Indigenous knowledge on bio-resources management for livelihood of the people of Sikkim

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Sikkim is not self-sufficient in food production due to limited land availability for cultivation and lower level of productivity affected by constraining mountain specificities such as inaccessibility, fragility and marginality. The people are rich in indigenous knowledge on bio-resources and supplemented their food from the wild plants and animals in the beginning. Now, fifteen types of indigenous farming systems have been identified, and these farming systems and wild bio-resource supplements have been described along with field verification study.

Keywords: Food bio-resources, Zhum cultivation, Farming systems

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Sikkim lies between 27° 04’ 46” and 28° 07’ 48” North latitude and 88° 00’ 58” and 88° 55’ 25” East longitude on the southern slope of the Eastern Himalayas with an area of 7,096 sq km in the Northeast zone. Sikkim constitutes 0.22% of the total geographical area and 0.05% of the total population with 540,851 persons (2001 Census) of India. The population of Sikkim today comprised of 14 hill tribes and many Plains-men communities. The hill tribes comprised of Lepchas, Bhutias, Sherpas, the ancient Kiratases (Limboos, Khombu-Rais, Yakhas), the communities analogous to Kiratases (Sunuwars, Magars, Gurungs, Tamangs, Bhujeels, Thamis), the Khasas (Bhahuns, Chettries, Kamis, Damais, Sarkis), the communities analogous to Khasas (Thakuris, Jogis/Sanyasis, Majhis), and Newars. The plains-men comprises of Marwaries, Biharies, Bengaliies, Punjabies, Kerelites, Madrasies, etc. More and more plains-men were added up after Sikkim was integrated into the Indian union in 1975 due to increase of developmental activities. Sikkim was first inhabited by the aboriginal bands from the Archaic Period of human migration (c. 38,000 – 2,500 BC). For the hunter-gatherers of the world, agriculture was not even a conscious choice between food production and hunting gathering. The indigenous people of Sikkim were at that stage of go-between as late as the middle of the nineteenth century when Dr JD Hooker visited Sikkim in 1849. Only in the last decade of nineteenth century (1890s AD), the Colonial British Administration started settlement of the ethnic people of Lepchas, Bhutias and Nepalis by clearing the forest and started settled agriculture on permanent basis. The rule of bench terracing of the land for cultivation by the tillers started by the 10th Chogyal Sidkyong Tulku (1879-1914 AD) was accelerated after 1890s in Sikkim.

Indigenous knowledge of Zhum or shifting cultivation

From antiquity, the people were hunters and gatherers in Sikkim also. From the tribal society of antiquity to the Namgyal Dynasty (Chiefdom society) till 1975, excess to market was very limited to the people of Sikkim. Money circulation was extremely limited. Even if money was there, the availability of food resources from the market was limited. Hence, the people of Sikkim used to collect whatever food bio-resources were available from the forest and streams/rivulets nearby to meet their additional requirement. The people of Sikkim before 1890s were shifting cultivators. They were not allowed permanent settlement by the chiefdoms. Upland rice Taguma (Lim for Limboo) Ghaiya (Nep for Nepali) forming their chief sustenance grown without irrigation, and produced a large, flat, coarse grain which becomes gelatinous, and often pink, when cooked. Finger millet Parama (Lim) Pangdur (Nep) was directly sown after clearing the forest. This was also fermented for preparing local beer known as Thi...
(Lim)/Jaanr (Nep) and used for offering to their gods and goddesses. Buckwheat of both tartary and common, Chongbakla (Sama), Fox tail millet (Poya), Junelo (Bajra), and Amaranthus were also sown directly after clearing the forest as Zhum cultivation. Similarly, mung dal, ricebean, horsegram, fieldbeans in pulses; soybean, mustard, niger (filingle), perrila seed (nambong in Lim) in oilseeds; orange, pineapple, jackfruit, hill banana, pear, peach, plum in fruits; cucumber, pumpkin, balsum apple, leafy mustard, iskus in vegetables; greater yams, colocasia, sweet potato, potato, Phultarul, cassava in root and tuber crops; large cardamom, ginger, turmeric, indian dill in spices were the crops grown in Zhum cultivation. Pork is a staple dish. They also reared poultry, goat, sheep, and cattle, and eat almost all kinds of animal food both wild and domesticated. When traveling, they lived on whatever they could find, whether animal or vegetable. Fern-tops, roots of Scitaminece, and other flower-buds, various leaves, and fungi are chopped up, fried often in animal fat, and eaten.

The reasons for the continuance of Zhum cultivation for many centuries in Sikkim was linked up with ecological, socio-economic and cultural factors, including the lack of communication, leading to physiological remoteness and isolation on the one hand, and Namgyal Dynasty’s policy of land taxation on the other. The land taxation and shifting cultivation policy of Namgyal Dynasty before 1890s has been clearly described by Hooker. “They never inhabit the same spot for more than three successive years, after which the Rajah demands an increased rent. They therefore, squat in any place, which he can render profitable for that period, and then moves to another. His first operation, after selecting a site is to burn the jungle; then he clears away the trees, and cultivates between the stumps.” The essential features of zhuming, as practiced in Sikkim of that period were: selection of sites on hill slopes, usually before December; clearing of sites by cutting jungles in December-January; burning of jungles around mid-February to mid-March; planting of various crops in an intimate mixture by dibbling; abandoning or surrendering of the land to Chogyal/Kazi administration to avoid heavy taxation after cultivation for two years usually, and shifting to another site; and no chance of returning to the same site to repeat the process as the Chogyal/Kazi administration has occupied the cleared land or sold out to some other tiller.

No animal or large implement is used by the zhumias for preparing the land. The only implements used in farming were the chopping knife (Bamphek/Mudenphe/Pheja), the dibbling-stick and a small hoe for weeding. The only inputs used were seeds and human labour. Except the cutting of jungles, and watching to protect the crops, the other operations, including weeding, were usually carried out by women. All essential crops, including Taguma rice, maize, pangdur millet, fox tail millet, chongbakla, buckwheat, Amaranthus, cassava, colocasia, perilla seeds, iskus, cucurbits, beans, yams, banana, etc. were planted in an intimate mixture although a single crop of Taguma rice or pangdur or buckwheat were sometimes grown in the second year of zhuming. The farmers then selected another site and repeat the same method of farming. After two years with or with no chance of returning to the same site as it is handed over to the administration – Kazis or Thekadars.

The effect of zhuming was extremely wasteful and the adverse effects included large scale deforestation, resulting in the denudation of hilltops and slopes; soil erosion on a large scale owing to deforestation and cultivation on hill slopes without effective soil-conservation practices, leading, in turn, to several adverse effects like silting up of reservoirs and streams, leading to floods, depletion of fertility, which is not easily built up again, etc.; practice of zhuming leaves very little scope for introducing modern technology; system is very low productive. Thus, food self-sufficiency was never there from agriculture and mostly depended on hunting and gathering of wildplant and animal bio-resources from forest and streams, rivers, rivulets around their habitations for livelihood.

Indigenous knowledge on settled agriculture

Settled agriculture in Sikkim was initiated by British Administration’s political officer, Sir JC White in Sikkim in 1889. He discouraged the nomadic life due to tax collecting problem and encouraged permanent settlement of the people. He also allowed settlement of people from Nepal especially in South, West and East Sikkim in spite of the prohibition imposed by the seventh Chogyal Tsugphad Namgyal against the settlement of Nepalis. Lasso Athing the brothers of Khangsa Dewan and Phodong Lama encouraged settlement of Nepalis as desired by White. Thus, he started settled agriculture
for the first time in Sikkim during 1890s. The settlement from Nepal was so fast that by the end of nineteenth century, almost every suitable part of land below 1,800 m was cleared for agriculture due to increase of population mainly due to in-migration from the neighbouring countries. The indigenous people as well as in-migrated people of Sikkim now slowly developed their own system of mountain farming systems in Sikkim. From antiquity to 1953 (before the beginning of Five Year Economic Development Plan), that is mainly during the Namgyal Dynasty (Chiefdom period), the farmers of Sikkim were cultivating a number of crops with the traditional crop-resources. The in-migrated people from neighbouring countries also brought a number of crops and crop varieties for cultivation with them. The various crops and crop-varieties cultivated during that period were:

Cereal crops
Maize (Zea mays): Muroli Makai, Kali Makai, Pahenli Makai, Seti Makai, Pangri Pakai, Pharasi Makai, Satthiya, Kukhrey, and Chepti Makai
Paddy (Oryza sativa): Direct Sown Upland rice–Taguma (Lim) Ghaiya (Nep) Transplanted Paddy–Takmaro, Bhuidhan, Kalo Marsi, Seto Marsi (Attey), Sijali, Timburey, Yangseri, Taali, Kataka, Thapachini, Sikre, Dahaley, Tirimpful, Krishnabhog, Kalmchanti, Darmali, Dudkhatti
Finger Millet (Eleusine coracana): Direct sown –Parama (Lim) Pangdur (Nep) Transplanted–Chiyetna (Lim) Angalmare (Nep), Sangsere, Siremna, Seto Murkey (Dudhey), Kalo Murkey, Nangkatua, Bhadare, Kartike, Mangsire
Barley (Hordeum vulgare): Tingsee (Lim) Uwa (Nep), Phakmeysee (Lim) Sungurpuchre (Nep), Khoksee (Lim) Muraley (Nep), Kane, Khaunginema
Wheat (Triticum aestivum): Kalo Gahun, Seto Gahun, Murule Gahun
Buckwheat: Tartary Buckwheat (Fagopyrum tartaricum)–Kalo Titey, Dolle Titey, Mandhaney Titey
Common Buckwheat (Fagopyrum esculentum): Chiniya, Mithey, Mandhanet
Fox tail millet, (Setaria italica): Phoktangpoya, Miyongney
Barnyard Sawan (Echinochloa crusgalli): Seto Sama, Kalo Sama
Pearl millet (Panisetum typhoides): local
Grain Ammaranthus (Amaranthus sp): Seto Latte, Rato Latte

Pulse crops
Mung dal (Phaseolus mungo): Kalodal, Pahenlodal, Ratodal
Ricebean (Phaseolus calcaratus): Alimesam, Ratomesam, Thangremesam
Horsegram (Dolichos biflorus): Kal Gahat, Setogahat, Ratogahat
Beans/Borhi (Phaseolus vulgaris): Sugeppa (Huidesemi), Harey semi (Singtamey semi), Dudhey Semi (Montulall), Jureli Semi (Ghew Semi), Kalo Semi, Pahenlo Semi, Muyansugeppa, Lachungey
Cowpea (Vigna sinensis): Lohore and Thangre

Oilseeds
Mustard (Brassica sp): Sarson (B. campestris dichotoma), Kalotori (B. nigra), Rayotori (B. juncea var. rugosa), Tori (B. toria)
Soybean (Glycine max): Kalo Bhatmas, Sainli Bhatmas, Seto Bhatmas
Niger (Guizotia abyssinica): Kalo
Perilla seed (Perilla frutescens): Kalo, Seto

Fruits
Citrus (Citrus reticulata): Sikkim Mandarin, Nite Jhyamir (Citrus junos), Kali Jhyamir (Citrus jambhiri), Phoksey (Citrus paradisi), and Kagati (Citrus aurantifolia)
Banana (Musa paradisica): Lallkera, Ghewkera, Mungreykera, Dhusreykera, Malbhog
Guava (Psidium guajava): Thulo, Sano
Peach (Prunus persica): Asare aru, Bhaadare aru
Pear (Pyrus communis): Thula
Mango (Mangifera indica), local
Jackfruit (Artocarpus heterophyllus): local
Pineapple (Ananas comosus): local
Ghewphal (Punica granatum): Rato
Plum, Arubukhara (Nep) (Prunus domestica insitita): Asare

Root and tuber crops
Potato, Khamse (Lim) (Solanum tuberosum): Darjeeling Red Round, Bombay,
Greater Yams:
Ghar Tarul (Nep) Himkhe (Lim) (Dioscorea alata): Pattale/Pangkhe, Jahantey, Nakhe
Sukhey (Lim) Bhyagur (Nep) (D. deltoidea): Yaksu, Pansu Ligo (Lim) Suthni (Nep) (D. esculenta): local; Phakwerek (Lim), (D. bulbifera): local
Kerimba Phakwer (Lim), Mithe Githa (Nep) (D. pentaphyla): local  
Cassava (Manihot esculenta): Local  
Sweet potato (Ipomoea batatas): White, Red  
Phungkhe (Lim) (Cana spp.): Seto, Rato  
Colocasia, (Colocasia esculenta): Dudhmaney, Lankey, Setomaney, Hatipailey, Phekhemba

Spices
Ginger (Zingiber officinale): Nangrey, Majhaule, Bhaise, Gorubathaney  
Turmeric (Curcuma longa): Rato, Panhelo  
Large cardamom (Amomum subulatum): Ramsey, Golsey, Sawney  
Indian dill, Soanp (Anethum sowa): local  

Although, settled agriculture was started after 1890s the farmers were never self-sufficient from agriculture even during this period. Hence, the people of Sikkim used to supplement their food produce from agriculture through hunting and gathering of rich bio-food resources of this part of the Himalaya.

Indigenous knowledge on agriculture
Five Year Development Plan was started in Sikkim in 1954 onwards. A separate Directorate of Agriculture was carved out from the Forest Department in 1954 headed by Dr. KL Narsingh for Agriculture and Animal Husbandry. Demonstration-cum-seed multiplication farm at Gyava, West Sikkim was established for Agricultural crops. Another farm known as Hilley Seed Potato Farm, West Sikkim for Potato was also established. Later on Mangan Nursery North District, Teen Mile Nursery and Naumile Nursery East District were also established for temperate and subtropical fruits, and fruit plants of temperate and subtropical types were also introduced for planting material production. For livestock development in Sikkim, Animal Husbandry Farm, Tadong, East Sikkim was established. All the above agriculture and Animal Husbandry farms were established from the Development Plans of 1954-1975. A number of improved seeds of various crops and improved breeds of livestock were introduced during this period. Sikkim merged into the Indian Union in 1975. The Department of Animal Husbandry and Veterinary Services was carved out from agriculture in 1976. The existing farms were also divided into the Departments based on their importance of the areas. In 1976, Sikkim adopted Regional concept of agricultural development for modernization of agriculture system. The State was agriculturally divided into 9 regions and 7 sub-regions. Each region and sub-region was provided a farm for demonstration, conducting adaptive trials, and seed and planting material multiplication. In 1996, the Department of Horticulture was carved out from Agriculture for horticulture development. A large number of crop varieties and horticultural plants were introduced for adaptive trials in these farms. The better ones with chemical fertilizer responsive varieties were multiplied and distributed to the farmers. Use of fertilizer and pesticides were promoted through large scale demonstrations, and distributed to the farmers excessively till 2001.

Indigenous knowledge of farming systems
Farming system is an almost stable arrangement of farming activities managed by a household or community to meet the needs of family. Forests, grasslands and croplands constitute the main ecosystems of Sikkim Himalaya. Locally, the agricultural lands are classified in to Dhankheti, Sukhabari, Alainchibari, Kotheybari, Khasmohal and Goucharan. In Sikkim, different farming system have been developed by the indigeneus farmers based on agriculture, horticulture, pastures and forestry which are largely influenced by geographical and climatic diversity prevailing in the different zones of the state. The yield potential of any particular site is the result of the interaction of many growth factors such as light, air, rainfall, topography, temperature, humidity and soil types. The aim of the grower is to simulate the conditions under which the crop can express its potential under the given environmental conditions.

Dhankheti (Paddy field)
Direct sown upland paddy Taguma/Ghaiya was cultivated without any irrigation on sloppy lands before 1890s. With the improvement of living standard of the people of Sikkim food habits were changed and they could not relish the upland rice Taguma/Ghaiya; and started cultivation of wet rice on terraced lands. The water from springs is collected into very small rivulet commonly known as Kholsa and are taken in channels to irrigate rice-transplanted terraces under the gravity from higher elevation. On the irrigated terraces, rice seedlings, raised in nurseries, are transplanted and fields remain almost submerged throughout the growing season and drain out through a single outlet of the field.
cropping systems on irrigated terrace ricelands are: Rice-Wheat, Rice – mustard, Rice–potato, Rice–fallow, Maize–rice–mustard (below 800 m), and Maize–rice–fallow at higher hills. In Sikkim, farmers intercrop rice with traditional variety of soybean, ricebean, and urd on bunds. During field preparation the top soils of the terrace risers and bunds fertilized by the nitrogen-fixing *Rhizobium* bacteria are sliced back to the terraces for fertility and new soils are put on the bunds for planting the legume crops every year. While harvesting the crop stalk is cut at 4-6 cm above the ground level to add more organic matter to the field. Most of the area even today is under cultivation of the local rice varieties, which yield from 1 to 2 t/ha.

**Sukhabari (dry land)**

Dry land includes terraced, partially terraced, unterraced fields and crops are raised under rainfed conditions. The main crop maize, occupies the largest acreage (40,000 ha) and is grown up to 2,700 m elevation. During field preparation crop stubles, weeds, etc. are collected and burned to add more phosphate in the soil. The field is ploughed well in time for exposing harmful insects which are eaten away by the birds, and pulverization. Farm Yard Manure is broadcasted before sowing the crop. The common practice of sowing the crop is by broadcast. Yield is very poor and often crops are harvested leaving 0.5 m stalk in the field. The following crop sequences are common in Sikkim depending upon the evelation. Maize–fallow, Maize–soybean–mustard, Maize–finger millet, Maize–finger millet–fallow, Maize–soybean–mustard, Maize+ricebean–fallow, Maize–ricebean/urd/fieldbeans, Maize–potato, Maize–buckwheat, Maize–barley, Maize–black gram (*urd*), Maize–vegetables, Maize+ginger, Maize+cassava, Maize+beans.

**Ginger+Maize cropping system**

Ginger is mainly cultivated by the small and marginal farmers and hence also known as the poor man’s cash crop, is cultivated extensively for the market as green ginger. Ginger is cultivated in raised beds; field is divided into beds of 60-80 cm width of 15-20 cm high with a spacing of 30-40 cm between the beds and gentle slope outwards to drain the rainwater. The seed rhizomes 40-60 q/ha are planted in pits and covered with organic manure (30-40 t/ha) maintaining 30-45 cm distance between rows and 15-20 cm between rhizomes in the last week of February to March. Maize seeds are sown either around the periphery of beds or in the space made for draining the water between two beds. The beds are covered with leaves and twigs of various forest trees, weeds and grasses available around fields, animals bedding and surplus rice straw as a mulch amounting 5-20 t/ha on dry basis. The mulch keeps the soil shaded and warm, prevents the weed infestation, minimizes soil erosion and protects the young plants from heavy rain. After decomposition, manure and mulch enrich soil nutrients and meets the need of growing plants. Ginger is harvested twice, first during May/June when only mother rhizomes are harvested. It is known as *mau* and is of inferior quality. The second harvesting is done after 7-8 months of planting and is also decided by market demands. Farmers harvest around 150-250 q/ha rhizomes, provided crop is not affected by rhizome rot disease.

**Mandarin-intercrops**

Sikkim mandarin (*Citrus reticulata*) is a commercial fruit crop of the State is intercropped almost everywhere throughout the year. The main intercrops are: ginger, ginger+maize, maize–ginger, maize–urd–mustard, maize–mustard, maize – vegetables (especially beans), maize–buckwheat, and maize+cassava. The scarcity of agricultural land in Sikkim hill terrain is the main factor for taking intercrops in mandarin orchards to meet their food requirements and cash money through ginger and vegetables in addition to orange fruits. The cultivation of ginger+maize/ginger is done in the same method as described earlier. The growing of leguminous vegetables and crops are preferred to improve the health of soil without competing with mandarin trees.

**Large cardamom agroforestry**

Sikkim is the largest producer of large cardamom (*Amomum subulatum*) in the world. It is adopted well as agroforestry crop from 600-1,800 m elevations of humid environments on steep sloppy hills under shade trees where other economic crops can not be grown. It is the native crop of Sikkim and there are number of cultivars among the cultivated species, which are considered to be derived from three main distinct cultivars namely; Ramsey, Sawney, and Golsey. It is propagated through rhizomes as well as through seedlings. Among the shade trees of large cardamom plantation, *Alnus nepalensis*, *Schima wallichii*, *Maesa*
chisia, Saurauia napoulensis, Machilus edulis and Melia composite are the most common. The fixations of atmospheric nitrogen and litter fall from the Alnus tree provide nutrient to the large cardamom plants. The raw capsules are fleshy and contain up to 85% moisture. They are cured locally in traditional Bhatties using fuel wood to reduce the moisture to around 10-14%.

**Potato cultivation**

The main cultivated area of seed potato is at higher elevations above 1,800 m. It is planted in February-March and harvesting is done in August-September using previous crop seed. Farmers prepare the compost by using collected forest litter and animal bedding along with animal excreta in pits. The compost is applied at the time of seed planting on furrows or pits. Pea is intercropped giving the space of 4-5 furrows between each row to avoid the shading effect and harvesting of pods is done in May-June for vegetable purpose. In some areas, farmers burn the residues openly on the entire field and then mix with the soil by ploughing. At higher elevation above 2,500 m it is mono-cropped and at lower elevation crop sequences of maize-potato, maize-rice-potato, rice-potato, and maize-ricebean-potato are most common.

**Zero-tillage cultivation of cabbage**

Cultivation of cabbage is done at higher altitude as off-season vegetable. In the month of April-May, growers cut the grasses, weeds and stubbles with sickles on sloppy lands and after drying, burn the same on entire field. The cabbage seedlings are raised on separate seedbeds prepared with organic manure. The field preparation is done by simple shallow digging of the field. Seedlings are now planted without any other input. No interculture operation is done. The cabbage is harvested and marketed in June-August.

**Vegetable cultivation**

All the vegetable crops such as cabbage, cauliflower, broccoli, knol khol in cole crops; tomato, brinjal, chilli, capsicum, tree tomat in solanaceous; pea, beans, cowpea, French bean, in leguminous; radish, carrot, turnip in roots, cucumber, pumpkin, bottle gourd, sponge gourd, ridge gourd, snake gourd, bitter gourd, sweet gourd, balsam apple, iskus in cucurbitaceous; palak, Amaranthus, methi, leafy mustard, celery, coriander, mint in leafy vegetables; onion, garlic, leek in bulbs; potato, sweet potato, cassava, colocasia, dioscorea, ginger, turmeric in tuber and rhizomatous vegetables and okra are cultivated based on organic manuring. Organic manure is applied in furrows or plant bases to get maximum output with minimum loss by erosion.

**Relay cropping of ricebean, urdbean, Frenchbean, pea, tomato and soybean with maize**

Ricebean and urdbean are grown as relay crops with maize only at lower altitude where as soybean is commonly cultivated everywhere. Pea, tomato and French bean are intercropped in small area near the house for off-season crop. Ricebean and soybean are intercropped in May-June in the standing maize field during the time of interculture. After the maturity of maize, cobs are harvested leaving the stalks in the field for the support of intercrops, however in case of soybean only half stalk is left.

**Legume crops in rotation**

Ricebean and urdbean are cultivated in rotation after the harvest of maize everywhere in the mid and low hills of Sikkim. Ricebean is a non-determinate type of legume, which enriches the soil by adding large amount of foliage and atmospheric fixed N compared to other legumes. Urdbean is extensively cultivated after maize crop at lower and mid hills of dry areas of Sikkim for harvesting the residual moisture of the soil.

**Kothebari (homestead gardening)**

This system consists of house, animal shed, few fruit trees, food crops, vegetables and other trees surrounding the house. There exists a large variation in the combination of above components from individual house to house depending upon area available and existing agro-ecosystems. The complex of trees and annual crops allows the continuous use of land around the house throughout the year. Recycling of nutrients is very high because for giving the same input to other lands, farmers have to carry the inputs on head loads to that distance. These systems not only beautify the landscape around the surroundings and improve the environment but also directly benefit the crops with which they are associated.

**Bamboo groves, fodder trees and broomgrass as a component of agricultural holdings**

The farmers of Sikkim by and large adopt the mixed farming system comprising of agricultural crops and livestock. In the agricultural field, stream
banks and drainage channels, stands of Choyabans (Dendrocalamus hamiltonii), Bhalubans (D. sikkimensis), Paren (Cephalostachyum hookeriana), Malbans (Bambusa nutans), Chilleybans /Tokribans (Neohouzeous dullosa) are common. Bamboos are extensively used by the farmers for meeting their various demands and the different species of bamboo are available in Sikkim even above 2,700 m elevations. Among the fodder trees Dudh jasto chop awaney jati (Ficus sp), Barhar (Artocarpus lakoocha), Kutmiro (Litsaeaa polyantha), Gogun (Saurauia nepalensis), Tanki (Bauhinia purpurea), etc. are the most common species. Broomgrass/Amliso (Thysanolaena agrotis) is extensively grown on marginal lands, field boundaries and terrace risers both for flower-broom and fodder during winter season14.

Transhumance system at high hills

Lachenpas of Lachen valley and Lachungpas of Lachung valley North Sikkim, Gurungs, Sherpas, Bhutias and Limboos of West Sikkim rear sheep, goat, yaks and upland cattle in temperate to alpine zones. The Gurungs, Sherpas, Bhutias, and Limboos of West Sikkim travel with their animals in summer (April-September) at higher elevation and come down to lower altitudes in winter (October-March) for grazing. The Lachenpas of Lachen and Lachungpas of Lachung valley of North Sikkim move with their animals (yak, sheep, goat) to the open control grazing meadows decided by the community headman (Pipon), the date/month from one pasture land to other to provide the equal chances of grazing the grasses at appropriate growth. In the dry high hills of North Sikkim, farmers of Lhonak and Chho-Lhamo leave a portion of good grassland without grazing for preserving in the form of hay as winter-feed and grazing is also controlled/regulated from January to March. The main animal yak is the beast of burden at higher altitude of this region. Every part of yak is used for human food and livelihood such as milk, hide, meat, bones and excreta for manure, ploughing, tail for worship, communication in high terrain, carrying loads etc. Sheep, goat and yak provide wool and meat. The grazers also collect the tender ferns, neetles, fresh bamboo shoots, certain rhizomes, tubers, fruits, medicinal plants like Jatamansi (Nardostachys jatamansi), Kutki (Picrorhiza kurrooa), Panch anguley (Orchis latifolia), Bikh (Aconitum sp), Dhup (Juniperus sp), and Sunpati (Rhododendron sp), Gentiana sp, Yarchagombuk (Cordyceps sinensis) from the wild over a period of long time, now is of major concern.

Tea garden

Temi tea state is the only garden located at Temi in South Sikkim at the feet of Tendong hill between 1,500 and 1,800 m elevation. Tea is grown in 200 ha land on hill slopes employing 450 persons for the care of estate and processing of green leaves. The tea produced at Temi fetched highest price among the Indian tea in Kolkata market. Tea plantation provides jobs to the people and also protects the soil from degradation.

Field verification study and discussion

The field verification case study was conducted by selection of two revenue blocks, namely Hee and Hee Patel, West Sikkim for field verification of food bio-resource management for livelihood with holistic approach (both cultivated and wild) during February-April 2008. The methodology adopted is based on questionnaire to randomly selected household family head covering 5% of the population (40 out of 370 HH Nos) person to person contact followed by consultative meeting and discussions at seven locations covering the entire area of the block scattered in the villages. The questionnaire were designed to obtain information about the land resources, food resources both cultivated and wild, family income and expenditures, commercial crops, livestock, historical questions of crop-varieties grown during chiefdom period, replacement of traditional varieties by the present day varieties, prospective of food resources, present day challenges, etc. The farmers selected were under the age group of 25-90 yrs. The study was conducted from first week of February 2008 to first week of April 2008. This information was analyzed and the summary is presented.

Indigenous knowledge on wild-food resources management

Since antiquity, the mountain regions of India (11 Himalayan states and Darjeeling district of West Bengal) were never self-sufficient in food from agriculture. Their food bio-resources were both cultivated and wild. They supplemented their food deficit through hunting and gathering of wildplants and animals from the forest and stream/rivers/rivulets
surrounding their habitation. Sikkim is no exception. These mountain regions of the Himalayas were dependent largely on hunting and gathering of wild food bio-resources for a long, long period in the earlier days while most of them are now slowly depending on market due to access to resources for purchase of food and access to market as well. These mountain areas of the Himalayas are not self-sufficient and will never be self-sufficient in food production in future also due to acute land degradation caused by imperatives of constraining mountain specificities (Inaccessibility, Fragility and Marginality) which needs continuous resource upgradation measures.\(^{15}\)

**Indigenous knowledge on hunting of wild bio-resources for livelihood**

Field study reveals that 79 species of big and small wild animals were hunted for food at *Hee* and *Hee Patel* villages of West District of Sikkim in the early days and are still being hunted illegally for their livelihood. These wild fauna include 13 species of grasshoppers and other insects, 4 species of crabs, 14 species of fishes, 8 species of frogs, 30 species of birds and 10 species of mammals from the nearby forests, streams, rivers and rivulets and their own cardamom fields.

**Indigenous knowledge on gathering of wild-bio-resources for livelihood**

The farmers also gather 193 species of wild-plants for food, medicine, timber, fuel, fodders for their domestic animals such as cattle, goat, pig, etc. for their livelihood and for their religious purpose from their cardamom fields and the forest, stream-banks, etc. legal or illegal means. They gather 22 wild fruit species for fruit, 8 fruit species for edible oil extraction, one fruit species for making candle light, 5 plant species for tea substitute, 9 plant species for root and tuber crops, 50 species for tender shoots, leaves, stems, roots, fruits, etc. for vegetables, 6 species of mushroom, 13 species for spices, condiments and seasoning herbagies, 29 species for health and medicines, 35 species for religious rituals and 16 species for agricultural tools, equipments and other household items.

**Land utilization at *Hee* and *Hee Patel***

Field verification study reveals that the land records of Land Revenue Department do not tally with the utilization in the field of the farmers. The farmers have started conversion of their land recorded in their *Khatiyen* (land records) as Dhankheti, Sukhabari and Banjho into cardamom plantations extensively since 1996 onwards. The shifting of their various types of land into cardamom plantation has left only 52.24% Sukhabari inclusive of their dwelling house and 8.60% Dhankheti now. The entire banjho land has been converted into cardamom plantation. The cardamom plantation has increased to 39.16% of the total land in these two villages.

**Food-grain production from *Hee* and *Hee Patel***

Field verification study reveals that about 30% farmers in the studied villages do not produce any foodgrain; 15% farmers produce foodgrains enough to feed the family for a week; 25% farmers produce food-grains for one month family consumption; and 30% farmers produce food-grains for family consumption for 2-3 months. All the farmers depend on market or Government subsidies for food.

**Sources of income**

In the study, the data on various sources of cash income was also analysed in these two villages for 2007-2008 financial year. The share of cash income from large cardamom alone was found 31.25%, followed by 16.87% by livestock. Among the cash income from livestock, dairy contributed 12.02%, piggery 2.81%, and goatery 2.04%, making a total of 16.87%. Thus, on average cash income from agriculture and livestock per family was found 48.12% in these two villages. The average cash income of the family from non-agricultural activities was highest, i.e. 38.19% from occasional government and private labour works while 13.69% from salaries, servives, pensions, etc. contributing 51.88% of the total cash income in these two villages. The data of these two villages were also verified from the market survey. Large cardamom dry capsule production for 2007-08 was about 700 monds or 28,000 kg. Most of the farmers sold their produce at the rate of Rs 4,000–5,000/- per mound (40 kg) or Rs 100–125/- per kg. Hence the total value of the production was calculable on an average rate of Rs 4,500/- per mound, come to Rs 31.50 lakhs.

Similarly, milk productions from these two villages were also verified from the MPCS (Multi-purpose Cooperative Societies) at *Hee Bazar*, Radu, and Patchrek, where the milk is delivered by the farmers. The average collection of milk by 110 members at *Hee*
MPCS was 320 litre/day and the average rate paid by the cooperative to the farmers was Rs 9.50/litre. Only two farmers of Hee and Hee Patel delivered their milk to Radu MPCS and the average rate paid by Radu MPCS was Rs 11.50/L. The average rate of milk delivered by these two members of Radu MPCS was 6 L/day. Thirty members of Patchrek MPCS were from Hee Patel and the average rate of milk delivered by them was 34 L/day at the rate of Rs 11.50/L. Thus, the average total cost of milk of 360 L/year paid to the three MPCS members (146 Nos) comes to Rs 12.60 lakhs. The milch animals were mostly Jersy cross breeds and were stall-fed. Milk from stall-fed cattle of Hee and Hee Patel is collected at MPCS Hee and Radhu 288 L/day and 320 L/day respectively is a very good source of income for many farmers. But Hee MPCS pays only average price of Rs 9.50/L as against Rs 11/ L at Radhu and Rs 19/-/L at Khandu (both for Dentam Cheese Factory).

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