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Food-based Approaches towards Community Nutrition and Health: A case of Uttarakhand Hills in North-Western India

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Abstract

In the present communication an outcome of a few recent case studies on traditional land and food systems of Uttarakhand hills in north-western India and its relationship with community nutrition and health are being discussed. High household production and dietary diversity in traditional farming landscapes of Uttarakhand hills has the potential of combating malnutrition and food-related non-communicable diseases. Some policy considerations on food-based approaches for better health and well-being in traditional farming agro-ecologies of Uttarakhand hills are also outlined.

Keywords: Traditional farming landscapes; Household production and dietary diversity; Community health and nutrition; Indigenous food sovereignty.

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Introduction

The diversity that we have today in present day crops and animals is the results of constant interactions of innumerable generations of farmers and the plants and animals they domesticated. This has resulted in wide-scale transition of several human cultures from a lifestyle of hunting and gathering to one of settled agriculture. The crop and livestock diversity, and the wild food resources have made appreciable contributions to human diets worldwide [1].

Agriculture plays a critical role in any given economy. In addition to providing food and raw material, agriculture also provides employment opportunities to very large percentage of the global population. The primary importance of the food and agriculture sector in improving household food security and alleviating and preventing malnutrition is well recognized. When agricultural development fails in countries where there exists no other fast-growing sector, the chances of the poor rising above the poverty level and contributing to the economic development of any given country is diminished (http://www.fao.org/ag/agn/nutrition/household_food_en.stm).

Further, the agricultural biodiversity has provided enormous nutrition and health benefits but overexploitation of some resources and widespread habitat loss has negatively impacted the dietary diversity, nutrition and health of some groups of society [2]. The world is today faced with attempting to assess these impacts and seek a sustainable way forward [3]. New approaches have been explored aimed at integrating environmental and human health, focusing especially on the many interactions between agriculture, ecology and human nutrition [1,4].

Despite the success of the agriculture, providing enough food to feed the world, today we are faced with issues of malnutrition, both over and under nutrition. More than a billion people today, in developing countries, are underfed and suffering from acute malnutrition, while much of the developed world is at the same time facing a crisis of obesity caused by over-nutrition, the so-called development-driven obesity [1] Worldwide 30% more people are now obese than those who are underfed. Over nutrition has been the result of an unhealthy lifestyle, leading to diet-related non-communicable diseases, such as cardiovascular disease, hypertension, cancer, diabetes, etc. The causes of these nutritional challenges are many and complex as are possible solutions [5].

An eco-nutrition model has been suggested for a healthy human nutrition that can be best achieved by an approach to agriculture that is biodiverse. However, such a model is sound in theory but very complex to achieve, as many complexities are involved, in reality [4]. Moreover, correlating agricultural biodiversity with human nutrition is generally difficult for a number of reasons including human diversity [6].

Since the time of colonization, there has been a drastic decline in health and integrity of indigenous cultures, social structures and knowledge systems which are integral to our ability to respond to our own needs for adequate amounts of healthy indigenous foods [7]. The changing food systems brought about by the forces of globalization have led to both challenges and opportunities [8]. There is alarm that local culture and food traditions are disappearing, where multinational and transnational corporations are increasingly controlling national food in addition, for most countries, micronutrient deficiencies are of concern. It is, however, being argued that "indigenous food sovereignty provides 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" *(*https://www.indigenousfoodsystems.org*/).*

Uttarakhand hills have a strong native food culture and traditions. Recently, we published the salient findings of a model case study on the potential of local food systems in addressing community health and nutrition with regard to hilly areas of Uttarakhand state in north-western India [7] in overall framework of indigenous food sovereignty. Based on the outcomes of the above case study, this communication succinctly presents some policy considerations on food-based approaches for better health and wellbeing in traditional farming agro-ecologies of Uttarakhand hills. The food-based approaches also include use of wild plant resources in agricultural systems, an important but undervalued supplement to household dietary diversity of native farming communities.

Food-Based Approach towards Community Nutrition and Health

There has been an enhanced emphasis globally now on indigenous food sovereignty. The enhanced production and consumption of native food is being emphasized so that the poor have adequate access to good quality healthy food for a nutritionally adequate diet. This includes not only food rich in energy but also micronutrients - the vitamins and minerals and other trace elements, necessary for normal growth and development.

Food-based interventions mainly focus on improving the quality of the diet for overcoming and preventing malnutrition and nutritional deficiencies. This approach recognises the essential role of food for good nutrition and emphasizes on role of local governments in the design, implementation and monitoring of flexible programmes to increase the production and consumption of native foods, especially those rich in micronutrients. Promoting biodiverse food is considered a key element in combating micronutrient deficiencies through the household production and consumption of appropriate foods (http://www.fao.org/ag/agn/nutrition/household_food_en.stm). Food-based, community-centred initiatives are being promoted by FAO using participatory appraisal and planning approaches that encourage and empower poor people to take an active role in designing and implementing such activities.

Representative Agro-Ecologies of Uttarakhand State of India and Comparative Studies on Household Nutrition and Health

Of the total geographical area of Uttarakhand state, about 86% is hills where subsistence agriculture is practiced which directly or indirectly sustains about 50% population of the State. On the other hand, there is 14% plain area where improved agriculture is practiced and most of the food grains are produced here. In this communication, the household production and dietary diversity of hill region is being discussed in relation to community nutrition and health.

Three representative farming agro-ecologies in Uttarakhand hills as outlined by Bisht et al. [7] include, i) small-scale crop-livestock mixed-farming systems representing about 70% of the net sown area under rain fed farming, ii) high elevation mountainous valleys adjoining Tibet, mainly inhabited by nomadic pastoralists and comprising about 10% of the net sown area, and iii) a few interspersed river valleys with improved agriculture under assured irrigation, comprising about 10% of the cropped area of the Uttarakhand hills.

A comparative study of household production and dietary diversity of three representative farming situations was carried during 2016 from 20 niche sites representing above stated three agro-ecologies of Uttarakhand hills. Greater household production and dietary diversity was recorded in traditional rain fed small-scale crop-livestock mixed-farming systems followed by mountainous valleys with nomadic pastoralists, and least in river valleys with improved agriculture [7].

A nutrition transition is clearly evident in farming agro-ecologies 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 these farming systems. About 70-80% of the cropped area is planted with a few improved cultivars of rice, wheat, and potato bred by public and private 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 and increased access to energy dense foods are creating an "obesogenic" environment in river valley areas.

Native Food Culture, Reversing the Nutrition Transition Trend and Indigenous Food Sovereignty

In spite of nutrition transition trends in many other parts of Uttarakhand, it is widely acknowledged that in the representative target regions rich in crop and livestock diversity and use of wild-harvested foods, the food traditions are still prevailing in the life

of rural households to a greater extent. This is indeed heartening that the traditional food habits are still playing a great role in contemporary food habits of the target communities; therefore, the possibility of reversing the trends in favour of dietary diversification from dietary simplification looks promising. It was found that the root cause of both malnutrition and overnutrition/ 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 indicates that high production and dietary diversity are linked with better community health and nutrition. Growing a range of local crops supplemented by wild food resources helps 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 only on growing a diversity of crops but also on the diversity within the crops [9]. The micronutrient superiority of landrace cultivars complemented with wild-harvested food resources in traditional hill farming has been revealed by the case study findings. Past research has shown substantial inter-varietal differences, for example, for beta-carotene in sweet-potato cultivars and the pro-vitamin A carotenoid of banana cultivars [10,11]. The protein content of rice cultivars has also been reported to range from 5 to 13% [10,12].

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 [10] and much of the evidence is anecdotal.

Coates et al. [13] suggest that dietary diversity can be used 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. Balanced nutrition in the human diet depends not only on growing a diversity of crops but also on the diversity within the crops [9]. The micronutrient superiority of some lesser-known cultivars and wild varieties over others has been confirmed by certain recent research [1,14].

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, as outlined by Smith (2013) include, i) holistic integrated food and nutrition interventions, ii) addressing under- and overnutrition simultaneously, iii) involving communities in planning interventions using a bottom–up rather than top–down approach, and iv) focusing on diversification of diets rather than a reliance on fortified foods and supplementation where possible.

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 [15].

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 other nutrition–agriculture interventions [1].

Uttarakhand hills are primarily an agriculture-based society with a rich native food culture and traditions. Kuhnlein et al. [16] rightly stated 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." Kuhnlein et al. [16] further assert that "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." Further sustainability of the environment happened to be one of the critical issues in the food acquisition and consumption of indigenous communities world over [17]. Industrial agriculture on the other hand is premised on a business model through neoliberal policies.

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 a route out of poverty and a source of income generation and can prevent people from falling further into poverty or in extreme cases as an emergency lifeline through the provision of "famine food" [18]. It can also play a major part in addressing issues of malnutrition [1].

It has been rightly argued by those concerned with the global food-sovereignty movement that it is the small-scale farmers that actually have control of the food system, of information, and of food culture as against the social perception in the Northern hemisphere that the large food chains feed society [19]. Facing this, in the entire world, and especially in the Northern hemisphere of USA, Canada, Europe, impressive associations of critical consumers, and producers are being developed. In France, for example, there are 3000 producers-consumer associations. In Canada and the USA, where there is a common problem of

reduced numbers of farmers, there is an enormous demand from citizens to have control over what they eat, how it is produced and who produces it. They are demanding a new type, a new model of farmer, one that isn't trained in a productivist model [19].

It is believed that one of the effects of producer-consumer associations is to support the new farmers, who are increasingly coming from urban areas. In Europe, for example, many farming men and women now make a living based on local markets. They have a much better chance of survival than those farmers who depend on the transnationals for their inputs and sales.

This is a very clear reality. To overcome this, urban social movements must come together with peasant movements to develop a new type of agriculture and training that dignifies the profession, in order to excite young people [19].

Food sovereignty advocates rightly argue that the anti-poverty approach runs the risk of reducing the issue of hunger and malnutrition to a humanitarian problem for rich countries to solve, a position which is highly contested by countries and societies which have long depended on agriculture for the livelihood [20]. Wittman et al. [21] defined food sovereignty as the right of nations and people to have control over their own food systems, including their own markets, production modes, food cultures and environments. Food sovereignty works with the concept of self-sufficiency in food production, democracy and diversity. Lack of appreciation of these complex issues explains in part the rising cases of chronic diseases such as obesity and hypertension associated with overeating in the midst of food insecurity [22]. The rising cases of chronic illness such as cardiovascular diseases, diabetes and certain cancers among native communities across the globe have been attributed to moving away from traditional foods rich in fibre, fruits, vegetables and leafy greens to foods high in fat, sugars, and salt [23-25] asserted that different cultures understand their relation to food differently. Whereas the goal of food and eating within many indigenous communities is a means of expressing culture, upholding traditions, and strengthening cultural knowledge about the world [26], the goal of conventional nutritional science research reduces foods to its biochemical properties and categorizes it according to chemical compounds [27-29].

The native food culture of Uttarakhand hills can be discussed here in greater detail based on local IK in the context of food, viz. spirituality, food security, harvesting regulations/restrictions and reliance on locally available material as outlined by [17].

The predominantly crop-livestock small-scale mixed farming systems of Uttarakhand hills encourages farmer households to consume more traditional crops instead of animal flesh, except for 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 systems save humans from competing with livestock for food and ensuring food sufficiency. In contrast, industrial agriculture contributes to creating food insecurity through the use of whole grains and cereals as key components of animal feed [17]. The transformation of US diets from high-calorie crop products to low-calorie meat, for example, has greater environmental consequences [30], with meat production contributing disproportionately to greenhouse gas emissions. Further, feeding farm animals on crop by-products and forage ensures production of lean meat that helps reduce fat-related complications and diseases [17,31,32].

Dependence of local communities of Uttarakhand hills on diverse plant resources including wild-harvested foods ensures that the plant species are protected, and in this way an effective mechanism of sustainability that indigenous communities can employ to maintain a cosmic balance with the ecosystem could be duly showcased by the present case study research.

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.

These practices intend to help improve human health and preserve the environment for future generations. 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 indigenous populations and a decline in the production of nutrient-rich foodstuffs that could benefit all communities. Kuhnlein et al. [16] argued that "Indigenous peoples' food systems contain treasures of knowledge 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 indigenous peoples living there, but also for everyone.

Our study clearly indicates that malnutrition is not the 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, indigenous communities, and particularly indigenous women are developing projects and building networks to revitalize local food capacity and strengthen food sovereignty.

Participatory nutrition and micronutrients

To achieve sustainable reductions in under-nutrition and other forms of malnutrition, national policies and programmes must be complemented by effective community-based actions. A key dimension of this strategy is enabling households to maximise food security and nutrition with existing household resources,

while also striving to increase such resources. This requires a process of effectively mobilising communities and shifting from a centralised to a more decentralised approach, with wider participation on the part of the community. A number of activities that address problems of household food insecurity and the various forms of malnutrition are being undertaken by FAO in both urban and rural areas. An important focus is community empowerment, with appropriate support from the various governmental levels and civil society institutions. At the community level, targeted and co-ordinated efforts focusing on improving household food security, fostering people's participation and empowering women and marginal groups are needed to address local food and nutrition problems.

Progress in promoting and implementing food-based strategies to achieve sustainable improvements in micronutrient status has generally been slow. These strategies focus on improving access to and availability and consumption of vitamin- and mineral-rich foods. Benefits of such food-based strategies include not only improved intakes of specific nutrients but also improved overall diet and health status.

Since 1985, FAO has participated actively in defining and implementing programmes to reduce micronutrient malnutrition. FAO strongly supports the promotion of the production and consumption of micronutrient-rich foods as the sustainable solution to micronutrient deficiency problems. This activity clearly falls within the Organization's mandate and overall strategy, which emphasises the relationship between nutrition and agriculture in order to ensure food security and to improve the health and nutritional status of all populations.

Policy Support to Farmer-Led Traditional Agricultural Innovations towards Better Nutrition and Health

Cross-sectoral collaboration and advocacy agenda for food-based approach towards community health and nutrition

Agricultural biodiversity is important for food and nutritional security. It also acts as a safeguard against hunger, a source of nutrients for improved dietary diversity and quality and strengthening local food systems and environmental sustainability. A recent compilation by Fanzo et al. [5] explores the current state of knowledge on the role of agricultural biodiversity in improving nutrition and food security. The book explores current strategies for improving nutrition and diets and identifies key research and implementation gaps that need to be addressed to successfully promote the better use of agricultural biodiversity for rural and urban populations, and societies in transition.

One of the World's greatest challenges is to secure sufficient and healthy food for all and to do so in an environmentally sustainable manner. A review by explores the interrelationships of food, health, and environment and their role in addressing chronic micronutrient deficiencies, also known as "hidden hunger", affecting over two billion people worldwide. While the complexity and underlying determinants of under-nutrition have been well-understood for decades, the scaling of food and nutrition system approaches that combine sustainable agriculture aimed at improved diet diversity and livelihoods have been limited in their development and implementation. However, an integrated system approach to reduce hidden hunger could potentially serve as a sustainable opportunity.

Uttarakhand state has limited political commitment to nutrition-sensitive agriculture. With the current emphasis on nutrition, a window of opportunity exists to promote nutrition-sensitive cross-sectoral strategies. However, efforts to communicate nutrition-sensitive agriculture and food systems as the system approach that encompasses all underlying causes of malnutrition in their interrelatedness and complexity along the whole value chain must be significantly increased. Such an understanding is especially needed for a sustainable development goal concerning nutrition such as eradicating malnutrition in all its forms through sustainable food systems. Nutrition-sensitive agriculture seems to be more of a term than a concept. To promote nutrition-sensitive agriculture, a systemic approach and true cross-sector collaboration are needed.

Research strategies designed to co-deliver economic, environmental and health goals will need to draw on inter-disciplinary collaborations to define priority research questions. They should include a range of environmental indicators and not just greenhouse gas emissions and they need to take into account differences in impacts (partly due to different production systems) between countries [33]. Food-based solutions to hunger, malnutrition and poverty are of global concern and must be addressed if food and nutrition security is to be achieved in a sustainable manner [34].

Nutraceutical and medicinal properties of a few important native and naturalized crops of Uttarakhand hills are documented in **Table 1**.

Enhanced market access for traditional food resources

Traditional varieties of different crops not only have different genetic attributes than modern varieties; they also have several consumption characteristics such as taste, aroma, cooking quality, nutrition, etc. In part for this reason - and in part, by virtue of commitments to environmental values - there is scope for development of local and distant markets in which traditional varieties command a price premium. Labelling systems can assist in creating such markets [17,35]. Again, this could not only provide direct rewards to growers, but also help to raise public consciousness of the importance of diversity and the need for public policies to sustain it.

Further, enhanced marketability and making them easily available in local markets through proper processing/packaging can add value to local food resources and increasing their value in household food choices and family diets. Markets can play an important role in mainstreaming local foods in household diets and integration on nutritional contribution of traditional food resources to the well-being of the rural poor in the region.

Table 1. A few important crops of Uttarakhand hills and their food, nutraceutical and medicinal properties.

S. No.	Crop (s)	Nutraceutical properties
1	Wheat (*Triticum aestivum* L.)	Besides being a major staple energy source and source of easily digestible quality protein, among health promoting phytochemicals in whole wheat grains, phenolic compounds have gained attention as they have strong antioxidant properties and can protect against many degenerative diseases. Profiling of grain phenolic extracts of modern and old common wheat varieties and evaluation of their potential antiproliferative or cytoprotective effect in different cell culture systems have indicated that increased intake of wheat grain derived products, particularly of old farmers' varieties, could represent an effective strategy to achieve both chemoprevention and protection against oxidative stress related diseases.
2	Rice (*Oryza sativa* L.)	Rice is not only the staple food, but also an integral part of rural culture in Uttarakhand hills. It can be attributed a cultural value, which is the most evident in areas that still maintain a large diversity of rice varieties. The immense genetic diversity in rice landraces is similarly reflected by their multiplicity of nutritional characteristics [36]. Appropriate rice varieties exist for enhancing the supply of various nutrients, including protein, essential lipids, certain minerals, and to some extent also β-carotene. Some varieties may even be characterized by a combination of favourable nutritional traits. This is true for varieties containing elevated levels of both β-carotene and essential lipids, for example. More synergies between nutritional components may exist and have to be elucidated in further scientific work. The function and the physiological effects of various antioxidant substances are not fully understood and represent an innovative research field. The diversity of rice varieties offers tremendous scope for scientists to further investigate the potential for the synthesis of antioxidants and their possible beneficial effects.
3	Barley (*Hordeum vulgare* L.)	Barley is a major cereal grain, commonly found in bread, beverages, and various cuisines of every culture. It was one of the first cultivated grains in history and, to this day, remains one of the most widely consumed grains, globally. The naked or hull-less barley, prevalent in higher Himalayan areas of Uttarakhand makes a wonderful addition to a healthy diet.
4	Minor or small millets (Finger millet, *Eleusine coracana* (L.) Gaertn; Barnyard millet, *Echinochloa frumentacea* Link; Foxtail millet, *Setaria italica* (L.) Beauv.)	The health benefits of minor millets include: i) Beneficial in detoxifying body, ii) Lowers bad cholesterol level, iii) Prevents onset of breast cancer, iv) Helps to prevent Type 2 diabetes, v) Effective in reducing blood pressure, vi) Helps to protect against heart diseases, vii) Aids in treating respiratory conditions such as asthma, viii) Helps to optimize kidney, liver and body's immune system, ix) Reduces risk of gastrointestinal conditions like gastric ulcers or colon cancer, x) Eliminates problems like constipation, excess gas, bloating and cramping, etc. A book by Belton and Taylor [37] describes the health benefits of pseudocereals and less common cereals including small millets.
5	Soybean (*Glycine max* L.)	Black seeded soybean or *bhat* of Uttarakhand hills is considered to be a source of complete protein. Soya protein can lower total cholesterol levels by 30%, LDL by as much as 35-40% and to raise HDL cholesterol levels. Soya protein has also been shown to reduce the stickiness of platelets because soybean is good source of important essential fats called Omega-3 fatty acids.
6	Black gram (*Vigna mungo* L.) Hepper)	Probably the most well-known and high nutritional beans is black gram or urad bean. Some health advantages of black gram include: it is energy booster, improves digestion, boosts heart health, good for muscle building, excellent for diabetes, good for nervous disorders, has anti-inflammatory properties, increases immunity, home remedy for pain and inflammation of the joints, good for diabetic patients, good for bones, good for pregnant women, etc.
7	Horse gram (*Macrotyloma uniflorum* Lam.)	Horse gram is the most protein-rich legume widely cultivated and consumed in Uttarakhand hills. It is high in iron, calcium, and protein, has the highest calcium content among pulses and is one of the richest vegetarian sources of protein. Raw horse gram is particularly rich in polyphenols, flavonoids and proteins, the major anti-oxidants. The health benefits of horse gram seem to be innumerable. Traditional medicinal texts describe its use for asthma, bronchitis, leucoderma, urinary discharge, kidney stones and heart disease. Ayurvedic cuisine also recommends horse gram for persons suffering from jaundice or water retention. Rheumatism, worms, conjunctivitis and piles are also said to quail before the power of horse gram. Horse gram has astringent and diuretic properties. It is also beneficial for extracting phlegm and controlling fever and cholesterol levels. According to some studies, the lipid extracts of horse gram are beneficial for treating peptic ulcers and it is said these magic legumes can reduce flatulence and control various menstrual problems.
8	Lentil (*Lens culinaris* Medikus)	Lentils have the second-highest ratio of protein per calorie of any legume, after soybeans. In Uttarakhand cuisins, lentil is usually eaten with rice or *rotis*, the lentil is a dietary staple throughout the region.
9	Yellow sarson (*Brassica rapa* L. yellow sarson)	Mustard seeds are very rich in phyto-nutrients, minerals, vitamins and anti-oxidants. Mustard seeds are also an excellent source of essential B-complex vitamins such as folates, niacin, thiamin, riboflavin, pyridoxine (vitamin B6), pantothenic acid. Mustard seeds also contain flavonoid and carotenoid antioxidants such as carotenes, zea-xanthin and lutein. In addition, the seeds compose a small amount of vitamin anti-oxidants such as vitamin A, C and vitamin K. The seeds are an excellent source of vitamin E, gamma tocopherol. Vitamin E is a powerful lipid soluble antioxidant, required for maintaining the integrity of cell membrane of mucus membranes and skin by protecting it from harmful oxygen-free radicals, viii) Mustards are rich source of health benefiting minerals. Calcium, manganese, copper, iron, selenium and zinc are some of the minerals especially concentrated in these seeds (http://www.nutrition-and-you.com/mustard-seeds.html).

10	Sesame (*Sesamum indicum* L.)	Sesame oil, queen of oils is an ingredient of varieties of food. It is used as a substitute for olive oil, as a salad oil and for cooking fish and vegetables in many parts of the world. The antioxidant property of refined sesame oil contributing for its greater shelf life makes it suitable for food industry.
11	Grain amaranths (*Amaranthus hypochondriacus* L.)	Bhat et al. [38] investigated grain amaranths for their phytochemical content, antioxidant and antimicrobial activity to understand the nutraceutical properties. Amaranth grains are a moderate source of phytochemicals. The alkaloids in the diet consisting of the Amaranth grains may lead to healing of wounds, varicose ulcers, hemorrhoids, frostbite and burn in herbal medicines. Saponins, on the other hand, will enhance the nutrient absorption, control blood cholesterol levels, bone health, cancer, and will build up the immune system. Saponins were obtained in negligible amounts in the sample.
12	Buckwheat (Common buckwheat, *F. esculentum* Moench; Tartary buckwheat, *F. tataricum* (L.) Gaertn.)	Ahmed et al. [39] has reviewed the functional and nutraceutical compounds present in common buckwheat (*Fagopyrum esculentum*) and tartary buckwheat (*F. tataricum*). The vital functional substances in buckwheat are flavonoids, phytosterols, fagopyrins, fagopyritols, phenolic compounds, resistant starch, dietary fibre, lignans, vitamins, minerals and antioxidants, which make it a highly active biological pseudocereal. Cholesterol-lowering effects that lessen the problems of constipation and obesity are important health benefits that can be achieved through the functional substances of buckwheat.
13	Perilla (*Perilla frutescens* (L.) Britton)	Perilla seeds are used as a flavouring agent. It is also a minor oilseed crop in some parts of India. Leaves are reported to be used in Chinese medicine to treat a wide variety of ailments, as well as in Asian cooking as a garnish and as a possible antidote to food poisoning. Leaf extracts have shown antioxidant, antiallergic, anti-inflammatory, antidepressant, anorexigenic, and tumor-preventing properties.
14	Asian Spiderflower (*Cleome viscosa* L.)	Jane and Patil [40] describes the phytochemical screening of *Cleome viscosa* extracts in different solvents like acetone, methanol and chloroform detected the presence of active biomolecules such as alkaloids, tannins, flavonoids, saponins, etc. Antioxidant activity in terms of radical scavenging activity of *Cleome viscosa* in acetone extract was found to be 29, 33 and 21% at 10 µg/ml, 50 µg/ml and 100 µg/ml, respectively.

Integrating local nutrient-rich food in mid-day meal programme in line with lessons learnt from Brazilian experience on school feeding programmes

In line with success of Brazil's school feeding programme, the traditional and healthier eating habits of Uttarakhand hills can also be rescued. Several of farmers' local crops offer more fibre, more vitamin B and complex carbohydrates. Through policy advocacy activities, the school students should be made familiar and comfortable with what they are eating.

Further, like Brazilian programme, a substantial amount of Ministry of Human Resource Development (MHRD) budget can be diverted to small holder farmers for local purchasing of native healthy food to school feeding programmes (mid-day meal scheme). In Brazil, 40 percent of food served to students is from local farmers and processors. The Brazilian experience has proved that small agriculture can produce good quality processed products - the kind of value-added products that can make farming more profitable. The small farms were able and capable of producing quality and good dignified products that could positively contribute to the Brazilian school feeding programme.

African countries yield positive that adapts the Brazilian successful school feeding model and public food procurement from family farmers (http://www.fao.org/partnerships/stories/story/en/c/449393/).

(Is India in general and traditional farming areas like Uttarakhand hills ready for the change?)

Conclusion

The small-scale ecological farming methods are the key to ensuring resilience to climate change in Himalayan agroecologies. They are based on enhancing diversity-thereby increasing options to respond to climate instability. There is a need to support these traditional systems in order to feed local communities and at the same time address the traditional food-based approach of community nutrition and health. A proactive alliance, collaboratively creating a research and advocacy agenda in support of agrobiodiversity and the revival of diverse local food systems and landscapes, will be needed between indigenous peoples, local communities, and their key allies within the broader framework of indigenous food sovereignty.

There is a need to re-assess existing food and nutrition-related health and agriculture policy and develop cross-sectoral implementation strategies on food security, nutrition, and health. Further, there is need of continuous policy advocacy activities to educate functionaries across different sectors. Developing food composition databases is vital for effective advocacy tools and critical for cross-sectoral policy and program development.

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