

Exploring the role of diverse underutilized nutri-crops on food and nutritional security of ethnic communities in Eastern Himalaya

Sujit Sarkar^{a,*}, V Sangeetha^b, Natasha Gurung^a, G S Mahra^b, Satya Priya^b, Lenin Venu^b, Pratibha Joshi^b, Dwijendra Barman^a & Premlata Singh^b

^aICAR-Indian Agriculture Research Institute, Regional Station, Kalimpong, West Bengal

^bICAR-Indian Agriculture Research Institute, New Delhi

E-mail: sujitgovt@gmail.com

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The role of traditional underutilized food in fulfilling the nutritional requirements of rural communities is acknowledged across the world. The Sikkim and Darjeeling Himalaya is considered as one of the hotspots of diverse underutilized nutritious crops and vegetables. Though the earlier generation used those diverse traditional nutri-crops to fulfill food and nutritional requirements, their usage and cultivation have declined over the period. The new generation is not aware of the nutritional values of these local crops. In this context, the present study was conducted to document the traditional nutri-crops of Sikkim and Darjeeling Himalaya, and to suggest future policies for mainstreaming these traditional crops into the farmers' existing cropping system. Participatory rationality analysis technique was conceptualized and used to understand the usage of different traditional nutri-crops in the region from a sample of 560 farmers. The findings revealed that the rationality index score of *Ishkush* (*Sechium edule*) was highest (4.66) followed by *Chuche Karela* (*Momordica charantia* L.- 4.38) and Pumpkin (*Cucurbita pepo*-4.37). The crops with highest perceived medicinal (4.86) and nutritive value (4.93) was *Ishkush* (*Sechium edule*). The major recommendation for popularizing the traditional nutri-crops was 'Ensuring better price for traditional nutri-crops (81%)' followed by 'Start research initiative specifically on local unexplored nutri-crops to enhance their productivity (80%)', and 'Demonstrating the potential of indigenous nutri-crops in fighting malnutrition through extension agents (78%)'.

Keywords: Food and nutrition security, Mainstreaming strategies, Traditional nutri-crops

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The wild crops especially diverse vegetables and fruits have been in use since time immemorial in our society. Millions of people, particularly tribal and rural communities in our country still collect and consume a wide variety of wild crops to meet their food and nutritional requirements. In India, Sikkim and Darjeeling Himalayan region is considered as one of the richest hotspots of plant biodiversity with many wild plants and crops^{1,2}. These wild plants and crops contribute greatly to the food diversity and nutritional well-being of the people living under extreme climate and difficult geographic terrain of the region.

Though the rural farmers of Sikkim and Darjeeling Himalaya have made conscious efforts to preserve their wild natural resources, but their availability and usage have declined significantly in recent past. It was noticed that there was growing ignorance especially among young generation and urban people about the consumption of these nutri-rich plants. It is feared that

the reduction in consumption of indigenous crops may bring back the serious malnutrition scenario in the region. The lack of knowledge about nutritional value of these wild crops is considered as one of the major reasons behind their non- consumption. The rapidity with which these indigenous nutri-crops are disappearing from hill landscape, a necessity is felt for its urgent documentation with detailed nutrition profiling. At present, very few information is available on the perceived rationale for usage of these local crops. Past research suggests that the benefits and the value of indigenous plants have not been fully understood and synthesized. Many studies were conducted on biological characterization of these crops. But very limited number of studies were conducted to understand the local perception of ethnic communities on role of traditional nutri-crops and varieties on food and nutritional security, the criteria of ethnic communities on usage of these crops and the rationale behind selection of different underutilized nutri-crops mainly due to lack of sound methodology^{2,3,4}. Hence,

*Corresponding author

the present study documented different underutilized nutri-crops, understand the rationale for consumption of these crops and validated their belief system through scientific findings. Besides this, the study documented different policy strategies for popularizing the underutilized traditional crops.

Methodology

The people in the region used their own criteria and guidelines in local dialect for consuming different underutilized crops. For example, people used criteria like 'Fulfilling hunger', 'Medicinal properties of crops', 'Nutritive value of crops' etc. for consumption of different underutilized nutri-crops. The present study explored those criteria and classified them as – Medicinal value (X1), Nutritive value (X2), Food security (X3), Easy availability (X4), Market price (X5), Consumer preference (X6) and Cultural suitability (X7). The perceived rationality score of each crop against each criterion was collected from local people on five-point scale ranges from 1 (Very low) to 5 (Very high). Then rationality score on usage of each nutri-crop was calculated using simple aggregate method and final value was calculated using simple arithmetic mean of all the indicators-

Rationality value of crop for each criterion
 $(Y_i) = \sum(X_i)/N$

Where, Y_i = Rationality score of each criterion, where 'i' ranged from 1 to 7.

X_i = Actual perceived rationale score

N = Number of observations.

Final value = $(Y_1 + Y_2 + Y_3 + Y_4 + Y_5 + Y_6 + Y_7)/n$

Where, Y_1 = score of medicinal value, Y_2 = score of nutritive value, Y_3 = score of food security, Y_4 = score of easy availability, Y_5 = score of market

price, Y_6 = score of consumer preference, Y_7 = score of cultural suitability

n = Number of criteria

The study was conducted in Sikkim and Darjeeling Himalaya over a period of three years (2019-2022). Two districts each from Sikkim (East and South Sikkim) and West Bengal (Darjeeling and Kalimpong) representing Eastern Himalaya were purposively selected keeping the rich bio-diversity of underutilized crops in mind. The villages from each district were purposively selected using disproportionate sampling technique. Numerous surveys were conducted at eight villages of Darjeeling district in 2019 and ten villages of Kalimpong district in 2020 for the present study. Five villages each from South Sikkim and East Sikkim were surveyed in 2021-22 under the present study. Besides villages, the local vegetable market and weekly *haat* were also surveyed for documenting and collecting information on diverse traditional nutri-crops. Total 560 respondents were interviewed to collect the information on local nutri-crops. Another 400 farmers were specifically interviewed to prepare future strategies for popularizing the traditional nutri-crops in the region.

Results

Participatory rationality analysis of underutilized nutri-crops

Historically, the farmers of this Himalayan belt were growing and preserving diverse wild crops to fulfill the nutritional demand of the people in the region. Despite low yield, the indigenous crops and their cultivars were found to be more palatable, resistant to pest and diseases, and tolerant to drought and natural hazards. The major indigenous crops and their perceived rationale for consumption are presented in Table 1.

Table 1 — Perceived rationale for consumption of underutilized nutri-crops N=560

Local name	Common name (Scientific name)	Plant part used	Medicinal value	Nutri- value	Food security	Easy availability	Market price	Consumer preference	Cultural suitability	Final score
<i>Dalle khursani</i>	Round chilli (<i>Capsicum</i> sp L.)	Fruit	2.35	3.87	2.69	4.41	3.34	4.59	4.49	3.68
<i>Chuche karela</i>	Bitter gourd (<i>Momordica charantia</i> L.)	Fruit	4.80	4.88	3.75	4.70	3.90	4.00	4.60	4.38
<i>Philungey</i>	<i>Niger seed</i> (<i>Guizotia abyssinica</i>)	Seed	4.24	4.17	3.36	3.95	4.32	4.25	4.30	4.08
<i>Bee</i>	Brinjal (<i>Solanum</i> sp.)	Fruit	3.96	3.89	4.37	4.28	3.95	3.85	4.15	4.06
<i>Red</i>	Rice Bean	Seed	3.19	3.81	4.19	3.83	3.72	4.23	4.17	3.88
<i>Thanraymosyam</i>	(<i>Vigna umbellata</i>)									
<i>Allapatray semi</i>	Common bean (<i>Phaseolus vulgaris</i>)	Seed	3.76	4.16	4.18	3.29	3.18	3.6	3.8	3.71
<i>Singtamai Semi</i>	Common bean (<i>Phaseolus vulgaris</i>)	Seed	3.68	4.12	4.17	3.37	3.21	3.7	3.9	3.74

(Contd.)

Table 1 — Perceived rationale for consumption of underutilized nutri-crops N=560 — (Contd.)

Local name	Common name (Scientific name)	Plant part used	Medicinal value	Nutri- value	Food security	Easy availability	Market price	Consumer preference	Cultural suitability	Final score
<i>Betgara</i>	Viagra palm (<i>Calamus erectus</i>)	Nut	4.73	4.63	3.70	3.45	3.57	4.11	4.10	4.04
<i>Simal tarul</i>	Cassava (<i>Manihot esculenta</i>)	Tuber	4.32	4.65	4.45	4.36	3.89	4.00	4.10	4.25
<i>Goondruk</i>	Fermented mustard leaf (<i>Brassica juncea</i>)	Leaves	4.18	4.32	3.78	4.86	4.18	4.50	4.62	4.35
<i>Kinema</i>	Fermented soybean nut (<i>Glycine max</i>)	Seed	4.33	4.71	4.32	3.92	3.84	4.38	4.30	4.26
<i>Kakro</i>	Cucumber (<i>Cucumis sativus</i>)	Fruit	4.78	3.73	4.19	4.39	3.71	4.21	4.19	4.17
<i>Pharsi</i>	Pumpkin (<i>Cucurbita pepo</i>)	Fruits, leaves, tender shoots & flowers	4.57	4.63	4.59	4.38	3.95	4.23	4.27	4.37
<i>Ishkush</i>	Chayote (<i>Sechium edule</i>)	Fruit, leaves, tender shoots, roots	4.86	4.93	4.27	4.80	4.43	4.60	4.71	4.66
<i>Ruk tamatar</i>	Tree tomato/Tamarillo (<i>Solanum betacum</i>)	Fruit	4.13	4.14	3.73	4.17	4.11	3.98	4.19	4.06
<i>Celery</i>	Celery (<i>Apium graveolen</i>)	Leaves	4.47	4.48	3.72	3.76	3.86	4.15	4.18	4.09
<i>Rai sag</i>	Leafy mustard (<i>Brassica juncea</i>)	Leaves	4.18	4.26	3.94	4.45	4.31	4.58	4.27	4.28
<i>Chamsur</i>	Garden cress (<i>Lepidium sativum</i>)	Leaves	4.49	4.58	4.13	4.54	4.12	4.41	4.10	4.33
<i>Phapar</i>	Perennial buckwheat (<i>Fagopyrum esculentum</i>)	Grain	4.13	4.56	4.78	4.19	3.95	4.21	4.23	4.29
<i>Rani Bhyakur</i>	Fiveleaf yam (<i>Dioscorea pentaphylla</i>)	Tuber	4.24	4.31	4.12	3.67	3.78	4.16	4.19	4.07
<i>Thotney</i>	Knot weed (<i>Polygonum molle</i>)	Young shoots	4.19	4.39	3.83	4.14	3.54	4.10	4.16	4.05
<i>Chiuri</i>	Indian butter tree (<i>Diploknema butyracea</i>)	Seeds	4.17	4.23	4.18	4.19	3.60	4.13	4.10	4.09
<i>Sil timbur</i>	Mountain pepper (<i>Litsea cubeba</i>)	Fruit & seed	4.37	4.31	4.02	4.00	3.83	3.91	4.19	4.09
<i>Simrayo</i>	Water cress (<i>Nasturtium officinale</i>)	Leaves	4.34	4.45	4.28	4.19	3.82	4.30	4.17	4.22
<i>Arucha</i>	Plum (<i>Prunus domestica</i> L.)	Fruit	4.11	4.36	3.72	4.12	3.63	4.21	4.09	4.03
<i>Bhogate</i>	Pomelo (<i>Citrus grandis</i> (L.) <i>Osbeck</i>)	Fruit	4.23	4.51	3.84	4.25	4.22	4.35	4.11	4.22
<i>Garandal</i>	Passion fruit (<i>Passiflora edulis</i> Sims.)	Fruit	4.39	4.67	3.78	4.17	3.93	4.23	4.15	4.19
<i>Alu bhakara</i>	European plum (<i>Prunus domestica</i>)	Fruit	4.26	4.51	3.75	3.89	3.97	4.29	4.18	4.12
<i>Kalo Ainselu</i>	Heart-leaf raspberry (<i>Rubus paniculatus</i>)	Root and fruit	4.37	4.63	3.92	4.24	3.80	4.00	3.8	4.11
<i>Batulpate</i>	Velvet leaf (<i>Cissampelos pareira</i> var. <i>hirsuta</i>)	Leaves	4.3	3.5	3.8	4	3.70	4.16	4.15	3.94
<i>Pindalu</i>	Cocoyam/Taro (<i>Colocasia esculenta</i>)	Stem, root and leaves	4.39	4.45	4.34	4.27	3.87	4.30	3.97	4.23
<i>Chipley ningro</i>	Vegetable fern (<i>Diplazium esculentum</i>)	Leaves and)shoots	4.69	4.81	4.65	4.18	3.68	4.23	4.31	4.36
<i>Dungdug</i>	Hooker chives (<i>Allium hookeri</i>)	Leaves and flowers	4.12	4.28	3.85	3.97	3.86	4.24	4.23	4.08

(Contd.)

Table 1 — Perceived rationale for consumption of underutilized nutri-crops N=560

Local name	Common name (Scientific name)	Plant part used	Medicinal value	Nutri- value	Food security	Easy availability	Market price	Consumer preference	Cultural suitability	Final score
<i>Nakima</i>	Tupistra (<i>Tupistra nutans</i>)	Inflorescence	4.58	4.62	4.37	4.41	3.52	4.35	4.16	4.29
<i>Ghariasnisnu</i>	Common nettle (<i>Urtica dioica</i>)	Leaves	3.98	4.12	3.75	4.21	3.55	4.18	4.11	3.99
<i>Nebara/Nebhara</i>	Himalayan Fig (<i>Ficus auriculata</i>)	Fruits	4.13	4.28	4.00	4.16	3.43	4.21	4.13	4.05
Sub-Index Score			4.22	4.36	4.01	4.14	3.81	4.19	4.13	4.13

Table 2 — Strategies for popularizing the traditional nutri-crops n = 400

S N	Strategies	Frequency	Percentage
1	Taking research initiatives on traditional crops to enhance production and productivity	320	80
2	Incorporation of modern farm practices within traditional nutri-crop based farming system	292	73
3	Demonstrating the potential of traditional nutri-crops through extension agents	312	78
4	Location specific policy at panchayat level to preserve and promote nutri-crops in local cropping system	268	67
5	Ensuring better price for traditional nutri-crops	324	81
6	Special emphasis on policy for traditional nutri-crops	212	53
7	Conserving the endangered species of nutri-crops	280	70
8	Promoting separate marketing platform for indigenous nutri-crops	304	76
9	Ensuring intellectual property right for farmers and communities who are preserving traditional crops and varieties	260	65
10	Applying the principle of organic farming in cultivation of traditional nutri-crops	212	53
11	Incorporation of diverse local nutri-crops in mid-day meal scheme	200	50
12	Establishment of traditional nutri-kitchen garden and herbal garden in each school and <i>Anganwadi</i> centre	172	43
13	Formation of nutri-smart village based on traditional crops	184	46
14	Establishment of cafeteria on nutri-crops in each KVK or University or research centre or <i>Anganwadi</i> centre	152	38
15	Establishment of traditional nutri-crop museum in KVK, Research Centre and University	132	33
16	Publishing extension literature on role of local nutritional crops in fighting malnutrition	168	42

The findings in Table 1 reveal that overall nutritive index score of traditional crops was 4.13. The sub-index score of 'Medicinal value' was 4.22 whereas the sub-index value of 'Nutritive value' was 4.36. The sub-index scores of 'Food security', 'Easy availability', 'Market price', 'Consumer preference', 'Cultural suitability' was 4.01, 4.14, 3.81, 4.19, and 4.19 respectively.

Strategies for popularizing the traditional nutri-crops

At present, a very limited number of farmers is engaged in commercial cultivation of these nutri-crops due to diverse socio-economic factors. It becomes highly essential to bring these local nutri-crops and varieties within the existing cropping pattern of the region to assure the nutritional security of all the people. Hence, the present study documented diverse policy strategies for mainstreaming these local crops within the existing farming system of the region. The finding (Table 2) reveals that ensuring better price (81%), research on traditional nutri-crops (80%), and extensive demonstration (78%) as the major strategies for the popularization of underutilized nutri-crops in the region.

Discussion

Participatory rationality analysis of underutilized nutri-crops

The study revealed that the ethnic communities of the region preferred to consume the local wild crops and varieties mainly due to their higher nutritive value (43.6) followed by medicinal value (4.22), consumer preference in terms of taste, aroma etc. (4.19), cultural suitability (1.19), easy availability (4.14), food security (4.01) and market price (3.81). Though local crops and vegetables were more costly than their modern counterparts, people still prefer to consume them because of their high nutritive value, medicinal value and cultural suitability. The finding in Table 1 reveals that the perceived rationality score for consumption of *Iskush* (*Sechium edule*) was highest (4.66). *Iskush* was the most widely consumed vegetable of the region for its multiple health benefits and easy availability. The people perceived that it has high medicinal and nutritive values with anti-cancer properties, and protects heart health and eye health. Hill⁵ reported that a single chayote squash (203 g) provides the essential nutrients like Fiber: 4 g -14% of

the Reference Daily Intake (RDI), Vitamin C: 26% of the RDI, Vitamin B9 (folate): 47% of the RDI and Vitamin K: 10% of the RDI. The second most popular nutri-crop was local cultivar of bitter gourd commonly known as *Chuche Karela* (4.38). Sharma *et al.*² reported that *Chuche Karela* was rich in polypeptide-P which acted as a plant insulin and lower down the blood sugar levels of human being.

Other important underutilized nutri-crops of the region with index score more than four were- *Pharsi* (Pumpkin, 4.37), *Chiple y ningro* (Vegetable fern, 4.36), *Goondruk* (Fermented mustard leaf, 4.35), *Chamsur* (Garden cress, 4.33), *Phapar* (Perennial buckwheat, 4.29), *Nakima* (Tupistra, 4.29), *Rai sag* (Leafy mustard, 4.28), *Kinema* (Fermented soybean nut, 4.26), *Simal tarul* (Cassava, 4.25), *Pindalu* (Cocoyam, 4.23), *Simrayo* (Water cress, 4.22), *Bhogate* (Pomelo, 4.22), *Garandal* (Passion fruit, 4.19), *Kakro* (Cucumber, 4.17), *Alu Bhakara* (European plum, 4.12) and *Kalo Ainsel u* (Heart-leaf raspberry, 4.11). The ethnic communities in the region used to consume all the parts of *Pharsi* like tender shoot, fruit, flower, root and seed to fulfill their food and nutritional demand. Hashash *et al.*⁶ reported about the high nutritional value of *Pharsi* with rich source of crude fibers, protein, β - carotene, potassium, sodium and calcium. The young frond of *Chiple y ningro* was consumed as vegetables to manage health issues like constipation, blood dysentery and stomach disorder. The diverse medicinal qualities like antibacterial, antiviral, anti-diarrheal and anticancer properties of ferns have been reported by Bajracharya & Bajracharya⁷ in their study on Nepalese ferns. The importance of *Gondruk* and *rai sag* in fulfilling food and nutritional security was already mentioned by Sharma *et al.*² in their study. The ethnic people consumed *Chamsur* to treat asthma, bronchitis and diarrhoea. Singh⁸ reported that *Chamsur* has several anti-bacterial, anti-fungal, anti-asthmatic, anti-oxidant and anti-inflammatory properties. The leaves of *Phapar* were consumed as vegetable while the dried seed was used to prepare flour. The people reported that the *Phapar* roti and vegetables played an important role to fulfill the food and nutritional demand of children and women in the region because of its high nutritional value. Rong *et al.*⁹ reported that the protein content of *Phapar* was higher than the tartary buckwheat and common buckwheat, and was much higher than that of rice, wheat, and maize flour. The people perceived that the inflorescence of

Nakima helps to fight diabetes and they consumed it mainly as vegetables. The study of Chettri *et al.*¹⁰ supported this perception of people and reported about the high nutrient profile of the crop with presence of fiber, protein, mineral like Ca, K, P and Mg, natural antioxidant and different phenolic compounds. The ethnic people consumed the soybean after fermentation using traditional method as they believed that it enhances the nutritional value of the soybean. They reported that it acts like probiotic, helps in indigestion and promotes immunity system of human being. Do Prado FG *et al.*¹¹ reported that the fermented soybean contains beneficial bacteria (*Bacillus subtilis*) and enhances the digestion capacity and immunity system of people. It is also rich in Vitamin K, enhances bone strength and provides protection against cancer. Salvador *et al.*¹² mentioned the vital role of *simal tarul* in food security due to its rich carbohydrate, mineral and vitamin C content. *Pindalu* was another wild vegetable consumed by the ethnic communities because of its easy availability, cultural suitability and health benefits like blood purification and bone formation. In this regard, Temesgen and Ratta¹³ reported that *Pindalu* contains high amount of starch and minerals and played an important role in maintaining human health. The ethnic people of the hill consumed *Simrayo* as a side dish leafy vegetable, soup and mixed vegetable. They believe that it helps in fighting goiter disease, enhances the appetite, acts as blood purifier, manages blood pressure and control cancer disease. The findings of Rai *et al.*¹⁴ supported this belief system as they reported that *Simrayo* is rich in vitamin K, glucosinolates and sulforaphane compound, and have antiscorbutic, stimulant and anti-cancer properties. Anmol *et al.*¹⁵ mentioned that *Bhogate* is a vitamin enriched fruit with high nutritional value and also has minerals like calcium, phosphorus, sodium and potassium which helps in maintaining the proper health and growth of the bones as well as the electrolyte balance of the body. The consumption of *Garandal* as nutritious food by ethnic people was justified by the findings of He X *et al.*¹⁶ who reported about antioxidant, anti-hypertensive, anti-tumour and anti-diabetic activities of *Garandal*. The wild *Kakro* was widely consumed by the people as fresh fruit, salad and vegetables because of its high health benefits, consumer preference, easy availability and cultural suitability. The high nutritional value of *Kakro* was reported by Uthpala *et al.*¹⁷ in their study.

The use of *Aloo bhakara* plum by local people for managing diabetes, constipation and cancer was supported by the findings of Singh R¹⁸. The fidelity level and usefulness of *Litsea* sp., *Rubus* sp., and *Passiflora* sp. as nutritious crops with high medicinal and nutritional values were already mentioned by Mahapatra *et al.*¹⁹ and Sharma *et al.*² in their studies.

The consumption of traditional nutri-crops with index score of just more than four were- Celery (4.09), *Chiuri* (Indian butter tree, 4.09), *Sil timbur* (Chinese pepper, 4.09), *Philungey* (Niger seed, 4.08), *Dungdug* (Hooker chives, 4.08), *Rani Bhyakur* (Five-leaf yam, 4.07), *Bee* (Brinjal, 4.06), *Ruk tamatar* (Tree tomato/Tamarillos, 4.06), *Thotney* (Knot weed, 4.05), *Nebara* (Himalayan fig, 4.05), *Betgara* (Viagra palm, 4.04) and *Arucha* (Plum, 4.03). Celery was mainly consumed as leafy vegetables in soup or in side dish for its multiple health benefits. Koti and Daraei²⁰ reported that Celery is an important source of carbohydrates, phenols such as flavonoids, alkaloids, and steroids. The local people reported that the seed of *Chiuri* tree was used for making pickles as well as vegetables and its high nutritional value was reported by Sundriyal & Sundriyal²¹ in their study. The village people of the hill used the Niger seed oil to cure asthma, coughing, wheezing and other lung function. They believed that it is good for heart health and helps in reducing body inflammation. Their perception gets justified by the findings of Firdous²² who mentioned that Niger seed is highly rich in protein, carbohydrate, fatty acids, minerals and contain healthy compounds like linoleic acid, niacin, oleic acid, fibres, riboflavin and ascorbic acid. Vivek and Prakash²³ found that wild *Rani bhyakur* had more carbohydrate, calorific value, fat and amino acids than other common varieties. *Bee i.e.*, wild brinjal was another common and widely available vegetable of the region. Though bitter in taste but ethnic people prefer it over common commercial brinjal varieties for more nutritional and health benefits. Khatoon and Sharma²⁴ reported that wild *Solanum species* were having relatively higher nutritional and multi-elemental composition than its commercial counterpart *Solanum melongena*. It was found that the local people specially the elder people still preferred to consume wild tree tomato due to its perceived high nutritional value than the popular tomato available in the market. The findings of Shah²⁵ supported this traditional food practices as he found that tree tomato contain relatively higher amount of Vitamin A, C, B6,

E and antioxidant than popular commercial varieties of tomato. Traditionally the Nepalese people consumed the tender shoots of *Thotney* for treatment of diarrhoea and young shoots as vegetables and pickles. The findings of Joshi *et al.*²⁶ confirmed the presence of nutritious phenolic compounds in the plant. The ethnic communities of the region reported that the ripened fruits of *Nebara* or *Nebhara* acted as immunity booster and helped to fight any viral fever including Covid-19. The findings of Panda and Thami²⁷ also reported that the Nepalese people used the extract of ripened fruits of *Nebhara* (2 fruits per 100 mL normal water) daily in the morning with an empty stomach for fighting any type of viral fever. The people of the region said that they consumed the *Betgara* as anti-diabetic fruit and now it has become quite popular among all the hilly people. Ghoshal and Mandal²⁸ confirmed the presence of the α -glucosidase and α -amylase enzyme in *Betgara* fruit and reported that methanolic extract of endocarp of the fruit has antioxidant and anti-diabetic capability. The people of the region consumed the wild *Prunus domestica* L. and findings of Rop²⁹ confirmed that regional cultivars of *Prunus domestica* L had more nutritional properties in terms of total phenolic content, antioxidant capacity, mineral and pectin content. All these facts prove that the wild vegetables of the hilly region are more nutritious, and their health benefits are in concordance with traditional belief system of people.

Other traditional nutri-crops with index score just less than four were-*Gharia sisnu* (Common nettle, 3.99), *Batulpate* (Velvet leaf, 3.94), *Red Thanray Mosyam* (Rice Bean, 3.88), *Singtamai Semi* (3.74), *Allapatray semi* (3.71), *Dalle khursani* (3.68). Another uncommon local vegetable was *Gharia Sisnu* which was consumed by the people for preventing cardio-vascular diseases. Bhusal *et al.*³⁰ reported that the leaves of *Gharia sisnu* are rich in fiber, minerals, vitamins, and antioxidant compounds like polyphenols and carotenoids and have ability to prevent cardiovascular disease. The use of *Batulpate* by traditional communities for treatment of ulcer, wound, and fever was also mentioned by Kumari *et al.*³¹. The people in the villages still consumed the wild rice beans or *Red Thanaray Mosyam* as they believed that the local variety or cultivar has more nutritional value than popular variety available in market. Katoch *et al.*³² highlighted the nutritional value of rice bean as a well-balanced source of

beneficial constituents such as protein, carbohydrates, minerals, vitamins, polyunsaturated fatty acids (PUFAs) and anti-oxidants. The people in the villages still consumed the wild common beans like *Singtamai semi*, *Allapatray semi* etc. as they believed that the local variety or cultivar has more nutritional value than popular variety available in market. Celmei *et al.*³³ in this regard reported about the higher nutritional value in terms of protein content, linoleic acid, Se and Zn content of wild beans as compared to modern beans. Similarly, the ethnic communities of the region consumed local chilli known as *Dalle khursani* for its better hotness and nutritional value. Khatoon³⁴ found appreciable nutrient content in *Dalle Khursani* and most of the proximate content was higher as compared to green pepper and reported about its high phytochemical content and good antioxidant capacity.

Strategies for popularizing the traditional nutri-crops

It has been noted that most of the wild crops were restricted within the rural communities and not much popular among the urban communities. Hence, the study documented different policy strategies for its up-scaling and out-scaling among the urban communities. The findings in Table 2 reveal that 81% of people felt that ensuring a better price for traditional nutri-crops will help in popularizing their cultivation among farming communities. The initiatives like opening a new market specifically for local produce in major cities like Kalimpong, Namchi, Gangtok and Darjeeling, creating local produce outlet in major tourist place, creating linkage with hotels and restaurants may help in getting more remunerative prices. It is found that the productivity of local nutri-crops are very low as compared to modern crops and varieties. Hence, eighty per cent people felt that there is a need to start research initiatives specifically on local unexplored nutri-crops to enhance their productivity. The ICAR research institute and agricultural university need to start specific crop improvement or breeding programme on these nutri-crops. Demonstrating the potential of indigenous nutri-crops in fighting malnutrition through extension agents was perceived as major strategy by 78% of respondents. The Krishi Vigyan Kendra of the region should start specific on-farm trial and demonstration programme on the indigenous nutri-crops of the region. Establishment of a separate marketing platform was perceived as a major strategy for promoting traditional crops by 76% of respondents.

Seventy-three per cent people believed that incorporation of modern farm practices like zero tillage, IPM, INM, line sowing etc. within traditional nutri-crop based farming system will help in promotion of these crops. More than half of the respondents perceived the strategies like 'Location specific policy at panchayat level to preserve and promote nutri-crops in local cropping system (67%)', 'Ensuring intellectual property right for farmers and community (65%)', 'Special emphasis on policy for traditional nutri-crops (53%)', 'Incorporation of local nutri-crops in mid-day meal scheme (50%)' will help in reviving the nutri-crops cultivation in the region. Just less than half of the respondents reported about the strategies like 'Formation of nutri-smart village based on traditional crops (46%)', 'Establishment of traditional nutri-kitchen garden in each school (43%)', 'Publishing extension literature on role of local nutritional crops in fighting malnutrition (42%)', 'Establishment of cafeteria on nutri-crops in each KVK or University or research centre or *Anganwadi* centre (38%)', 'Establishment of traditional nutri-crop museum in KVK, Research Centre and University (33%)', 'Publishing extension literature on role of local nutritional crops in fighting malnutrition (42%)' will be helpful for promotion of traditional nutri-crops.

Conclusions

Though modern agriculture has come with diverse high yielding crops and varieties, but in the process, they have increased 'hidden hunger' (micronutrient malnutrition) by displacing important local crops and varieties. With the advent of fast food, the new generation forgetting the role of traditional crops in fulfilling nutritional demand and gradually they are disappearing from their dishes. The recent increase in modern day diseases like increased incidence of heart attack, stroke, sugar, cholesterol problem and cancers are testimony of the fact. The study showed how the ethnic communities of Sikkim and Darjeeling Himalaya fulfilled their food and nutritional security through traditional foods. This proved the importance of local crops and food for ensuring the food as well as nutritional security. The study showed that the ethnic communities have their own rationality system for consuming different crops for fulfilling their food and nutritional requirement. However, this knowledge is restricted within a section of communities and not getting percolated among the younger generation. Hence, there is a need for a special policy or

communication drive to document this knowledge and educate the new generation. There is need of extensive research programme on comparative bio-chemical nutritional profiling of all these traditional crops with common popular varieties. Beside this, the future research focus should be directed toward taking up specific crop improvement programme to enhance the yield and taste of all these traditional crops and varieties so that these nutri-crops can be integrated with modern farming system. All these initiatives may help to popularize these nutri-crops among all the stakeholders and ensured food as well as nutrition security for all the people.

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Conflict of Interest

There is no conflict amongst the authors as it is evidence-based learning and collection of information from the farming community, although nothing is confidential.

Author Contributions

SS: Investigation, data collection, writing; VS: Review, and editing; NG: Data collection, GSM: Review and editing, SP: Review; LV: Editing, PJ: Review; DB: Data collection; PS: Review.

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