations/restrictions and reliance on locally available material as outlined by Demi (2016).

The predominantly crop-livestock small-scale mix farming systems of Uttarakhand hills encourages farmer households more on consumption of traditional crops instead of animal flesh except the nomadic pastoralists of high mountainous regions who depend relatively more on animal products. In indigenous animal husbandry of Uttarakhand hills, the livestock are mainly fed with crop by-products while substantive food is mainly reserved for human consumption. Such system saves humans from competing with livestock for food and ensuring food sufficiency.

Dependence of local communities of Uttarakhand hills on diverse plant resources including wild harvested

foods in local food culture ensures that the plant species are protected and this way an effective mechanism of sustainability that indigenous communities can employ to maintain a cosmic balance in the ecosystem could be duly showcased by the present case study research.

An important tradition of harvesting regulations/restrictions commonly practiced in local farming communities/ food culture of Uttarakhand hills also ensures sustainability and helps control human desires which is considered an important learning in environmental education (Orr, 2004).

Use of local readily available materials, for example use of forest litter, animal waste, farm-yard manure, etc. and avoidance of synthetic fertilizers, except in river valleys where modern agricultural practices are followed, ensure that safe organic foods are produced for human consumption in Uttarakhand hills. These practices intend to improve human health and preserve the environment for future generations.

The exploratory case studies therefore suggest that the traditional food consumed by rural communities in Uttarakhand hills contain nutrients and calls to revert to the diets of our ancestors to regain lost nutrients. It is believed that such a shift would help to improve society's relationship with the Earth and restore human and environmental health. Many traditional and non-processed foods consumed by rural communities, such as millets, leafy greens, legumes, wild harvested food resources are nutrient-dense and offer healthy fatty acids, micronutrients and cleansing properties widely lacking in diets popular in high- and middle-income societies/countries.

Indigenous diets worldwide are varied, suited to local environments, and can counter malnutrition and disease. For many indigenous communities, their food systems are complex, self-sufficient and deliver a very broad-based, nutritionally diverse diet. But the disruption of traditional lifestyles due to environmental degradation, and the introduction of processed foods, refined fats and oils, and simple carbohydrates, contributes to worsening health in native communities, and a decline in the production of nutrient-rich foodstuffs that could benefit all communities. Kuhnlein *et al.* (2009) says that "Indigenous peoples' food systems contain treasures of knowledge from long-evolved cultures and patterns of living in local ecosystems". Therefore, the traditional food systems need to be documented so that policy makers

know what is at stake by ruining an ecosystem, not only for the native peoples living there, but for everyone.

Not only does food diversity have relevance in a public health and food policy sense, but also in individual counselling in clinical practice. Assessment of a patient's food variety can be rapid and semi-quantitative, encouraging small and consequential changes in diet. When ethnicity is taken into account, in the clinical setting, this process can be even more rewarding for the practitioner and patient (Wahlqvist, 2005).

The exploratory research outcome clearly indicates that malnutrition is not result of food scarcity but foods poor in essential nutrients. Although the problem of diminished food sovereignty and food insecurity is one that affects all people, not just indigenous communities, indigenous peoples are uniquely situated to offer solutions. Armed with ancient traditional knowledge and a deep connection to their lands, native communities, and particularly native women, are developing projects and building networks to revitalize local food capacity and strengthen food sovereignty.

The present study, therefore, shows that with a strong native food culture and agriculture, Uttarakhand state provides us with a greater opportunity for food sovereignty research and activism. A recent article by Henderson (2017) argues that the articulation between the state and peasant organizations' internal structures – the class characteristics of their mass bases, their leaderships and the modes of interaction between the two – is critical for determining the nature of contemporary struggles guided by the discourse of food sovereignty. Schiavoni (2017) emphasizes on a historical, relational and interactive (HRI) framework, in context of Venezuela, that can help us to understand the crisis facing the food system, and implications for food sovereignty research and activism.

Wild harvested foods form a significant portion of the total food basket for farmer households of Uttarakhand hills. However, the focus on the contribution of wild harvested foods to total food and nutritional security is undervalued. The continued contribution of wild species to food and nutritional security is threatened by some of the processes that seek to increase agricultural production and enhance economic development. Further, the sustainable harvesting of wild economic species requires a strong policy support by ensuring its continued availability for livelihood security of local communities.

Wild harvested food species provide more than just food and income to hill communities. The hill communities with a tradition of wild food use; it is part of a living link with the land, a keystone of culture. The decline of traditional ways of life and decreased wild food use are interlinked. Research needs are twofold: (i) standardized, accessible and comparable studies on the nutritional and toxicological properties of currently used/underused wild species on a broad scale; (ii) the identification of priority areas for conservation of wild food species and the recording of food-relevant LEK. Policies on conservation, food-security and agriculture 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 a necessity for hill communities. It is a well-recognized fact now that wild species and intra-species diversity have key roles in global nutrition security. The evidence shows that wild foods provide substantial health and economic benefits to those who depend on them. It is now clear that efforts to conserve biodiversity and preserve traditional food systems and farming practices need to be combined and enhanced.

It has been argued that healthy human nutrition is best achieved by an approach to agriculture that is biodiverse, providing a varied and ecologically sustainable food supply. But such an eco-nutrition model is sound in theory but very complex to achieve, as many variables are involved, in reality (Blasbalg *et al.*, 2011). Such a biodiverse food-based approach should be seen as an element in an overall strategy that also includes continuing improvement of agricultural production, breeding cultivars that are more resistant to disease and stress, nutritional enhancement of crops, industrial fortification, vitamin supplementation and other nutrition- agriculture linkages (Chung *et al.*, 2010).

There is therefore a necessity to broaden our approach even further and explore the linkages between agriculture, food production, nutrition, ethnobiology and ethnopharmacology and the resource base of wild and agricultural biodiversity in the context of accelerating global change. At an institutional level, both globally and nationally, these issues are very loosely (or not at all) coordinated (Heywood, 2011).

Conclusion

Nutrition improvements and health promotion interventions with native communities can be successful when they give full attention to the social context, social support, social capital and local food resources and provisioning. The exploratory research outcome offers the perspective that understanding how to use local foods to improve native communities' health benefits them directly, and also gives new insights for nutritional health promotion initiatives in general.

The authors hope that the evidence supplied from this study will stimulate others to promote traditional food systems for native communities' in their regions, and to contribute to mainstreaming food-based approaches with local resources. This issues a clear call for nutritionists and their colleagues in leadership roles in indigenous communities to experience the wide variety of unique foods and the social settings in which they are used, and to promote these important elements of local culture and ecosystems for their health benefits and their promise to provide sustainable solutions to food and nutrition security

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