Format for Proposals of Candidate Systems
For The Globally-important Ingenious Agricultural Heritage Systems (GIAHS) Programme

SUMMARY INFORMATION

a. **Country and location**
Country : India
Location : Sikkim State

b. **Project title / name of the system**
Sikkim Himalaya-Agriculture : Improving and Scaling up of the Traditionally Managed Agricultural Systems of Global Significance

c. **Requesting agency**
Department of Agriculture, Government of Sikkim, India

d. **Governmental counterparts and other partners**
Lead Agencies :
1. Government of Sikkim
2. International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal
3. Local NGOs

Collaborating Agency:
4. United Nations University (UNU), Tokyo Japan

e. **Summary of objectives and activities (max. 200 words)**

The proposed GIAHS project, **Sikkim Himalaya-Agriculture** is a part of globally significant biodiversity hot spots of the world within the greater quadri-national junction of Khanchendzonga landscape in the Eastern Himalayas. The region is an assemblage of sacred landscapes called ***Demazong*** (the valley of rice) or the ***Shangrila*** (the hidden paradise on earth). This cultural-landscape is endowed with rich agrobiodiversity adapted and managed through traditional ecological knowledge of the culturally diverse ethnic communities. It comprises of trans-Himalayan agro-pastoral system of the ***Dokpas*** in the alpine plateaus, traditional agroforestry such as alder-cardamom and farm-based systems in the temperate zones, and terraced/valley rice systems in the lower sub-tropical zones. It is paradoxical to see that culturally and biologically diverse landscapes are marginalized. The development opportunities are enormous but persistent problems of poverty, access to markets, economic and ecological fragility are prevalent.

This proposal envisage to foster wider recognition of the Sikkim-Himalayan ecosystems and practices for local, national, regional and global importance by proper validation of greater capacity of ecological resilience and environmental services. Outcomes should ensure sustainable development through appropriate capacity building, institutional support, and strengthening. Main activities are :

- Assess and document trans-Himalayan ecosystems and adaptive traditional agriculture systems. Biophysical diversity, management regimes, social institutions/organizations and cultural services will be strengthened in relation to diversification of sustainable livelihoods and poverty alleviation;
- Validate and demonstrate the agricultural biodiversity management systems at all levels of ecosystems, species and genetic diversities from subtropical agro-ecological to alpine agro-pastoral zones for mainstreaming in development processes;

- Create networking with the institutions (government, R&D, NGOs, CBOs) of the region and UNU for dialogue on the issues and appropriate policy interventions to strengthen and up-scaling of the systems and reduce the biodiversity loss and ecological degradation for achieving environmental sustainability

DESCRIPTION OF THE SYSTEM

1. Description of GIAHS

The proposed GIAHS pilot site in Sikkim (Figure 1A) covers a range of ecosystem diversity extending from the rice cultivation systems along the valleys of glacier fed river Teesta, Rangit and Rangpo-chu in the subtropical zones (above 300 m), traditional agroforestry such as alder-cardamom and farm-based systems in the subtropical and warm temperate zones (600–2200 m), extreme subsistence farming in the cool temperate zones (2300–4000 m), to the trans-Himalayan nomadic Tibetan agro-pastoral ecosystems in the alpine plateaus (4000–6000 m) of the Khanchendzonga landscape in the Eastern Himalayas (Figure 1 B).

The characteristics and functioning of the agricultural ecosystems can be categorized into three broad systems:

- **Agro-Pastoralism of the Nomadic Tibetan Herders**
- **Traditional Agriculture Systems**
- **Valley Rice Cultivation Systems**

1.1 Agro-Pastoralism of the Nomadic Tibetan Herders

Agro-pastoralism in the alpine cold deserts of Lhonak valley, Chho Lhamo and Lashar valley above 4000 m asl in North Sikkim has been a part of human life support systems over several centuries. The trans-Himalayan nomadic Tibetans the ***Dokpas*** (graziers) herd yaks, dzos (cow-yak hybrid), sheep and goats (pasmina type) in the high altitude Tibetan plateaus and meadows adapted to sustain the harsh climatic conditions. The dry grasslands of these unique valleys of the world have been traditionally managed and inhabited by the ***Tibetan nomads,*** a unique example of how people survived in such drought and cold - stricken landscapes in the history of mankind through mobile livestock production systems tolerating all environmental fragility, marginality and poverty.

Presently, there are only 23 families of the ***Dokpas*** managing about 90% of yak population of the Sikkim state. Yaks and dzos are important pak animals (Figure 2). The wool, meat, cheese, fat (*tsilu*) of yak and sheep, and other various products are rare items. In recent years, through intriguing challenges and pressures, the ***Dokpas*** are restricted to a limited patch of the vast Chho Lhamo, Lhonak and Lashar plateaus, the ***Roof of the World***. In the olden times, herders had open movements from the Chho Lhamo, or from the Lhonak valley into Tibet and back through *Nyima La* or *Naku La* pass during the time when the boarder was open. The cross border grazing had advantages for yak cross-breeding and social-cultural relationships in the form of marriages, trade and religion. Once the border was closed, apparently after 1975, there emerged the challenges into their socio-economic lifestyles, the herd reproductive rates inextricably decreased with consequent reduction of their population. While in the present times, enormously rich medicinal plant wealth of high altitudes, wildlife and livestock are threatened from downstream population by pressurizing and using un-sustainable harvesting practices. However, a recent development of opening of the *Nathu La* Pass between Tibetan

Autonomous Region of China and Sikkim of India has raised the hopes of resuming the traditional practices.

1.2 Traditional Agriculture Systems

The agro-ecosystems are innovated, adapted, managed and evolved over 600 years by traditional communities initially by aboriginal Lepchas and Limboos (now one of the Nepali ethnic group), followed by Bhutias after 1275 AD and later on by the other Nepalese (Rai, Yakha, Gurung, Mangar, Tamang, Sunuwar, Thakuri, Bahun, Chettri, Kami, Damai, Sarki, Majhi, Newar, Sherpa, Thami, Bhujel, Jogi) after 1774 onwards through the generations to the present state. Mass clearing of forest area for agricultural use was accelerated during the British protectorate period (1817-1947 AD) mainly after the policy of Nepali settlement in Sikkim for revenue rising by Mr. J.C. White (1889 to 1908 AD). The traditional shifting agriculture system over centuries is gradually conversed into sedentary system. This conversion is still continuing. The sedentary system is a combination of compartments such as agroforestry, forestry, livestock, and parcel of agriculture land forming altogether a unit mountain garden-based farming system. In the recent times, remains of shifting cultivation are rarely observed in the form of ***khoriya*** in ***Dzongu*** (traditional ***Lepcha*** area) and elsewhere.

The microcosms of traditional agriculture are typically organic in Sikkim, the people and their knowledge of steep slope conversion to agroforestry and terraced productive zones (traditionally called ***pakho-khet***, ***pakho-bari***, ***birauto***, ***sim-kholyang***), ridges of operational fields, and management of very steep slopes as ***bhasmey*** and ***khoriya***. The agricultural tools, farm implements and techniques, cultivation methodology, farm raised animals; local crops, irrigation system etc. are traditional. The Bhutias and Nepalese are composed of a number of ethnic communities with different languages/dialects, and social and cultural background. The cultural diversity attributes to a rich agrobiodiversity and traditional ecological knowledge.

Below the trans-Himalayan agro-ecosystem between 3000–4000 m, the communities mostly ***Bhutias*** and ***Sherpas*** in Phadamchen-Kupuk, Lachen, Lachung (Figure 3), Thangu and Thegu area practice subsistence farming by cultivating a variety of crops and fruits such as barley, wheat, potato, cabbage, apple, maize, peas, beans, peach, medicinal plants etc. Grazing of cattle is a part of their life and livelihood. The communities are very enterprising; their traditional homestead products such as blankets, rugs and carpets made from the wools of high altitude sheep are rare marketable products apart from other products such as meat, cheese, butter etc. Communities collect seabuckthorn (*Hippophae tibetiana*), *Yartsa Guenboob* (*Coedyceps sinensis)*, mushrooms, tubers and many edible products from the wild for household consumption and often sell them in small quantities in the nearby markets.

The lower agro-ecological zone consists of a wide range of traditional production systems, that includes the terraced and valley rice cultivation, locally called the *Khet* system, agroforestry systems such as alder-cardamom (*alainchi-bari*) or farm-trees-mandarin (*suntola-bari*) agroforestry, *Sukha-Bari*, *Pakho-bari* system, and forest-based agroforestry system. Livestock are mostly stall-fed as grazing land is very limited. This system has traditional irrigation systems, management regimes, several cropping systems, crops diversity including medicinal plants, wild edibles, a large number of underutilized (also known as lesser-known) crops, semi-domesticated crops and their wild relatives. Land parcels are classified under traditional system for resource allocation and utilization.

Farmers have developed systematic management and conservation alternatives of mixtures of crops and farm animals with multipurpose agroforestry tree species that create appropriate environment to some high value crops and intercropping of many other local varieties.

1.2.1 *The Ghar-ghuryan* (Homestead)

The mountain homestead in a marginal farm consists of intensive livestock raising, multiple crop production systems such as cereals and pseudo-cereals, legumes, vegetables, spices, fruits and nuts, medicinal or aromatic plants, roots and tubers, and farm-trees (Figure 4).

House gardens are traditional sources of food and nutrition and are important contributors of food security and differ between the ethnic communities. Diversification of crops in the homestead is a traditional practice as different communities require a large number of local crops and wild plants for performing their cultural and customary rituals. Mixed fruit trees, vegetables and crop varieties in home gardens provide subsistence and cash income to ingenious farmers. Home gardens are the basic units of agrobiodiversity and are custodians of seed bank of large number of horticultural/fruit/tuber crops and provide significant economic benefits. House gardeners diverse subsistence needs for food and social-cultural rituals are reflected in their multiple crop specialization, thus diversity of crops are grown.

1.2.2 *Agroforestry Systems*

The traditional agrofrestry systems are rich in agricultural biodiversity. They are the centre of *in situ* conservation of high species and genetic diversity, of both managed and wild crops, and associated trees. These agroforests can be categorized into the farm-based, forest-based and the traditional high-value-crop-based types.

1.2.3. Farm-based and Forest-based Agroforestry

In the farm-based agroforestry, farmers manage multipurpose tree species for sustained provision of fodder, fuel and timber and for multiple benefits, both direct and indirect. Trees are grown in and around the cultivable land and in the terrace risers for soil stabilization. Livestock is an integral component and management of fodder species is critical. Intercropping is a traditional practice under farm raised trees, but the tree canopies cause shade effects resulting into fairly less productivity and agronomic yield of understorey crops (Figure 5). To achieve a balance between generating high quality resources and crop production, farmers manage N_2-fixing trees within the cultivable land and other multipurpose species on the terraces or at the edges.

The forest-based practice of agroforestry is developed for supporting cultivated systems. This system comprises of bamboo groves, good timber, fuel-wood and often fodder species and supplies litter, nutrients and organic matter to the farm. Farmers collect minor forest products such as wild edible fruits, mushrooms, leafy vegetables, medicinal plants, and tubers. This agroforetry is an efficient land-use scheme for resource utilization, protection of traditional slope-land agricultural technology, biomass, biogeochemical cycling of nutrients and improvement of agro-ecosystem performances and services. For seasonal water regime management, control of excessive flooding and erosion, and for stabilization of the slopes, these agroforests are developed along the ridges and furrows through the slopes vertically and between the slopes, horizontally. The terraced cultivated slopes are then necessarily protected from four sides by the agroforests. Such intersection

of agroforests both on horizontal and vertical zones in upland-terraces play a strong protection mechanism to the system.

1.2.4 *Alder-cardamom and Albizzia-mixed trees-mandarin Agroforestry*

Large cardamom (*Amomum subulatum*) is a high value cash crop grown in about 30,000 ha in the Sikkim Himalaya. The cultivation is cost-effective compared to other farming systems and has high international market potential. It is an undertorey crop, which was first believed to be domesticated by *Lepchas* that was later on adopted by *Bhutias* and the *Nepalese*. Cardamom is grown both under N_2-fixing trees and mix-forest trees (Figure 6). It has large genetic diversity and wild relatives (Table 1). Himalayan alder (*Alnus nepalensis*) is an excellent tree associate to cardamom for its appropriate shade, N_2-fixation ability (100–155 kg ha^{-1} $year^{-1}$) and nutrient rich litter. In the lower altitudes, between 600–1200 m, *Albizzia* and alder are grown together as shade trees. The annual cash return from cardamom is about USD 15 million. The system has strong social acceptance for its greater economic viability and ecological sustainability. This is an inventive self reliant system and an example of harnessing mountain niche that also provides basic support services of resources. Soil and nutrient loss are negligible; the system maintains live fence of trees and other associate biodiversity. It is a comparatively advantageous crop for the region.

In the *Albizzia*-mix trees-mandarin agroforestry, mandarin orange is a major tree crop while intercropping of maize, pulses, ginger, buckwheat, finger millet, pulses, oilseeds, taro and yam are also practiced (Figure 7). Mandarin orange and ginger are potential cash crops in Sikkim after large cardamom. *Albizzia* is widely grown with other agroforestry trees in mandarin-based farming. Mandarin orange is a high value, comparatively less labour intensive cash crop. Diversity of crops and other associate tree species are maintained in the system for other subsistence requirements and benefits.

The on-farm agroforestry species such as *Erythrina indica, Ficus* spp. *Alnus nepalensis, Albizia* spp., *Artocarpus lacoocha, Thysanolema maxima, Dendrocalamus* sp. etc. are agro-ecologically adapted and socially accepted keystone species for their role in conserving and enhancing biodiversity in the mountain watersheds. *Alnus* and *Albizzia* have been a boon to the region for their role in nitrogen fixation, ecological adaptability, natural regeneration and restoration of degraded landslide areas, and accelerated nutrient cycling in the cultivated systems.

1.3 Valley Rice Cultivation Systems

The ancient ***Demazong*** *vis-a-vis* Sikkim is characterized by *Ghyya-dhan* (dryland paddy), which is followed by the valley rice cultivation along the river banks on flat lands traditionally called *Thang* (sometimes examples are *Tarey-thang-byansi, Pi-thang-byansi*) and along the typically terraced slopes in the lower hills (Figure 8-11). A large number of landraces of rice are cultivated. Some of the dryland paddy varieties were *Ghyya-dhan, Takmari, Bhuindhan, Marshi* etc. while the irrigated rice varieties now are *Attey, Timmurey, Krishnabhog, Bachhi, Nuniya, Mansaro, Baghey-tulashi, Kataka, Champasari, Sikrey, Taprey,* etc. adapted to agro-ecological zones between 300–1800 m. *Krishnabhog, Nuniya* and *Kataka* are famous for their aroma, medicinal importance and fine quality grain as good as Indian basmati rice. Almost all the dryland paddy landraces have now disappeared from the state. While many traditional irrigated landraces are disappeared already and others are on the verge of disappearance. The household mothers are generally the custodians of gene-banks of crop diversity; they keep the record of varieties/yields and

preserve germplasm by growing them at different parcels of home garden allotted for growing heterogeneity of landraces. Farmers allow a variety of pulses and beans to grow along the raised bunds with terrace rice and follow maize, wheat, buckwheat etc. after rice is harvested. Legumes are the source of protein, household earning and enrich fertility to the soil through the roots. Between the terraced open rice fields, along the slopes, are the traditional agroforestry systems, mostly cardamom-based and forest-based agroforests. Such traditional landscape designing of multifunctional agroforestry and protection to the terraced open rice cultivation system is characteristic of unique agro-ecosystem management in the mountains. The system in addition supports water conservation and flood control, provides nutrient and biomass to the rice field and farm.

1.4 Ethnic Food-habits and Cultural Importance

The existence of rich agrobiodiversity is due to diversity in cultural and traditional food-habits of ethnic communities. Cultivation of crop varieties is dependent on different agro-ecological ranges and the inhabitant ethnic societies, and follows cultures, traditions and customary rituals. Indigenous communities have sound knowledge on landraces of domesticated crops and their wild relatives, underutilized crops and conserve them for their traditional and cultural rituals and festivals. For instance, the ***Newar*** festivals include the *Kokkti-Purney* or *Kwanti Purnima* and the *Rakhi Purnima*. On the day of *Rakhi-Purnima*, Newar community prepare a special soup of newly germinated pulses known as *Kwathi* or *Kokti*. It is prepared out of nine types of pulses such as a mixture of beans (*Ghew simi, Singtamey simi, Mantulall simi, Rajmah*), Mung (*Kalodal, Panhelidal*), Field Peas (*Matar/Kerau*), Horse gram (*Gahat*), Ricebean (*Masyam*), Soybean (*Bhatmash*), Cowpea (*Tuneybori),* Gram (*Chana dal*) and lentil *(Musuridal*). The mixed pulses are soaked in water and allowed until the sprouts come out. Thus mixed beans sprouts are used to prepare traditional delicacies with local spices (medicinal herbs). *Kwanti Purnima* is an auspicious day, families and relatives are invited, and soups are served with other traditional recipes. Similarly other communities have different traditional food recipes prepared on auspicious days. The communities thus protect the agro-biodiversity of pulses and crops grown in the Himalayas, and thus is one of the best examples of managing cultural agrobiodiversity.

Communities enjoy fermented products and local beverages (such as ***Janrn***, ***Rakshi***, ***Bhati-Janrn*** etc. traditionally prepared out of finger millet, cana, rice) throughout the year. These products are primarily used to perform rituals called *pitri puja*, *kul puja*, *tonsi mundhum* etc. by different communities as per their culture or religion. Other fermented products, such as ***Gundruk*** (from leaves of mustard, cabbage, radish, taro leaves), ***Sinki*** (made from raddish), ***Kinema*** (soyabean product), ***Khalpi*** (pickles from cucumber), ***Tama-ko-achar*** (bamboo shoots) and a lot more have health benefits as an appetizer, fast-food supplement during the lean season, and support earning cash for the households. For instance, Tamang (2005) has listed out more than 29 types of fermented foods, 9 types of alcoholic beverages, and 85 types of traditional non-fermented foods of different ethnic communities of Sikkim.

1.5 Biodiversity and Functioning of Agro-ecosystem

Sikkim Himalaya is a part of the 34 globally significant biodiversity hot-spots and endemism with rich agrobiodiversity as one of its principal components for livelihood security of the mountain people. It forms a part of the meeting ground of Indo-Malayan and Indo-Chinese biogeographical realms as well as Himalayan and Peninsular Indian

elements that has given rise to a very rich biodiversity both wild and in cultivated landscapes. Sikkim is phytogeographically rich and houses about 4500 species of plants (about 26% total plant wealth of Indian sub-continent), 60% of which are endemic. In Sikkim, 36 species of *Rhododendrons*, 450 species of trees, 515 species of orchids, 424 species of medicinal plants, and 363 species ferns and allies are found. While it also houses a great number of wild animals consisting of 150 species of mammals, 552 species of birds, 690 species of butterflies, 48 species of fishes, 33 species of reptiles and 16 species of amphibians reported till date. About 80% of the total geographical area of the state is under the administrative control of the Forest Department, Government of Sikkim, the major land use is forestry (44%) with about 39% under protected area network.

Wild biodiversity and agrobiodiversity, in the context of Sikkim Himalaya, can be considered integrated agro-ecosystem and holistic which is characterised by the proximate interaction between natural systems and human dimensions. The high crop diversity and agro-ecosystem diversity is due to heterogeneity of landscapes adapted by different traditional societies. Rich agrobiodiversity is a part of indigenous culture attributed to advancing agro-ecological variations within short distances, offering a unique example to the world. The prevalence of diversity of crops and local livestock breeds is the result of century's long human breeding efforts depending on the locally differentiated resources in this part of the world.

1.6 Landscape and Land and Water Resource Management Characteristics

The unique mountainous landscape consists of varied physiographic factors and topography giving rise to microclimatic variations and a range of ecosystem, species and genetic diversity. As stated above, ***Demazong*** consist of diverse natural-cultural landscapes and ecosystems that have brought together a network of ingenious cultural societies and management systems into a single regular natural continuum. Here, the biophysical features of landscapes at a shorter distance are conducive for genetic variations and landraces with sustained natural resource management.

Sikkim Himalayan glaciers e.g. the Zemu glacier are the water tanks, a key limiting factor for any land use in the downstream. The traditional ways of conservation of water such as local water seepage (***pani-pandhero***) is linked to cultural antiquity of the communities. Natural springs, streams and seepages, cliffs and peaks are all considered as sacred and are conserved. The ***Devisthan*** (place of mother god), ***Dewrali*** (hills-top, abode of deity), ***Teesta mai, Rangit mai, Rongli mai, Ramphu mai*** (mother goddess in rivers), sacred groves and agroforests are the existing examples how people conserve land and water resources through social-cultural and traditional systems. The forests and mountains, valleys and plateaus are reservoirs of clean water. Indigenous communities have strong belief that the ***Maharani-Thakurani*** (mother goddess who keeps the vigil on them) would punish upon disturbing these sacred places. Slight pressure would result into calamities, diseases and illness, and also an extreme situation (aapath-bipat) is their cultural belief.

1.7 Indigenous and Local Knowledge Systems

In addition to the knowledge system for managing alpine agro-pastoralism, traditional agriculture, and agroforestry down the mountains, the other typical examples of knowledge base are represented by mountain slopes converted into garden-based organic production systems. Such management system is continuous from the ancient times for cultivation of upland rice and other crops.

The indigenous traditional ecological knowledge (ITEK) is the inherent identity that is embedded to each ethnic community, very different and diverse in all respects. It is reflected on their cultivation system, ethnobiology, and health and nutrition management system.

The ITEK associated to medicinal plant wealth of the communities has become the centre of attraction to national and international pharmaceutical companies and an immediate concern of Intellectual Property Rights and Farmers' Rights of the people. Recently, the State Government has initiated the Peoples Biodiversity Register at the village level through the village Panchayats. The documentation would help register knowledge-base, prevent biopiracy and promote bioprospecting.

The accumulated form of empirical knowledge system, the ITEK, is the inherent wealth and a basis of sustenance to the traditional societies which bridge between the nature and culture.

1.8 Cultural and Social Aspects of Agro-ecological Management and Conservation Strategies (including values, practices and regulatory frameworks governing access to natural resources and other customary and/or formal institutions governing the management of the agro-ecosystem and its benefits).

The traditional societies worship the broader Khanchendzonga sacred landscape, described in ***Neysol*** (holy script) as ***Beyul*** (the hidden land) and the ***Ters*** (the hidden treasure) which are linked to diversity of natural resources and ecological functions and show strong social integration and cultural harmonization. This Himalayan landscape is also described as ***Ney-Pemathong*** or ***Shan-grila*** and worshipped in various traditional and cultural festivities such as ***Pang-Lhab-Sol*** (mother deity Khanchendzonga) for protection from calamities, ***Tendong-Lho-Ram-Faat*** (worship of the Tendong hills) by *Lepchas* and *Bhutias* for better rain, production and harvest, and ***Sansari-Puja*** (mother goddess earth) by *Nepalis* for better production, rain and good season. Thus, the social-cultural and social-ecological functions are purely traditional and interdependent.

There are customary institutions and local governance systems. One example of such an institution is the ***Dzumsa*** of North Sikkim. ***Dzumsa*** (*dzoms-sa*) is a traditional institution of the *Bhutias* in the two remote high altitude villages, Lachen and Lachung. It is a local community-based village-governance system. ***Dzumsa*** is a formal legal body that is elected/selected by the villagers, and has well defined role (written in *deb chen*) on socio-religious and socio-economic prospects and issues, socio-political situations and challenges, resource ownership and land use systems, and resource extraction and use. This traditional organization has a formal set up to show an example of social cohesion between the people with range of activities. ***Dzumsa***, which has been under operation for over 600 years, controls over resource utilization, conservation, pasture management for grazing, conflict resolution, social and community mobilization, traditions and local governance.

1.9 Overall Ingenuity and Remarkability of the Human Management and Characteristics of the Agro-ecosystem

The adaptive system and practices, from the alpine agro-pastoralism to agroforestry systems down the mid-hills and terraced / valley rice cultivation, is an ingenious creation of agro-ecosystems that are mutually benefited to each other (Figure 7, 8, 9). Categorically, they were, over centuries, invented and developed based on the holistic concept considering mountain attributes together through human nature interaction. Most

remarkably, systems encompass through appropriate management of steep slopes and cold deserts into sustained productive zones keeping both forest and biodiversity embraced within. A vertical transect covers the sub-tropical warm to alpine cold zones within very little spatial difference, leading to diversity in micro-climatic variation and adaptation of different systems, species of plants and animals.

The agro-ecosystems and practices are interdependent and interact between each other. They are sustained through the harmonious relationships between the communities, and interactions between the components of the ecosystems at all levels of diversity.

The human managed systems are innovative and self-reliant. Beyond this, the wider natural spaces are being conserved as sacred landscapes; both culture and biodiversity are integral components managed through ingenious approaches. The landscape is endowed with large repository of biodiversity and endemic species which is recently considered as a part of biodiversity hot-spot of the world.

The unique biophysical environment and agro-ecosystems demonstrate adaptive capacity to adverse environmental phenomenon and have even persisted even under negative policy options over the past. Introduction of seeds from outside state, the HYVs, chemical fertilizers, policies and plans developed without communities' participation had negative impacts. But, these farming practices have strong social-ecological and social-cultural adaptability and sustainability. Communities and systems thrive against vulnerable situations and maintain both natural and artificial ecosystems. Traditional wisdom and inherent policies of the social institutions are the basic tools in maintaining their livelihood and the environment.

2. Goods and Services Provided by the System

Describe the important services and products provided by the system at local, national and global levels. Please pay attention to:

Livelihood services

2.1 Food security

The cultivated crops and minor forest produce are the constant source of food, fruit, and nutrition. The lesser known crops are the everyday food supplements of the poor-people in the villages. A large number of wild relatives of citrus, cardamom and yams still exist in the wild which are often the source of earning to the people. Food security has become a big question as the productivity of the crops has declined over the years; farmers are compelled to depend on the food that is brought from the plains.

However, these landscapes are marginalized over the years. They encompass degradation and erosion leading to overall insufficiency in food productions. Shortage of food has become a regular occurrence.

2.2 Housing, Fuel/energy, Health and Related Needs Provided for

Housing and construction of the ethnic communities are traditional in the rural villages from the locally available materials. Cattle sheds are also traditionally built. The construction of traditional houses and cattle sheds differ to ethnic communities. In the recent past, concrete structures have started appearing on the road sides. Household energy and timber is to be met from the private agroforests as extraction from the government forest is banned.

2.3 Other Products and Economic Services

The unique local products that can be sold in the international markets are traditional handicrafts/handlooms, Temi-tea, cardamom and other agro-products. Traditional wood-carving and woollen carpet weaving are household level industry in Sikkim and a source of livelihood. Carpet weaving is a livelihood option especially to the women. Natural dye is used in these products and dye yielding species such as *Rumex nepalensis* etc. are locally available. Recently, the Food Preservation Factory at Singtam has been revived that produces quality products (orange squash, passion fruit squash, dalle chilli pickle, jams, marmalade etc.) from locally available agro-products.

The traditional mountain paper industry (***paharey kagaj***) was a small village level enterprise in the past. The paper is made from the fibre of locally available plant argeli (*Edwarthia garneria*). Recently, the factory is closed. While the market demand for this paper is high and can be developed as a good enterprise. The revival and promotion would provide good economic backup and local employment.

Whilst, the agricultural landscapes are also represented by the biodiversity indicator species, the honey-bees *Apis cerena*, they contribute for cross pollination, and honey. Farmers practice bee-keeping in a traditional way actually by rearing indigenous species. They also conserve indigenous tree and cliff bees. Honey from indigenous species has high medicinal value which is used as health tonic and also for curing ailments.

The high value products (cardamom, medicinal plants, fruits, traditional crops etc.) of Sikkim are absolute advantage resources that are considered as potential neutralizers of globalization risks of open market economy and environment changes. The production systems are indigenously evolved location specific farming systems which can be replicated to similar agro-ecological locations in the Northeast India and other parts of the world for ecological and economic advantages.

2.4 Social and Cultural Services (equity, cohesion, security, ethics, identity, art, values, etc.)

The traditional belief system of the ***Demazong*** covers all biotic and abiotic components of nature within Khanchendzonga sacred landscape. The great guru Padmasambhava, the revered incarnate of Lord Buddha, is considered to have blessed this landscape and placed enormous hidden treasures. Thus, this cultural landscape is a significant centre for cultural amalgamation, cohesion and pilgrimage. Rumtek Dharma Chakra Centre and Tibetology are the main research centres for Buddhist culture, religion and philosophy in the world. There are other cultural centres of pilgrimage viz., Dubdhi monastery, Pemayantse Monastery, Sangetsoling monastery, Tholung Gumpa (a typical Lepcha Gumpa), Norbugang at Yuksam, Tato-pani at Yumthang and Reshi, Sidhi, the four great caves of Sikkim, Sandup-tse, and Indra-kil Prayag are the prominent centres of cultural and religious importance. Cultural festivals such as Gumpa-dance, Bomchu, Gumpa-fair etc. are organised on auspicious days of the year. People from all communities visit these places and enjoy with great enthusiasm during festivals. Apart from the local people, many cultural-tourists from India, Nepal, Bhutan, Southeast Asia and other parts of the world visit these places.

This social-cultural landscape has preserved the biodiversity and agricultural biodiversity of global significance. The landscape is the centre of cultural harmonization and cohesion of diverse ethnic communities. (Also given in Section 2.6).

2.5 Quality of Life (opportunities, leisure, education and arts)

The significance of biodiversity in cultural landscapes provides a readymade industry for

ecotourism and agro-tourism. Tourism has been one of the successful livelihood options in Sikkim. The unique agricultural heritage systems provide ethical, cultural, religious and aesthetic importance to support this sector and improve quality of life.

The quality of life in rural areas is still difficult, limited with access to many necessary basic endowments like good public distribution system, health services, hygiene, quality education etc. which need proper planning and improvements. The government, in the last three decades, has been trying to improve the quality of life. As a matter of retrospect, there is a gradual declining of total well-being of the people because of the external pressures such as infiltration of population from outside state in projects, control of trade and commerce by downstream population, and saturation of employment opportunities. The state is dependent for food and necessary commodities from outside.

Environmental Services

2.6 Biodiversity and Ecosystem Services (conservation, functioning and regulation)

In a broader term, agrobiodiversity encompasses from the associated biodiversity that supports agricultural production systems, nutrient cycling, and pest control and pollination. Beyond this biodiversity that is closer to the cultivated systems, the wider biodiversity landscapes provide ecosystem services such as watershed protection at spatial and temporal scales, habitats, and other provisioning and regulating services. Both managed and natural ecosystems are interdependent and maintain increased gene flow between the species and between the landscapes in the wider natural spaces. Besides the existence of high biodiversity (see section 1.5, pg. 6), the cultivated system has very high species and genetic diversity (see Table 1 and 2). Agroforests and sacred groves are gene pools in the marginal landscapes adding significant contribution to maintain biodiversity, socioeconomic development, food and nutrition to human health, and act as a functional compartment to supply litter, crop residues, mulch, and manure for soil fertility maintenance.

Agro-pastoralism, agroforestry, garden-based cultivated system, and the broader biodiversity provide humanistic value (such as the aesthetic, economic or recreational) apart from the other intrinsic values that it is providing. Biodiversity and cultivated systems should sustain and continue for today and tomorrow, to the foreseeable future generations providing goods and services.

2.7 Soil and Water Conservation and Restoration

The forestry and agriculture management is based on the large accumulated empirical knowledge system tested over centuries on land use, soil and water conservation and restoration. Farmers manage water seepages in small ponds, ***pandhero*** etc. in a typically conserved small sacred groves. The important water bodies, rivers or rivulets are often conserved by the traditional organizations of the communities. They still believe that there resides the *Nag-Devata* (holy-snake) that protects its sanctity. Besides, the glacial rivers and their tributaries are supported with amply catchments forest area called as the khola/river reserves.

Soil health, water regimes, environment health and quality are the critical factors to maintain agro-ecosystem components in the hilly terrain for a balanced biogeochemical cycling of nutrients and ecosystem productivity. Suitable slopes of the river valley are terraced to conserve soil and water for rice cultivation. Conservation and management of cultural landscapes in the mountains has created a suitable micro- and macro-habitats to support biodiversity especially to a number of flagship species.

Management and promotion of agroforestry in steep slopes prevent excessive loss of

soil and nutrients from the system, conserve water and facilitate carbon consumption from the atmosphere. It helps mitigate environmental risks and develop resilience to climate change. The Himalayan integrated system provides the ecological viability, sustainability and functional equilibrium for evolutionary processes.

2.8 Climate Regulation (micro and macro) and Carbon Sequestration

Carbon fixation and sequestration is comparatively very high in the agroforest-based farming systems. The alder-cardamom system is five times efficient in carbon sequestration amongst the various land use stages in a mountain watershed. Mountain production system is the centre of carbon fixation and sink. Traditional agroforestry systems provide a model with multilateral benefits in terms of self supportive ecosystem, resilience to global environment change as well as a risk mitigation mechanism for farmers against changing market forces.

Alternatively, reports are there about the impacts of climatic changes, and Sikkim is not an exception. The low land species have been appearing in the sub-tropical, temperate and trans-Himalayan belts.

3. Threats and Challenges

Identify and analyse threats and challenges to the continued existence of the systems and/or to its sustainability and viability. Identify and analyse the local, national and/or global nature of these threats, paying particular attention to occurrences and trends of economic, social, environmental or political nature. Illustrate the changes in the human and ecological dynamics of the system and their effects on ecosystem health, resource endowments and human well-being.

The survival of the Himalayan ecosystems and biodiversity, conservation and management for sustainability is a great challenge at the present time. This requires a lot of collective effort, targeted plans and programmes that has to reflect issues, threats and challenges at different levels through participatory processes involving communities, social institutions, government, regional organizations and international bodies.

3.1 Threats

3.1.1 Land Conversion

Multiple values of the traditional agricultural landscapes are not appreciated. The landscapes are converted or changed through mining, construction of roads, long tunnels, high-level dams, underground powerhouses, and alternative purposes. Due to lack of understanding of protective function of the traditional practices, much traditionally managed forest areas and alpine plateaus are classified as protected areas for conservation. Communities lose access to these areas for continuation of their traditional lifestyle and resource management. The nomadic Tibetans in trans-Himalayan pastures are restricted to a small grazing area in the Tibetan Plateau at Chho Lhamo, Lahsar and Lhonak valley in spite that they are the guardian of the alpine plateaus.

3.1.2 Indiscriminate replacement of traditional practices, including genetic resources and social institutions

In post-merger Sikkim, of late 1970s, consequent to introgression of new planting materials in the form of HYVs resulted into decrease of areas under traditional crops and landraces. The area under horse gram, buckwheat, landraces of finger millets, broad bean, soybean, sweet potato, barley, *uwa*, amaranths, chenopods and other lesser known traditional crops have been decreased by 50 to 60 per cent. These crops contain immense medicinal importance with high nutritive value and market potential. The area under

landraces of traditional pulses, maize and rice is declining. Diseases of crops, e.g. cardamom, mandarin orange, ginger and other corps is also a major challenge.

Similarly, genetic erosion of indigenous livestock breed is not undisputed, about 45% of the breeds that existed before 1970 have merely disappeared from the system, and the remaining livestock population is declining. There are examples of loss of agrobiodiversity in the marginal lands which is attributed to changing ecological, socio-economical transformation and policy dimensions.

Functions and effectiveness of customary institutions and forms of social organization are not valued. They are increasingly under threat because of the imposition of new forms of organization by the state and the destruction by large-scale construction projects. The human induced large-scale constructions such as large dams in the sacred lands and water systems have been resulting in loss of customary institutions and organizations, and the situation underpins management of agro-ecosystems. There is a large scale displacement of farming communities, they are turned into landless labourers, and there is an increasing trend from the new projects.

3.1.3 Migration and demographic change

Over the years, the population have increased, families fragmented, resources divided, food requirement per person: land ratio decreased and the farmers are compelled to look out for off-farm livelihood options. The new generation has been out migrating to urban cities and towns in search of better employment opportunities. The population of *Lepcha* community is declining; one of the reasons may be due to low fertility problem.

At a given circumstances of low income generation in agriculture, the young generation better wants to migrate in cities or participate in politics for immediate earning. Traditional Knowledge is rarely percolated to the young generations as they do not take interest due to lack of appropriate incentives. Thus, shortage of farm experts and managers has been explicitly felt in recent years.

Regulation of downstream population infiltration and their influence is very important to reduce the increasing loss of culture, tradition, ethics and ecology. The impact of globalization to vulnerable communities of the fragile ecosystems is already a debatable issue. The irreversible over-exploitation of medicinal plants and most abating poaching threats to ***Schedule I/II/III*** wildlife species would increase many times more mostly from downstream population if, by any reason, the nomadic Tibetans (the ***Dokpas***) are out from the alpine region.

3.1.4 Impacts of climate change

Reports are there about the microclimatic changes in Sikkim, the low land species have been appearing in the sub-tropical, temperate and trans-Himalayan belts. The house sparrows were only found in the low land area such as Melli in South Sikkim are seen common in temperate areas in Gangtok, house crows are seen to appear in higher elevations of Lachung. Likewise the American cockroach (*Periplanata americana*) and house gecko have been seen in Gangtok and in the higher elevations. Mosquitoes have started appearing in the trans-Himalayan Lhonak Valley over 5000 m. These changes would reflect the climate change impacts in the long transect from the low land to the glacial belts of the higher Himalayas.

3.1.5 Threats from development activities

There in an extensive use of dynamite detonations by the new hydro power projects

(National Hydroelectric Power Corporation, Gati Infrastructures Limited) both above ground and underground for large constructions and tunnelling. Such activities are underway along the main rivers Teesta, Rangit and Rangpo. These river systems cover the entire cultivated systems, in valleys and in hill slopes, watersheds and biodiversity rich natural spaces in Sikkim. The explosion both on ground and in tunnels has caused the cracks in traditional dwelling houses, agricultural lands and hills causing excessive landslides and habitat destructions. In the upland valleys seepages, springs and upstream weirs feed canals that water for rice cultivation and other agricultural uses. These local water management sources are dried up. Explosion cracks have now destroyed ecological balance and hydrological processes in the mountain watersheds.

3.2 Root Causes and Challenges

3.2.1 Lack of awareness and recognition

Productive, social and protective functions of traditional agricultural systems listed in previous sections, are not understood nor recognised. Investment in research and promotion of the traditional practices is almost not in place. Ecosystem services in the upstream are not appreciated nor compensated by the downstream. Those multiple values are not captured in the modern market. Traditional agricultural systems are seriously undervalued.

3.2.2 Lack of capacity to address the threats or seize the opportunities

Traditional agricultural systems are complex and integrated. The modern, but sector-based approaches are ineffective to support the adaptive capacity of traditional agricultures. In spite of the new green policy, the government does not have policy tools to integrate traditional agriculture into the policy implementation nor does it have adequate mechanisms for involving indigenous and traditional communities in decision making for sustainable development.

Due to lack of policy support, communities are unable to cope with external threats (immigration, indiscriminate transfer of modern agricultural technologies, etc.) or capture new opportunities, such as niche markets and agricultural tourisms. Motivation of innocent farmers on new high yielding seeds and lack of integrated information and management systems on the importance of traditional systems have undermined agrobiodiversity conservation.

3.2.3 Lack of alternative environmentally-sustainable sources of income

Prospects of alternative environmentally sustainable sources of income within the cultivated systems have rarely been researched and programmes intervened. Such income would primarily help farmers invest in agriculture. Commercialization of agriculture has an implication on traditional practice. People have started tea plantation (in some villages) at *bairland* and passion fruit cultivation in terraced fields.

3.2.4 Insecure land tenure

The Sikkim State is purely agrarian which earns for nearly 40% of GDP from agriculture sector. About 90% of the population constitutes from the rural areas with agriculture as the main livelihood option. Only about 15.69% of the land resource is operational to farming. The land tenure is private, safeguarded by the old Land Revenue Acts of the Kingdom of Sikkim.

On the one hand, customary land tenure is undermined by the formal system. Traditionally managed land is taken away for construction or conservation without adequate compensation and consensus. The cross border grazing had advantages for yak cross-breeding and social-cultural relationships in the form of marriages, trade and religion. Once the border was closed, apparently after 1975, there emerged the challenges into their socio-economic lifestyles, the herd reproductive rates inextricably decreased with consequent reduction of their population.

On the other hand, landholding according the ethnic groups in Sikkim is highly uneven. The small farmers with operational land holding of less than 2 ha constitute more than 70%, holding only 28% of the operational area, while 30% of the farmers hold 72% of total operational area which shows disparity of land possessions. The small and marginal farmers are sharecroppers of ***Kutiadaars*** who pay the land owners a fixed quantity of foodgrains as agreed upon. Here, the tenant-farmers who hold the knowledge has little choice of the crop, the land-owner would advise which crop to be grown the following year.

Private landholding is rapidly shrinking, the per capita availability of land has declined from 0.31 ha in 1971 to 0.27 ha in 1981 and 0.17 ha in 1991. It has further declined to 0.12 in 2001. The land tenure continues to generations through equal distribution of land and property of the parents to their sons traditionally called ***Banda*** system. The fragmentation of family due to ***Banda*** has caused reduction of the availability of land. The low-income marginal farmers' show high conservation willingness and act as a network of active managers of integrated ecosystems throughout the landscapes.

3.2.5 Non-availability of planting seeds in agriculture

From the recent past, farmers have reduced access to seeds of native crop varieties. Most of the social, ecological and economic problems cited above have given rise to breakdown of traditional seed production and dissemination routes. Similarly, traditional seed exchange mechanisms and farmers networking have been consequently disorganised. The distribution of improved and exotic varieties is one of the reasons for this.

3.2.6 Invasive species

The invasion of exotic species of *Lantana camara, Eupatorium adenophorum, Ageratum haustonianum, Bidens biternata, Erigeron karvinskianus,* and *Caleolaria maxicana* have caused serious problems in the traditional agricultural lands which involves heavy labour input on land preparation during cultivation and management. Traditional farmers have recently started converting these plants into bio-composts that is prepared mixing with dung.

3.2.7 Existing Poverty

Existing poverty ratio clearly confirms that the access to food and other essential necessities is a primary concern for about 35% of the population. In such situation, farmers divert their livelihoods to short term economic benefit and either work as labour in projects and elsewhere. While the free BPL (Below Poverty Line) rice distribution system, provision of GIC sheets, housing loan, construction of model houses (Indira Awash Yojana) etc. by government has turned people dependent, less productive in agriculture and less self reliant as well.

3.2.8 Lack of access to wider natural areas

Sikkim has only 12.3% of the area suitable for cultivation in agriculture. The remaining area includes the biosphere reserve, national parks, wildlife statuaries, reserve forests and alpine deserts. These areas, nevertheless, are the repositories of wild crop genetic resources although protected under designated special areas. While, denial of access to such natural areas has interrupted the synergies between the communities, on-farm crops and gene flow from cultivated systems to their wild relatives and vice-versa. Grazing (a traditional livelihood option) in forests has been banned. Opportunities are seldom on potential benefits from biodiversity and wild crop relatives.

4. Policy and Development Relevance

Describe possible lessons to be learned and benchmark management strategies and principle / practices provided by the system, which are relevant for formulating national and international policies for sustainable agricultural development, as well as their (potential) contribution of the to global concerns of food security and poverty alleviation, biodiversity conservation and climate adaptation.

Very recently the Sikkim Government has developed the Green Policy to promote high value horticultural crops for greater economic return while declaring the Sikkim as the first organic state in India. The new policy ***Ecotourism-based Green Policy*** is a positive step towards biodiversity conservation and empowering people to take advantages of their traditional practices and cultures for new opportunities on ***Sikkim green agriculture***, niche markets and ecotourism. The government has also given top priority on soil conservation and reclamation of land slide areas.

While policies on improvement of agricultural biodiversity, control of disease and pests of major cash crops cardamom, mandarin orange and ginger, appropriate farm-based technology for production improvement are rarely intervened. Most of the issues of agro-ecosystem highlighted herein above sections are not addressed in the National Biodiversity Strategy and Action Plan (NBSAP) for Sikkim and elsewhere. The agro-pastoralism of the alpine Tibetan ***Dokpas*** has been, although, prioritised in the NBSAP, it is yet to be implemented in action.

There are undoubtedly several development activities that took place in the last three decades, but the discernible trend of poverty still prevails. Sikkim is the third poorest state of India with 34.5% population under below poverty line.

The present proposal would emphasize on the issues cited above in Section 3 and build-up partnerships between potential organizations in the region with communities and the Government of Sikkim. Policies and plans evolved through participatory approaches would address the issues outlined hereinabove.

The UNU will facilitate as a collaborating organization. The regional institution ICIMOD has been working in the region for the last four decades and has expertise and experience on mountain issues and development. This partnership will support reframing and restructuring policies, and development plans in a participatory manner. Such strategies, plans and activities for development would mobilize the decentralised Panchayati Raj and communities from the village level and enable a bottom-up approach.

The proposed project would identify the indicators of sustainability to develop and improve the systems and to cater the dimensions of change. The activities involved would help comply with the international agreements and conventions such as WSSD, CBD, UNFCCC, ITPGR, MDGs. Such networking would facilitate a flow of information from the local, national, regional and global level and vice versa.

5. Global Importance

Summarise the outstanding features of the system in terms of their relevance to global concerns in agricultural development and ecosystems management and their cultural and heritage value.

The greater Khanchendzonga (Mt. Khanchendzonga, 8598 m asl, third highest peak in the world) Complex in the Eastern Himalayan eco-region is an assemblage of ecological units from subtropical (300 m) to tundra (5000 to >7000 m), houses globally significant biodiversity including agrobiodiversity managed by traditional communities, and stands at the quadri-national border of India, Nepal, Bhutan and Tibet Autonomous Region of China as a wider Himalayan sacred landscapes in the world with its unique architecture and geography.

The Sikkim Himalaya stands between international tranboundary conservation areas such as Kanchenjonga Conversation Area (KCA) of Nepal in the west and Quomolongma Nature Reserve in the Tibet Autonomous Region of China in the north bordering with the Khanchendzonga Biosphere Reserve (KBR) of Sikkim. The contagious complex has a natural continuity from Pangolakha National Park of Sikkim extending with the Jigme Wanchuk Wildlife Sanctuary of Bhutan and the Neora Valley National Park of West Bengal State of India. The KBR also continues its natural homogenous forests extended with Singhalila National Park in West Bengal State of India.

The PA networks, agroforests, and agro-ecosystems serve as the biological corridor for the movement of wild animals in the wider landscapes along the Himalayas, and across international corridors and borders. Agricultural landscapes allow gene flow of the globally threatened and biologically restricted species and retain the biological connectivity of the discrete biological units.

The traditional communities, over space and time, have evolved out with sound ecosystem-management technologies and unique production systems that provide goods and services of local, national, regional and global importance. The agroforestry system and terraced-crop management are the biodiversity products and processes for food and nutrition, and appropriate land use system for soil stabilization and fertility maintenance, hydrological processes and ecological functioning.

Himalayan watersheds have greater role in carbon fixation and sequestration potential contributing services to global level directly from the local. It holds true that the diverse traditional communities through social integration, knowledge and practices have put forth, over centuries the standing example of creating a system of greater resilience, although there is a fundamental trade-off between environmental health and poverty.

Sikkim Himalaya is considered as the highly revered sacred landscape with the concept of holism and interconnection between the soil, air, water, biota, mountain peaks, forests, water bodies, river and the lake systems. ***Demazong Heritage*** is an example of social-cultural and social-ecological integration of human and nature and a symbolic identity of ethnic nationalism.

NB. For those who wish to propose the system as a project site to the GIAHS programme:

6. Outline of activities during project

6.1 activities you would foresee to be included in such a pilot framework

The initial activity would be wider recognition of system and practice from local,

national, regional and global level for outstanding ecological, environmental and cultural services in all levels. The intriguing issues, threats and challenges would be worked out by participatory approaches and assessment, documentation and demonstration of the systems using tools of sustainable agro-ecosystem management as well as by finding new suitable methodologies.

In the pilot phase following activities can be worked out:

- Document the dynamics of nomadic agro-pastoralism and produce a conceptual framework for their sustainability through participatory approaches. The activities would address the issues of inbreeding of yaks, nomadic production systems, livelihoods and market.
- Situation analysis on sustainability and adaptation of agro-ecosystems in response to socio-economic development, strengthening of traditional/customary institutions and environmental conservation through participatory process.
- Conduct agrobiodiversity assessment, characterization of the land-use system, resource management regime, indigenous knowledge base, adaptation patterns and develop frameworks for up scaling of the systems and practices through participatory process for poverty alleviation and sustainable development.
- Issues of dimensions of change (social-ecological, social-cultural and social-economical), impacts of externalities in the sacred landscape, ecosystems and biodiversity would be analysed with direct and indirectly involved stakeholders to address and find a possible action plan for conservation.
- Create and strengthen partnerships between community based institutions and organizations, State Government, National Government, regional institutions such as ICIMOD and the global organizations such as UNU/UNDP, FAO, and find a interdisciplinary linkage to address the issues to augment the challenges, and develop a network between the communities, governments, NGOs and institutions for information sharing.
- Organize a forum for policy dialogue by holding workshops and meetings between the policy makers, NGOs, organizations and institutions to develop an appropriate mechanism as well as methodologies and action plans to mainstream and ensure the provisioning/supporting, cultural and regulating services

6.2 how these activities will respond to the threats as described under 3.

The activities given in Section 6 will address the issues enumerated in detail in Section 3. Each of the issues would be clearly analysed and activities sorted through participatory processes to reach the outcome. The activities would help in understanding and valuing of the importance of cultural landscapes, systems and practices, role of agrobiodiversity and challenging issues and constraints in the diverse form of ecosystem composition in the region. Exploitation of local knowledge, agrobiodiversity transformation processes, opportunities in the mountain farming practices, enhancement of productivity for the betterment of livelihoods, sustainability of mountain environment, and socio-cultural identity of traditional societies are the promising questions to be addressed in the present situation.

6.3 co-financing potential

Shall be submitted later.

6.4 a baseline description of activities, policies and experiences, which are already ongoing in the area and that the project could build upon.

6.5 institutional involvement and embeddedness (support and involvement of institutions that carry responsibility or are otherwise involved in the project area, both local, regional and national)

6.6 participatory approach and community drivenness

Presently, the United Nations University and Kyoto University are jointly carrying out a preliminary research on Sustainable Agro-ecosystem Management in Sikkim with a grant received from the Japan Society for the Promotion of Sciences (JSPS). A joint UNU-Kyoto-ICIMOD-Government of Sikkim and local NGOs workshop was organized in Sikkim India on 27 September 2006 to exchange information and activities and find opportunities for future collaboration. This proposal is the outcome of the workshop.

The present ongoing JSPS-UNU-Kyoto University project research on SAM would be continued further along the line of the GIAHS programmes and perspectives.

The proposed GIAHS activities would bring together the communities, researchers and decision makers and increase the use of research results help the governments for better and suitable policy options to promote sustainable development. It is important to continue to raise government attention and strengthen local institution needs to the specific requirements and opportunities. This effort can assist in identifying and documenting improved communication and dialogue mechanisms that are required to ensure that action at local level is well informed by policies and that these analyses are informed by the needs and knowledge of the local people.

The proposed project, at the pilot sites, would identify the primary stakeholders and other stakeholders both direct and indirect and build up a close collaboration to test, demonstrate and up-scale the existing agro-ecosystem management. The successful experiences would be disseminated to appropriate areas in the subsequent phase of the project time.

SUGGESTED ANNEXES:

- **maps**

Figure 1.

- **lists of species**
  - Appendix (Table 1, 2)
- **description ecosystem interactions (human and bio-physical)**

The trans-Himalayan ecosystem and agrobiodiversity management in the wide range of land use types and land use stages confirms that the ecosystems are interdependent and form a single entity and the entire biodiversity is a part of these systems in practical terms. Biodiversity conservation in globally significant landscapes, habitat restoration of scheduled species such as great Himalayan bear, red panda, snow leopard, Himalayan takin and many other, medicinal plant including *Taxus bacata*, aconites etc. and unique social-ecological harmonization as well as corridor management for wider habitat between the PAs and human existence form a larger unit of complexity interdependent to each other. A slight disturbance/change to one of the units would lead to unpredictable disturbance to all social-ecological units mutually benefited to each other.

- **listing of other resource endowments and goods and services provided by the system**

- Crops, fodder, timber, medicinal plants etc. for health, nutrition, construction, economic benefits etc.
- Clean water from the local streams and glacial rivers
- Endemic plants and animal species of the Sikkim Himalaya
- Best landscape management for biodiversity conservation
- Carbon fixation and sequestration
- Excellent slope management, soil fertility maintenance and resilience to extreme conditions
- Ecological stability and resilience, and environmental health, security and sustainability

- **a schematic cross section/catena of the landscape indicating the biophysical elements/process/flows.**
- **historical and archaeological description of the system or site**
  - Sikkim was a North-East Frontier Kingdom, *de facto* protectorate of British India, and independent India until 1975, and now a frontier state of India bordering with Tibet Autonomous Region of China, Bhutan and Nepal.
  - The state of Sikkim encompasses the lesser Himalaya, Central Himalaya and the Tethys Himalaya, the major portion is covered by Pre-Cambrian rock while hard massive gneissose rocks are found in southern part.
  - The ancient monuments are symbolic identity of people and archeologically important sites. There are about 32 monasteries built between 16 to 18th century in Sikkim. Sikkim is believed to be blessed by the His Holiness **Guru Padmasambhava**, the revered Buddhist Holy Saint in the eighth century.
  - Norbugang in Yuksam is the first initiation of a new history of people of Sikkim. This place commemorates the great historical event of the crowning ceremony of Phuntshog Namgyal as the first Chogyal (king) of Sikkim in AD 1641. The festival "Bhumchu" is observed every year for maintaining the peace and harmony in ***Demazong*** landscape for its prosperity and security. Similarly, "Cho-Tsho" is a festival where the Holy deity is thanked for his blessings and food security.
  - There are four great sacred caves in Sikkim which are the centre of great pilgrimage to the Buddhist of the world.
  - Statue of Guru Rimpoche at Sandup-tse, the patron saint of Sikkim in Namchi is the tallest statue in world.
  - Sikkim had the British trade road the **ancient silk route** from India to Tibet and to China with Central Asia and Europe through high altitude outposts of Sikkim, ***Nathu LA*** Pass (4,310 m) and ***Zalep La*** Pass for trade.
  - Chinese had recognized Sikkim as ***To-Ban*** during the 7th century and ***Dremojong*** later in the 9th century as an independent kingdom.
  - The historic trade agreement between India and China has reopened the ***Nathu La*** Pass for international trade from 6 June 2006.

- A part of the Biodiversity Hot-spots of the world in the Himalayan range.

- **Photos – Appendix Figures 1-9**

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Table 1. Agro-ecological zones of occurrence and genetic diversity of large cardamom.

Domesticated cultivars	Wild relatives (600-2200 m)
Diversity	
Large cardamom *Amomum subulatum*	*Amomum aromaticum*
Agro-ecological zones (local cultivars)	*Amomum linguiforme*
1500 –2200 m *Ramsai*, *Sawney*, *Bharlng, Madhusey, Ramla*	*Amomum kingii*
1000–1500 m *Sawney*, *Chibey* and *Ramnang*	*Amomum corynostachyum*
600–1000 m *Golsai*, and *Saramna*	*Amomum dealbatum*
	Amomum costatum
	Amomum plauciflorum

Table 2. Some important plants and animals of the trans-Himalayan Sikkim and in the cultivated system of the lower agroclimatic zones.

Biodiversity in Wider Natural Spaces	
Wild animals	
Scheduled Species, under endangered and threatened categories	Red Panda, Barking Deer, Clouded Leopard, Civet-cat, Ghoral, Himalayan Thar, Porcupine, Wild Pig, Marbled Cat, Must Deer, Serow, Snow Leopard, Red fox, Flying Squirrel, Tibetan Wolf, Wild Dog, Himalayan Black Bear, Martens, Weasels, Snow Leopard, Lynx, Kiang, Tibetan Gazelle, Nayan, Bharal or Blue Sheep, Himalayan Marmot, Woolly Hare, Mouse-Hare, Vole and many other species.
Important Birds	Blood Pheasant, Monal Pheasant, Snow Pigeon, Tibetan Snowcock, White Breasted Dipper, Crimson Horned Pheasant, Forest Eagle Owl, Black-necked Crane, Bar-headed Goose, Rudy Shelduck, Lesser Sand Plover, Redshank and many other important species.
Scheduled Species, under endangered and threatened categories	**Migratory birds:** Golden Eagle, Himalayan Griffon, Lammergeier, Lesser Kestrel,, Short-eared Owl, Tibetan Snowcock, Snow Petridge, Snow pigeon, Hoopoe, Raven, Himalayan Crows, Ground Chough, Redstarts, Grandala, Walcreeper, Horned Lark, Wagtails, Pipits, Robin Accentor, Snow Finches, Mountain Finches and many other important species.
Agrobiodiversity Species in Farming Systems	
Domesticated Animals	**Higher Agro-climatic zones**
	Yaks (Pure Tibetan stock)
	Dzo/Urang (Strayed over from Tibet)
	Horse (Tibetan and other stock)
	Sheep (of pure Tibetan stock)
	Goat (Pashmina type, Tibetan stock)
	High altitude dogs (Tibetan Mastiff, Lasha Apso Breed)

	Lower agro-climatic zones
	Local goats, sheep, pigs, ducks, chicken
	Local breeds of cow (Paharey Gai), horse
	Local breeds of buffalo (Paharey Bhainsi)
Plants (wild edibles)	**Along the altitudes**
	Plants with religious and cultural significance
	Such as *Juniperus* sp., *Rhododendron* spp.
	Edible plants like nettles, wild onions, wild citrus, ground orchids, edible ferns, other wild edibles
	Edible lichens and fungi (*Agaricus* spp., *Polyporus umbellatus, Pleurotus oestratus* etc.)
	Edible algae
Cultivated Crops	
	Landraces of upland rice: Ghyya-dhan, Takmari, Bhuindhan, Sikrey, Taprey, Timmurey, Marshi, Bachhi, Nangkatwa, Krishnabhog, Phudungey, Chungthangey, Bagheytulasi, Tsungthangey, Kalchanti, Lalbachhi, Mansaro, Nuniya, Kataka, Attey, Banghi, Tulashi, Dudhkalam, Champasari, Bangi, Jhapaka, Phaudel, Sanu-attey, Kalomarshi, Chirankhey, Sanu-bacchi (***needs documentation***)
	Landraces of finger millets: Pangdur, Mudkey, Chamligey, Bhadaurey, Kattikey, Mangshirey, Panchaunley, Nangkatwa
	Buckwheat: Methey-phaper, Titey-phaper, Kere-phapar, Yapha,
	High altitude barley
	Beans and Pulses: Bhatmas, Ghew simbi, Singtamey simbi, Ghew bori, Khostey Bori, Harey simbi, Soshta bori, Nepali simi, Kalo dal, Pahenli dal, Masyam dal, Hiundey simi, Rahari dal, Tuney bori, Ghew bori, Rajma, Khesari, Gahat, Bori, Bakuley simi, Kerau, Matar, Arhar, Kauchhey simi (***needs documentation***)
	Domesticated and wild relatives of citrus: Suntola, Kagati, Nimbu, Nibuwa, Bimirow, Bhogatey, Pbhoksey, Kali gyambir, Gyambir, Kamal, Naietey gyambir, Chaksi (***needs documentation***)
	Landraces of colocasia, yams, oil seeds, leafy vegetables
	Other local crop varieties and related wild edibles

Medicinal plants: *Abies wabiania, Aconitum ferox, A. heterophyllum, A. biswa, Acorus calamus, Allium wallichii, Amaranthus spinosus, A. tricolor, Arisaema speciosum, A. tortuosum, Artimisia vulgaris, Astilbe rivularis, Berberis aristata, Betula utilis, Budleja asiatica, Cinamomum tamala, C. camphora, Cordyceps sinensis, Dioscorea bulbifera, D. deltoida, D. pentaphylla, D. alata, Erigeron sikkimensis, Heracleum wallichi, Hippophae salicifolia, Mahonia nepaulensis, Melia azadirach, Myrica esculenta, Nardostachys jatamansi, Panax pseudoginseng, Picrorhiza kurooa, Podophyllum haxandrum, Rheum emodi, Rhododendron anthopogon, R. arboreum, R. barbatum, R. campanulatum, R. cinnabarinum, R. lepidotum, R. setusum, Swertia chirayita, S. multicaulis, Taxus bacata, Urtica dioca, U. parviflora, Viscum album, Veleriana hard wickii, Zanthozylum acanthopodium, Z. alatum, Z. budrunga, Z. hamiltonianum, Z. oxyphylum* (and **many endemic species**)

Multipurpose agroforestry trees: *Alnus nepalensis, Albizia marginata, A. odoratissima, A. procera, A. lebbeck, Bauhinia purpurea, B. vahlii, B. variegata, B. malabarica, Brassiopsis speciosa, Gamblea ciliata, Citrus reticulata, Cedrella toona, Rhus similiata, Orozylon indicum, Grewia elastica, Diploknema butyracea, Bauhinia indica, B. variegate, B. vahlii, Garuga pinnata, Erythrina stricta, E. arborescens, E. variegata, Morus alba, Terminalia myriocarpa, T. tomentosa, Garcinia stipulata, Juglans regia, Artocarpus lacoocha, Echinocarpus aristatus, Elaeocarpus lanceae, Castanopsis hystix, C. indica, Delbergia latifolia, Erythrina sticta, Chukrassia tabularis, Litsea polyantha, Firminiana colorata, Buhinia purpurea, Sterculia villosa, Styrax serrulatum, Symplocus candata, Bridelia retusa, Callicarpa arborea, Elaeocarpus lancaefolius, Cordia* sp., *Psidium guajava, Schima wallichii, Ficus hookeri, F. roxburghii, F. elastica, F. benghalensis, F. nemoralis, F. hookeri, F. toona, F. ciliata, F. semicarpa, F. hirta, F. cunia, F. benjamina, Saurauia napaulensis, Stereospermum suaveolans, Tamarindus indica, Edwarthia gardeneri, Oroxylum indicum, Michelia champara, Rhododendron* spp. (and many other species)