Currently, the beekeeping industry in Bhutan is promoted with introduced European *Apis melifera* species. Some ICIMOD reports have alleged that there is a threat of replacing the local bees by this species and therefore warrants conservation of the local bees. Besides contributing to conservation of local biodiversity, promotion of bee industry using local bees can provide a viable proposition especially in the southern part of the country. Most of the households in the south keep one or two log hives of local bees.

Apis cerena hive

Observations made by experienced beekeepers in Bhutan indicate changes taking place in the population dynamics of these important wild bees. Information on its population distribution, its trends and characteristics are limited. Its contribution to the agricultural productivity through pollination services is also not widely recognised in Bhutan. The *A. laboriosa* bee, which is considered as a rare species, is still less understood, and not many references are available. Attention is required for the conservation and utilization of these important bee species. The use of these wild bees for conservation and as a tool to monitor the health of the forests could become an innovative, pro-active strategy for ecological monitoring of the mountain ecosystem in Bhutan.

Honeybees such as *Apis laboriosa* are key natural resource indicators to good environments. This bee has not been subjected to gathering – thus the nesting habitat is still abundant. Cliff sites close to riparian forest patches and occurrence of these bees at diverse altitude contribute to the richness of ecological diversity and pollination services. Conservation through protection of bee habitats, monitoring of nesting sites, mapping of bee rich zones and understanding their behavior could be a benefit for understanding the wild bee ecology and their role in the biodiversity conservation.

1.4.5. Flora

Bhutan has a very diverse flora with affinities to Southeast Asia (mainly tropical taxa), China/Japan (temperate taxa), Tibet, the Euro-siberian region, and the Arctic/alpine areas of Europe and Asia, and to a very limited extent to the floras of India and Sri Lanka (Grierson and Long 1983).

Of the known 5,446 species of vascular plants, as many as 750 are endemic to the Eastern Himalayas and 50 or more are endemic to Bhutan itself (Grierson and Long 1983; Myers 1988; Sherpa et al, 1991; Yonzon 1992; FAO 1994).

Several plant species are of high conservation value; e.g. the Himalayan yew (*Taxus baccata*), an important alpine fungus (*Cordyceps sinensis*) which commands a high price in the international market. *Podophyllum hexandrum*, *Aconitum* spp., *Delphinium* spp., *Herminium* spp., *Pleurospermum* spp, *Gentiana* spp, *Corydalis* spp., *Parnassia* spp., *polygonatum* spp., for their valuable alkaloids and various medicinal properties; species of *Allium* spp., *Fritillaria* spp., *Lilium* spp., as wild gene pools for future crops research; *Rheum nobile*, *Pterocephalus hookeri.*, *Aster* spp., *Senecio* spp, *Saussurea* spp., *Rhododendron* spp., *Geranium* spp., *Meconopsis.*, *Epilobium* spp.,

Aconitum sp.

Anemone spp., and *Potentilla pedicularis*, as potential horticultural crops of ornamental value; *Circaester agrestis, Triosteum himalayanum, Helwingia himalaica, Diapensia himalaica, Corylopsis himalayana* as rare endemic species for Bhutan.

Several plant species listed under schedule I of Bhutan's Forest and Nature Conservation Act, 1995 are also from the alpine and sub-alpine regions and have very specific microhabitat requirements. For instance, the threatened species *Podophyllum hexandrum* (Himalayan May Apple) grows only among Berberis-Juniperis shrubberies in rocky areas, and frequent fires and systematic removal of shrubs from such areas may cause the local extinction of this species. Another, e.g. *Circaeaster agrestis*, is a rare plant that grows only under rock shelters and caverns.

The comprehensive description of the Bhutan flora is now available in the form of the Flora of Bhutan finished early in 2002. The Flora includes three Volumes of three parts each. It includes 8 families of Gymnosperms, 180 families of Dycotyledons, and 66 families of Monocotyledons (Grierson and Long 1983, 1984, 1987). The flora includes 46 species of rhododendrons and numerous species of economic value, including valuable timber trees, medicinal, aromatic, horticultural and ornamental plants and very many species that provide essential non-timber products to rural users (Grierson and Long 1983; UNIDO 1994; Dorji 1995). The Bhutanese flora is considered to be of great scientific value, both because of its biodiversity and because of its relatively good state of preservation compared to adjacent Himalayan areas (Grierson and Long 1983), although many taxa are now considered to be nationally threatened (WCMC 1995)

Table 5. Characteristic Flora and Fauna in Bhutan (some species are subject to change)

Zones	Altitude (m)	Precipitation (cm)	Characteristic Flora	Characteristic Fauna
Dry Alpine Scrub	4,000-4,600	?	*Ephedra gerardiana, Meconopsis simplicifolia, Chesneya nubigena, Picrorhiza scrophularifolia, Tanacetum gossypinum, Saussurea gossypiphora, Rheum nobile.*	**Mammals:** Marmots, Snow leopard, Blue sheep, Pika, red fox, musk deer. **Birds**: Tibetan snow cock, Snow partridge, Grandala, Lammergeier, Himalayan monal pheasant, Himalayan griffon, Alpine accentor, Oriental skylark, Blood Pheasant.
Juniper/Rhododendron scrub	3,700-4,200	?	*Juniperus recurva, J. squamata, Rhododendron lepidotum, Morina nepalensis, Thalictrum chelidonii, Pedicularis megalantha*	**Mammals**: Wild dog, Barking deer, Serow, Musk deer, Takin. **Birds**: white browed rose finch, Snow pigeon, White browed bush robin, Golden bush robin, Blood Pheasant, Fire tailed Sunbird.
Fir forest	3,100-3,300 (-3,800)	130 cm or more	*Abies densa, Juniperus pseudosabina, Skimmia laureola, Viburnum nervosum, Rheum acuminatum, Maddenia himalaica.*	**Mammals**: Musk deer, Leopard, Yellow throated martin. **Birds**: Rufous vented tit, Grey crested tit, Orange flanked bush robin, Long tailed thrush, White browed fulvetta, and Eurasian tree creeper.
Hemlock forest	2,800-3,100 (-3,300)	130-200	*Tsuga dumosa, Larix griffithiana, Gaultheria fragrantissima, Panax pseudo-ginseng, Daphne bholua, Arundinaria griffithiana.*	**Mammals**: Sambhar, Serow, Black Bear, Barking deer. **Birds**: Black throated tit, Black throated fulvetta, Green-tailed sunbird, Rusty flanked tree creeper, Lesser cuckoo.
Spruce Forest	(2,500-) 2,700-3,100 (-3,200)	50-100	*Picea brachytyla, Rosa macrophylla, Taxus baccata, Picea spinulosa, Acer cappadocicum, Larix griffithiana, Hydrangea sp.*	**Mammals**: Sambhar, Birds: Black throated tit, Rusty flanked tree creeper, and Black throated fulvetta.
Blue pine	2,100-3,00(-3,100)	70-120	*Pinus wallichiana, Berberis asiatica, Cotoneaster griffithii, Lyonia ovalifolia, Rhododendron arboreum,*	**Mammals**: Leopard, Sambhar, and Goral. **Birds**: Green backed tit, Yellow billed blue magpie, Grey backed shrike, Red billed cough,

			Arisaema consanguineum.	Common kestrel, Collared blackbird, White throated laughing thrush.
Everygreen oak forest	1,800-2,000(-2,600)	200-300	*Acer campbelli, Castanopsis hystrix, C. tribuloides, Elatostema hookerianum, Quercus lamellosa, Skimmia arborescens*	**Mammals**: Tiger, Leopard, Barking deer, Sambhar, Wild dog. **Birds:** Kaleej's pheasant, Leaf warbler, Grey winged Black bird, Green backed tit, Chestnut breasted patridge, wood snipe.
Cool broad leaved forest	2,000-2,900	250-500	*Acer campbelli, Betula alnoides, Exbuclandia populnea, Lindera pulcherrima, Persea clarkeana, Symplocos dryophila*	**Mammals:** Leopard, Black bear, Barking deer, Red panda. **Birds**: White throated laughing thrush, Rufous necked hornbill, Chestnut crowned laughing thrush, Snowy browed fly catcher, Mountain hawk eagle, Tawny owl, Ward's trogon Pygmy wren babbler, Great babbler.
Chir pine forest	900-1,800 (-2,00)	100-130	*Pinus roxburghii, Cycas pectinata, Cymbopogon flexousus, Euphorbia royleana, Woodfordia fructicosa, Grewia sapida, Buddleja bhutanica, Rhododendron arboreum.*	**Mammals**: Goral, Yellow throated martin, Barking deer. **Birds**: Black bulbul, Mountain bulbul, Grey-tree pie, Rufous woodpecker, Red-vented bulbul, Bar-winged flycatcher shrike, Saphire flycatcher, and Himalayan bulbul.
Warm broad leaved forest	1,000-2,000(-2,300)	230-400	*Altingia excelsa, Bischofia javanica, Castanopsis indica, Engelhardia spicata, Macaranga postulata, Schima wallichii, Alnus nepalensis, Michelia exelsa, Morus sp., Amoora rhotica.*	**Mammals**: Red panda, Barking deer, Sambhar, Tiger, Capped langur, Serow, Leopard. **Birds**: Rufous necked hornbill, Palla's fish eagle, Great hornbill, Wreathed hornbill, Common lora, white breasted kingfisher, Oriental turtle dove, Leaf warbler, Hodgson's hawk cuckoo, Chestnut breasted partridges.
Subtropical forest	200-1,000 (-1,200)	250-500	*Acrocarpus fraxinifolius, Ailanthus grandis, Bombax ceiba, Duabanga grandiflora, Shorea robusta, Pterospermum acerifolium, Aquilaria agaloocha, Gmelina arborea, Terminalia sp., Michelia champaca, Acacia catechu, Chukrasia tabularis, Toona ciliata, Lagestroemia sp., Phoebe sp., Artocarpus sp.*	**Mammals:** Golden langur, Capped langur, Pygmy hog, Marbled cat, Asiatic golden cat, Fishing cat, Tiger, Elephant, Clouded leopard. **Birds**: Large billed crow, Blue whistling thrush, Pin-tailed green pigeon, Orange breasted green pigeon, Spotted dove, Great coucal, Rose-ringed parakeet, Asian emerald cuckoo, Blue bearded bee-eater, Blue bearded barbet, Large hawk cuckoo, Rufous-necked hornbill, Pallas's fish eagle.

Source: NCD, Flora of Bhutan Vol. I to Vol. III.

1.5. Domestic Biodiversity

1.5.1. Agriculture

The traditional, self-sustained farming system integrates crop production, livestock production and use of forest products. The wide range of climate and altitude has allowed the Bhutanese inhabitants who come from different ethnic backgrounds to use a variety of crops and vegetables. This diversity in crop species surpasses anything one would expect considering Bhutan's small size.

Elevation and rainfall temper climatic zones, and so climatic types often coincide with topographic zones. The dramatic elevation gradients account for its diverse flora and fauna, the species richness further enhanced through its relative isolation from other parts of the continent. Through a

long process of natural and human selection, a wide array of crops and of varieties within crop species exists, sometimes hidden in remote areas. Many of the native crops as well as those, which have been introduced into Bhutan long time ago, possess significant genetic diversity and are ecologically well adapted to the specific requirements of the local environment.

The Himalayan ecosystem that includes Bhutan has diverse biodiversity values of national and global significance. One of the world's ten global biodiversity hotspots, the Eastern Himalayas includes Bhutan, which is squarely placed at the intersection of three world centers of diversity of cultivated plants. With over 70% forest cover, Bhutan is known to harbor approximately 7,000 species of vascular plants. Many of these include fruits, vegetables and cereal crops in Bhutan that are either native, invasive, ecological escapes or introduced long time ago that they have developed unique genetic, morphological and ecological characteristics. The country's diverse flora includes numerous economically important plants: timber trees, medicinal herbs, industrial plants, horticultural and agricultural crops.
The natural forest and the traditional integrated farming systems remain largely intact. Bhutan not only has a wide diversity of plant genetic resources but also has a large number of endemics- both cultivated and wild species. Thus Bhutan, least developed in economic terms, plays an important role in conserving the global biodiversity in general, and the biodiversity of the Eastern Himalayas in particular.

Today there is a global awareness concerning the urgency and importance of conserving biodiversity and the sustainable use of the biological resources in terms of their roles in the survival of the human species. In Bhutan, farming has remained largely at the subsistence level. Apart from the integration of the three sub-sectors in the farming systems, a special characteristic typical of Bhutan is its tremendous diversity in its landscape and ecosystems. The need to maintain a high level of self-reliance and the variation dictated by climate and other environmental factors has broadened the scope for biodiversity in the agricultural systems.

In addition to the major crops listed below, there are also minor crops such as finger millet, foxtail millet and amaranth. In the past and to some extent at present these have played an important role in farmers' diet and cropping pattern. For example, foxtail mitllet is harvested in May/June, a lean period for farmers because the harvest from previous crops is over and other crops are still not ready for harvest.

It is often stated that only 30 crop species feed the world. These are crops that provide 95% of the dietary energy (calories) or protein. Based on the extent of cultivation and their contribution to the daily diet of the rural population, maize, rice, millet, wheat and buckwheat are the predominant agricultural crops of Bhutan (Table 1.6). Horticulture crops are mainly grown with commercial objectives in mind. There is no definitive list of staple or important crop. Nonetheless, the listing in the table does constitute a range of crops, which include different crop groups, species with different breeding systems, and crops of temperate and tropical origin. There are many other species that are important to large numbers of people at sub-national levels as suppliers of other dietary factors (protein, fat, vitamins and minerals, etc.). A crop-wise review on the state of diversity for some major staple food crops is provided.

Table 6. Area and production figure figures of major agricultural and horticultural crops in Bhutan (LUPP, 1995)

Crop Species	Area ('000 Ac)	Production (MT)	Yield (kg/Ac)
Rice	111.406	107,877	968
Potato	13.914	43,325	3,113
Wheat	23.642	10,747	454
Buckwheat	18.013	6,443	357
Mustard	11.816	3,686	311
Barley	10.887	4,849	455
Maize	137.072	75,380	549

Millet	25.498	9,159	359
Vegetables	14.802	22.257	1,503
Legumes	4.070	2,098	515
Chilli	1.688	887	525
Ginger	2.817	4,503	1,598
Orange	19.866	77.031	3,877
Apple	4.858	9.266	1,907
Cardamom	17.231	3.980	230
Arecanut	0.277	1.073	3,870

a). **Maize**

Maize is the most important field crop in terms of the area under cultivation. No information is available on how and when it was introduced and distributed in the country. The presence of maize had been noted by Bogyle during his visit to Bhutan in 1774 (Markham, 1876). Some even hypothesized that maize might have been in this region even prior to the discovery of the New World. The advent of maritime exploration, especially the opening of communication between the old and new world, and the trade links between Europe and East Indies are most plausible elucidation to the entry of maize into Bhutan.

Today, maize is grown throughout the country up to an altitude of 2900m (Rodder & Gurung, 1990), with main growing areas concentrated in Eastern Bhutan at altitudes below 2500m. It is grown in areas without irrigation facilities and on unterraced slopes. Local maize includes dent, flint and popcorn types planted almost throughout the year, and cropped twice in some low-lying areas. Generally, maize is intercropped or relay-cropped with beans, soyabean, vigna spp., potato, taro, sweet potato, amaranth, chenopodium and pumpkin.

The farmers' varieties or landraces contain high level of genetic diversity visually distinctive in their morphological make-up. Therefore, the farmers have names for them and different landraces are understood to differ in adaptation to microclimates, soil types, time of seeding, date of maturity, height, nutritive value, socio-economic use and other properties. The inherent variation within landraces of maize may be high since it is a cross-pollinated species.

The RNR-RCs in Bumthang and Khangma are currently involved in collecting, characterisation and evaluation of high altitude (>1800m) local maize cultivars for use in crop improvement programmes. Large-scale exotic introduction has been curtailed to avoid marginalizing the traditional varieties. Nonetheless, a high yielding variety Suwan 1 was released as Yangtsipa in 1992. By 1993, this variety had spread to over 30% of the maize area in Eastern Bhutan. Studies on the adoption rate and success indicated that over 90% of the households were either growing Yangtsipa as a sole variety or in combination with a local variety (RNRRC-Bajo, 1996). This HYV is said to have a yield advantage of 20% over landraces. Collected local varieties from Eastern Bhutan have been crossed with the released Yangtsipa and segregating materials are currently under evaluation by RNRRC Khangme. Selection is for cold tolerance (>1800 m) and high yield. Two more varieties, Palmirah 8529 (white) and Suwan 8528 (yellow) were released in 2000. This is definitely a case for concern from the conservation perspective since the situation leads to widespread replacement of diverse local varieties by homogeneous modern varieties.

b). **Rice**

Rice is the preferred staple food and often consumed three times a day. The landraces in general have medium to high amylose and a low gelatinization temperature (Chettri, 1990). In Bhutan rice is grown from 300m to about 2600m in altitude. Rice is cultivated in terraces and about 90% of the rice fields are irrigated following a rice-fallow or rice-another field crop system of farming. It is estimated that landraces cover about 95% of the total rice growing area in the country (Roder, 1990). The number of farmers' varieties in the field is tremendous. Traditionally, rice landraces are assorted into two groups: Bjakaap (white pericarp) and Bjamaap (red pericarp). Within these groupings, local farmers distinguish several varieties with discrete indigenous names that relate to

certain unique morphological characteristics or ascribing special socio-cultural attributes. The diversity in rice ecotypes and morphotypes and the genotypic variation within these constitute invaluable genetic resources for the breeding work. The present knowledge across the whole spectrum of genetic variation in rice in Bhutan is minimal. Bhutan lies within the region considered to be the primary center of origin and diversity for rice. New variations may be evolving all the time through continued geneflow between crops and their wild relatives. Thus it will be difficult to achieve comprehensive and exhaustive information on rice, but proper inventory and documentation must be maintained to facilitate conservation and use.

To illustrate the extent of diversity in rice, the farmers from five geogs in the eastern part of the country grow in total 16 rice landraces (Chhetri & Schouten, 1995). The concentration of landraces at the country level will, therefore, be very high. These varieties deserve concerted attention since they confer several benefits that the HYVs cannot provide toward the fulfillment of a farmer's multiple needs.

Throughout the subsequent years since the establishment of the Center for Agriculture Research and Development (CARD) in 1982, the introduction and evaluation of HYVs has gained intense momentum in the pursuit for domestic food security. From 5000 or more introduced lines, seven improved HYVs have been recommended since 1988 for general cultivation in the middle and low altitude environments. A small-scale shuttle breeding program is implemented to develop varieties suited to the high altitude areas (>1800m). More than 100 crosses were made between local varieties and HYVs generating 100 bulk populations and over 2500 pedigree lines. Some of them are undergoing screening for resistance to rice blast and cold tolerance at Gaynekha. Initially CARD relied more on introduction of HYVs for different agro-ecologies and adaptation to local conditions. However, the rice shuttle breeding with IRRI has gained momentum and introductions have reduced greatly. The emphasis now is on utilization of local germplasm in breeding programs and improving the productivity of local cultivars while retaining their good traits such as red color and grain quality. From this cross-breeding program, 4 improved varieties that contain Bhutanese genes have been released in 2000, and 3 more are pending release from the blast and cold tolerance program of Geynekha.

The RNRRC-Bajo in collaboration with other RNR-RCs has embarked on a nation-wide exploration and collection of traditional rice germplasm. Systematic follow-up leading to utilization is constrained by the lack of storage facilities and associated infrastructure. There is only one reality in the field, and that is to acknowledge the fact that solutions to many problems of rice farming in Bhutan are inherent in these landraces.

c). Wheat

Wheat is the third most important cereal crop after rice and maize in terms of production. No records on the introduction of wheat to Bhutan are available. Nakao & Nishiokha (1984) speculated that it might have been introduced from Tibet. Records by early visitors (Markham, 1876; Kuloey, 1865) suggest that wheat cultivation as second crop after paddy was more important in the last century than it is today (Roder, 1990). There are several factors contributing to the depression in wheat cultivation in Bhutan. Certain element of social bias restricted its wide-scale acceptance as a staple food; and often, it does not contribute directly to the alimentary needs. The transition from a subsistence and barter economy to market economy has brought radical changes in the approach to agriculture development. Low grain yield and subsequently low returns to investment, and cheap import from India were considered to be the main reasons for stagnant wheat cultivation (Mann & Hobbs, 1988).

purposes. Most of these landraces, according to them, have disappeared from the field as they are progressively being replaced by exotic wheat varieties (or Jaga-Kaa as they call these improved varieties). It is likely that few of them may still be surviving in the very remote areas, far removed from the present network of seed distribution system. Immediate and effective action must take precedence of all debates on priority issues to save the remaining populations of wheat landraces maintained in the periphery of its gazetted provenance by few insipid but enterprising farmers.

The common border with India and the prospect of monetary income heralded the demise of wheat landraces in Bhutan. Since wheat is secondary as a staple crop, farmers have been complacent of the entry of Indian improved wheat into the country through formal system or farmer-driven seed acquisition and exchange system. Under the formal agriculture development programs, the landraces were further neglected with public resources concentrated into the introduction and identification of improved varieties like Sonalika. As a product of formal breeding work, such cultivars are genetically uniform with narrow genetic base. As a result, problems like the stripe rust epidemic in 1986 and 1987 began to emerge. Sonalika became susceptible and consequently two more introduced varieties: Bajo Ka 1 and Bajo Ka 2 were released as rust resistant... but for how long? It has been noted at the First Field Crop Co-ordination Workshop that almost all the area under wheat in the rice-wheat system is under the improved varieties. This roughly accounts for more than 60% of the total area under wheat cultivation.

Wheat is grown in almost all the different agro-ecological regions of the country, right from 300m to locations above 3000m, as the main crop or secondary crop after maize, rice and potato; and in rotation with buckwheat at higher altitudes. Wheat is also grown as winter fodder at elevation up to 2500m, and for haymaking at elevations of 3500-4000m (Roder & Gurung, 1990).

i). Oilcrops

Oilseeds constitute major agricultural crops next to cereals and hold an important place in our economy. Mustard and Rapeseed (*Brassica juncea* and *B. campestris*) are the predominant oilseed crops of the country that grows from 200 m to 3000-m elevation. A total of 11816 acres of land area is estimated to be under rapeseed cultivation. Mustard/Rapeseed have been grown by most farmers since time immemorial as the major oilseed crop. Today, the acreage under oilseed crop is gradually diminishing simply because it is not economically viable due to limited choice of cultivars and the cost of production at home is relatively high and thus the import of cheaper oil from India depresses domestic production. In the wetlands, there are other competing crops such as wheat and vegetables grown in rotation with rice. In the dry land, mustard is grown only as a secondary crop under marginal/rain fed conditions. At the national level, the average yield of Mustard/Rapeseed is only about 311 kg/acre.

- So far 4 improved varieties of Brassica spp released from Research Centers, but not very popular
- High diversity of local varieties in the country
- Local varieties not systematically collected and conserved
- Risk of losing them soon – being open-pollinated, easily cross and degenerate

Besides *Brassica* species, there are other oil-bearing crops grown traditionally in Bhutan. Niger seed (*Guizotia abyssinica*) is grown in small areas in Bhutan during summer. Oil content is 35% and is known to produce crop even under poor fertility and compete well with weeds. It is planted late in monsoon in middle hills, and lower hills. Sesame (*Sesamum indica*) is found growing very sparsely in the southern part of the country. There are two types of sesame, one with white seed and other black. The oil content in black seed (60 % oil content) is higher than that of white seed. Yields are often low and less than 500 kg/ha. Sunflower (*Helianthus annuus*) is a minor source of vegetable oil and is grown mainly in the cool Temperate Zone above 2000 m. Soybean (*Glycine max*) and Groundnut (*Arachis hypogeae*) are two of the leguminous oilseeds cultivated in large extent in the eastern Bhutan, which are yet to be exploited for good quality oil mainly due to lack of oil extracting devices. Other exotic high altitude spp in the process of being introduced from India and elsewhere include Ethiopian Mustard (*Brassica carinata*) which is grown for oil in the Ethiopian

and elsewhere include Ethiopian Mustard (*Brassica carinata*) which is grown for oil in the Ethiopian highland up to 2500 m elevation. It is generally late in maturity, but early types are also available now. The crop is usually grown from June-September under 13-hr day length.

In addition, there are some perennial oil-bearing trees from which seeds are harvested to extract oil. Locally known as Yhika (*Maduca butyretica*) contains 50% oil and is found in the Eastern part of the country. It is commonly used for lighting lamps. The oils and fruits are used for consumption. It lacks improved oil extraction technology and management practices. Karshing, also called Kadam (*Jatropa curcas*) contains 35% oil. It is widespread in the country. Oil is used for soap making. Plants are used as live fence and for erosion control. Pangtshi (*Symplocus paniculata*) contains 20% oil and is available in Punakha-Wangdue. Oil is used for consumption and leaves are used as dye. Shingshe (*Neolitsea* spp) contains 28% oil and is found in Eastern Bhutan. Oils are used for consumption and lighting lamps, oilcakes for manure.

e). Buckwheat

Buckwheat is an important food for the non-rice-growing areas at elevations above 2500m (Roder, 1995). Both bitter and sweet buckwheat species are grown. Owing to its short growing period, the crop can be accommodated under various cropping patterns. While it may be the only crop for high altitude farmers, it can be grown as second crop after potato, wheat or barley up to 2900m of altitude. Traditionally, buckwheat was the major crop in grassland shifting cultivation systems in regions from 2500m to 3400m. The duration of fallow period in these systems generally increased with altitude such that fallow of 15 years was common above 3000m.

So far one local variety of bitter buckwheat and two local varieties of sweet buckwheat has been recorded under cultivation. It may be possible to have enormous diversity within these landraces. In fact the farmers do discriminate between morphotypes found under different agro-ecosystems. These buckwheat landraces are most prominent in Bumthang and Ha districts.

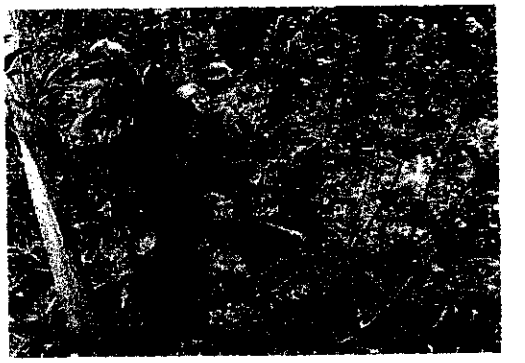
Buckwheat production has not receded like wheat under the competition from surrogate crop species and improved varieties within. Research in the introduction and evaluation of improved varieties is at the initial phase. The traditional seed exchange and distribution methods are still intact, thereby preserving the available diversity and contributing to the enrichment of germplasm by assenting to parallel but mutual human involvement and natural evolution.

1.5.1.1. Domesticated Medicinal and Aromatic plants

More than 300 species of plants are used in the Bhutanese Traditional Medicine. These have been collected from the wild resources for many years. This repeated collection from the wild resources lead to some reduction in plant population in the wild. Because of this, it has become increasingly difficult to collect medicinal plants from the wild. To address this situation as well as to improve the quality of the traditional drugs and to diversify the income of the rural population the cultivation of medicinal and aromatic plants was initiated in Bhutan.

The Medicinal & Aromatic Plants (MAP) Research Program at RNRRC Yusipang conduct research on the domestication of High altitude species where as the research sub-center at Mongar works on low altitude species and essential oils.

With the cultivation program that started in 1997, 6 high altitude species have been released to the farmers for cultivation on large scale. In total, more than 20 farmers are cultivating medicinal plants in the 3 western Dzongkhags. Through their cultivation the ITMS annual demand for 4 species have been met since the year 2000.



Dracocephalum tanguiticum *(Ti yangku) a medicinal herb usually imported from Tibet but now cultivated in Bhutan*

In the future, as there are many medicinal and aromatic plants species in the country, it is not possible to take up research on everything, therefore the effort must be focused on few potential species that has good outside market as well as good response to cultivation practices.

1.5.2. Livestock

The main domestic livestock in different regions of Bhutan are cattle, yaks, poultry, pigs, equines, sheep and dogs. Goats, buffalo and cat are other domestic livestock, but the former two are found in lower valleys or parts of Southern Bhutan. So far following breeds and sub-breeds of domestic livestock have been recorded in Bhutan.

Table 7. Domestic Biodiversity in Bhutan

Species	Type	Main Breeds	Sub Breeds[i]
Cattle *(Bos indicus/ taurus/ frontalis)*	Local	3	9
	Exotic	2	6
Yak *(Bos grunniens)*		1	9
Pigs (Sus spp.)	Local	3	
	Exotic	4	4
Poultry *(Galus domesticus)*	Local	4	
	Exotic	2	
Horses (Equs spp.)	Local	4	
	Exotic	1	1
	Donkey	1	5
Sheep *(Ovis aries)*	Local	1	2
	Improved	2	4
Dogs (Canine spp.)	Local	7	
Goats (Capra spp.)	Local	1	nk[ii]
Buffalo (Bos spp.)		nk	nk
Cats	Local	nk	nk

1.5.1.1. Domestic Breeds and Sub-Breeds

a). Yak *(Bos grunniens)*

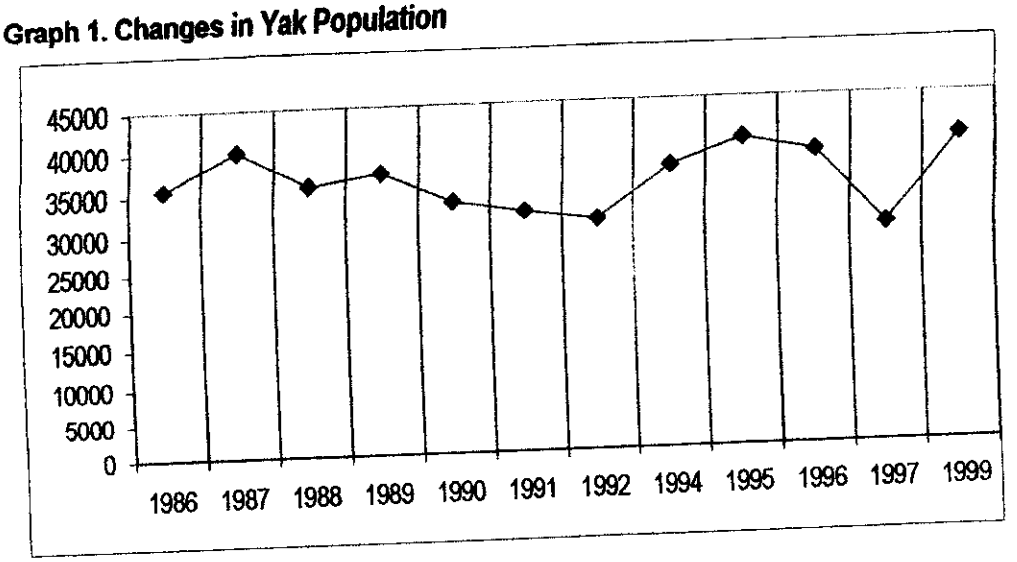
Yaks are the integral part of the pastoral system and are the most important in terms of domestic biodiversity in Bhutan. They are herded mainly in Thimphu, Trashigang, Ha, Paro, Punakha, Wangdue and Bumthang Dzongkhags (districts) in the northern areas of the country by pastoral groups. The yak being the capital, there is the need to have a large number of these animals from the economic point of view. Barter system of trade still exists in some areas. *Brokpa* (yak pastoralists mainly in eastern Bhutan) are entirely dependent upon herds of yaks without having cultivable land holdings. Most of the Brokpa do not have permanent habitations but spend their entire year in crude shelters or yak hair tents tending their animals in a transhumane migratory pattern that follows fodder availability through the season often covering large distances.

The population of yaks was about 35000 in 1986. By 1999 this has slightly increased to 40000. Yaks herds are mostly concentrated in the districts in upper temperate to alpine zone of Tashigang, Gasa, Ha and Paro.

---

[i] *The term used to describe the inbreds between various species and breeds within species*
ii not known

Graph 1. Changes in Yak Population



The yaks of Bhutan generally appear smaller than in other regions.

In summer yaks graze in pastures up to 5000 m and remain there until late October when they begin their descent to lower altitudes to elevations of 2500 m. In spring when the weather turns warmer, yaks once again start the cycle of movement to higher elevation grazing lands. Yak herders may be having as many as 20 different pastures that are only grazed for a week or a month or more in other situations. In some places, there are also tenant herders who pay 10 to 15 kg of butter per year for each milking animal and keep the rest of the excess butter, cheese, hair and wool.

In some cases yak and *dzom* (the female progeny of *Langu* and yak) herds are kept together for two to three months in the summer but separate at other times. Some households with fewer animals may combine their animals with others to form one herd.

The dzom herds usually leave for lower elevation winter grazing lands in late September or early October and are kept there till the middle of May. In late May the herds are moved up, usually reaching the highest elevation alpine grazing lands in July where they usually remain until late August. Yaks are crossed with Golengs or Langus to get different bloodlines. The average annual production of a yak cow is about 25 kg of butter and 30 kg of cheese while that of a dzom is 30 kg of butter, and 40 kg of cheese. Butter and cheese are consumed by the herders, exchanged for rice or sold in the market.

The long hair and wool produced by yaks is vital to the herders' existence. The long hair is cut in early summer. The fine inner wool of the yak is obtained at the same time by plucking it out. The inner wool is used for making clothing and the long hair for making ropes, pack strips, bags, blankets and tents. This wool and hair are not sold but spun and woven by herders for their own use. The average hair and wool production from one yak is reported to be 1 to 1.5 kg and about 2 kg respectively. Hides from animals that have been slaughtered or have died from natural causes are used as carpets and are also tanned for making leather straps and ropes. Some yaks are also slaughtered for meat, which can fetch Nu. 6000 to 10000 depending on their size. Yaks are also exchanged with rice. There is great demand for meat and yak tail throughout the country.

b). Mithun

A typical Jatsham

The Mithun (***Bos frontalis***) is the domestic form of Gaur. It is indigenous to parts of India (Assam & Arunachal Pradesh), Burma and Bangladesh. These animals are big and strong, have a typical dorsal ridge on the crest of the shoulder, a flat forehead and big horns with an enormous base. In order to meet the demand and to create a continual source of genome there are two Mithun breeding farms producing more than 20 pure Mithun bulls which are distributed among the farmers for crossbreeding with Siri (**Nublang in Bhutan, *Bos indicus)***. The F1 generation obtained after mating Mithun (male) with Siri breed (female) is the most prized animal. The males, *Jatsha*, are very huge and powerful and are excellent draught animals when compared to the indigenous bulls, but are sterile. The female (*Jatsham*) populations are very good milk producers having relatively higher fat percentage in the milk. They are preferred for easy maintenance in the difficult terrains of Bhutan. They are superior in feeding on steep hills/slopes and for grazing on native grass and tree leaves. The interesting feature is that all the male progenies are sterile.

The following box shows Mithun Breeding practice to produce Jatshamin, which is superior productively, compared to either of their parents:

Mithun_X Siri_ 100%

	ß	
F1		**Jatshamin 50M X Siri_ Siri Blood 50S**
	ß	
F2		**Yankumin 25M X Siri_ Siri Blood 75S**
	ß	
F3		**Deobam 12.5M X Siri_ Siri Blood 87.5S**
	ß	
F4		**Deotha 6.25M X Siri_ Siri Blood 93.75S**
	ß	
F5		**Thabamin 3.125M X Siri_ Siri Blood 96.875S**
	ß	
F6		**Thabazing1.5625MX Mithun_100% Siri Blood 98.4375**
	ß	
F7		**Jatsham & Jatsha Siri Blood 49.215**

The F1 male (Jatsha) although excellent for draught purposes are considered infertile and therefore cannot be used for breeding. Hence, future research will be focused on producing a stable Mithun breed, whereby mating can be made possible avoiding the disadvantages of the very long traditional backcrossing system. Preliminary research has shown that there are jatshas, which are fertile and are able to produce progenies with all normal characters. This research work is expected to turn out to be quite costly. In the meantime a technological breakthrough was made in Artificial Insemination using Mithun semen, which is being widely used through out the country now.

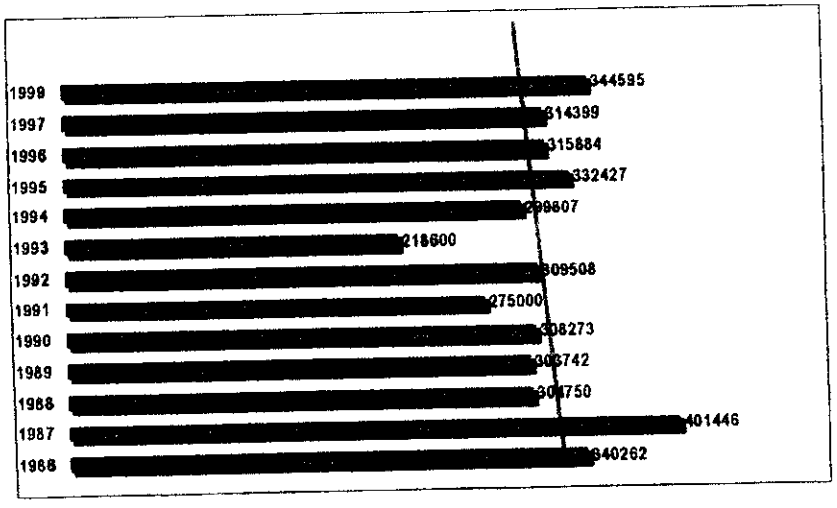
c). **Siri or local cattle**

A typical Siri cow (Thrabam)

Nublang origin is linked with the legendary lake in Western Bhutan -Nob Tshonapata, located on the western mountain ranges of proper Haa and above Nakha village of Sombe Geog. It is said that the Tsomen had given a breeding bull to a kind Norpen from Nakha village who had given her a nights shelter in his herd camp and our present Nublang is the offspring from the Tsolang.

In Bhutan this animal is by far the most trend setting and important animal. Most of the farmers keep this breed for milk, draught and for crossbreeding with Mithun to produce Mithun crosses. The latter use is one of the foremost purposes in the Northern and Eastern part of the country. Although the low milk production, late age of maturity, delayed conception, impaired fertility and long calving interval are some common algeny of our indigenous breeds, they become good asset for some of the productive traits and hetero-genesity particularly disease resistance, foraging ability, traction capacity and butter fat production. The Nublang population is highest in Chukha, Bumthang, Haa and Wangdue. With the continuous use of this breed for crossbreeding, pure stock of Nublang is becoming scarce due to inbreeding and degeneration.

Graph 2. Changes in Cattle Population



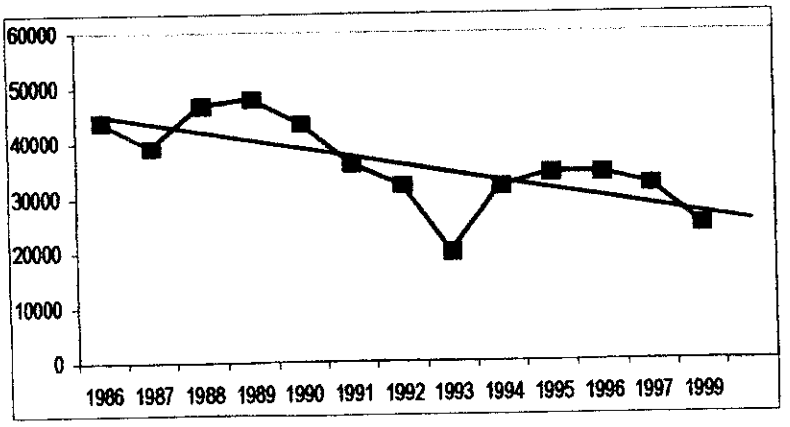
This breed is localized to conditions in the subtropical zone although it is prevalent from alpine to lower subtropical areas. It migrates to higher areas during summer and low-lying zone (warmer zones) in winter. It is known that these animals like the deciduous vegetation and warm climate where it produces best.

d). **Sheep**

Sheep (***Ovis aries***) rearing tracts of Bhutan are the temperate zones, above 1800 masl covering Wangdue, Bumthang, Tongsa and Trashigang where concentration is above 3 sheep per household. But otherwise they are mostly reared along with yaks. The local adult sheep of Bhutan (Tibetan type) has an average 65 cm height at withers, length 70 cm from shoulder point to pin bone, girth 75 - 100 cm and weighs 25 to 50 kg. The average wool yield in two shearing is 0.750 kg to 1.5 kg which is coarse.

The economic importance of sheep in the sheep rearing areas is only for wool and not for meat. It is however, very important for the mountain people as the wool is used for making yarn and clothing.

Graph 3. Changes in Sheep Population



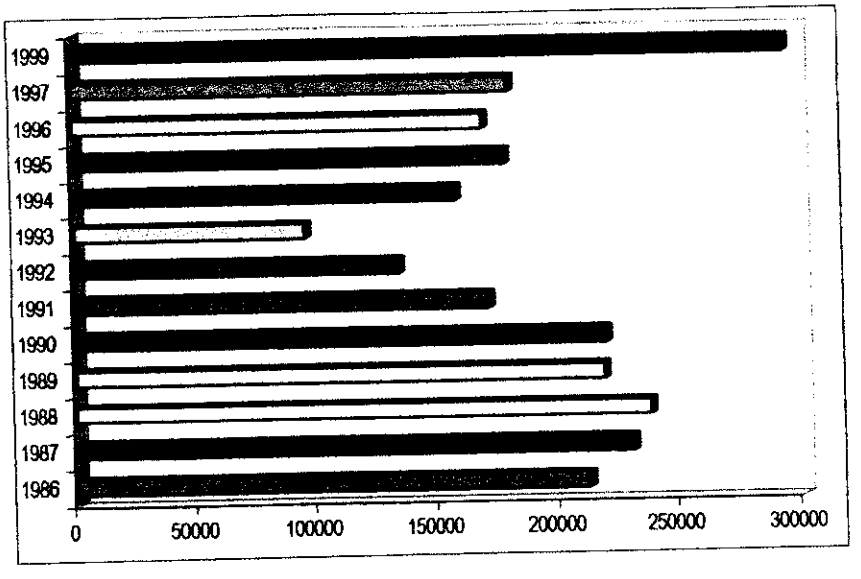
Local sheep, having coarse wool, is the most predominant among the farmers. Others are the crossbreeds of Merino and Comeback exotic breeds introduced for production of finer wool. The local ones are very good for Bhutanese terrain while the crossbreeds give good yields of lamb, wool and have bigger body size. The population of sheep in Bhutan was about 25000 in 1999. There is a dicresing trend in the population.

e). **Poultry**

Poultry (*Gallus domesticus*) keeping is very common among the permanent rural settlements. It is mostly kept for meeting the household demands of eggs, although it is also meant for chicken in some pockets of the country. Although many types of poultry birds are found in Bhutan (yet to be surveyed) the common type is the one with single and pea comb. These are of white, buff, red, spangled and striped colored types.

In addition to indigenous breeds (descendant of Red Jungle Fowl), in the past, two exotic breeds of poultry have been used in the country namely: Rhode Island Red (RIR) and White Leg Horn (WLH). In recent times commercial hybrid chicken have been used for egg production purpose in the country. The indigenous breed is good for scavenging and production, broody habits, and disease resistance. (The RIR is an exotic dual-purpose breed while the WLH is very good for egg laying).

Graph 4. Changes in Poultry Population



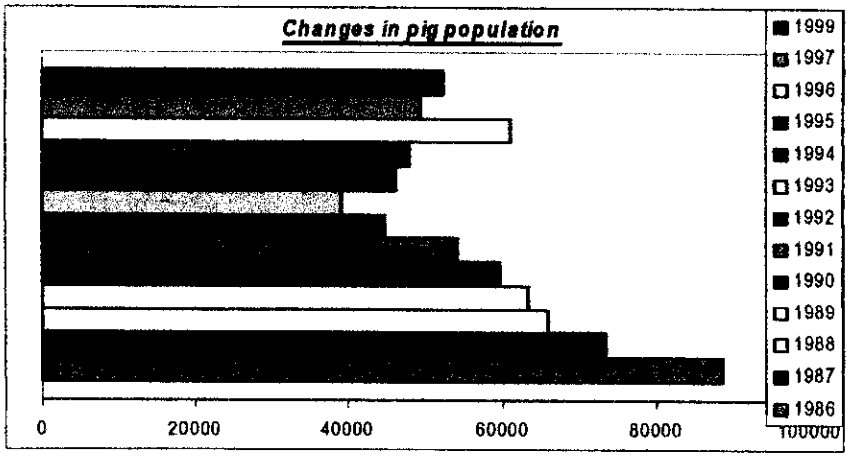
Poultry keeping are predominantly an integrated practice among the crop farmers. In Bhutan the highest relative density per household is in the districts of Chukha, Dagana, Tsirang, Zhemgang, Mongar and Lhuntse. The population of poultry has increased in recent years.

f). Pig

The pig is predominantly present in the central valleys of Phochu-Mochu, Western and Eastern Dzongkhags. In addition to local pig there are also crossbreeds of exotic breeds. Local breed is mostly left free to scavenge. It has tough skin, jaw and small tapering body with rough bristles.

The crossbreeds are mostly of Duroc breed, Landrace breed, Saddle back breed and Hampshire breeds. These are very high yielding animals in terms of piglet production, body size and breeding efficiency.

Graph 5. Changes in Pig Population



g) Horses

Horses play a very important role for transportation in areas where road transport is not available. The Dzongkhags of Gasa, Bumthang, Haa, Trashigang and Zhemgang have the highest density of horses. The local (Tibetan type) horse has been used to cross breed with the exotic Haflinger breed.

The popular Austrian breed, known for its higher load bearing capacity was supposed to be very good for higher altitude and difficult terrain. However it has been rendered unsuitable, and in the quest for suitable horse type for Bhutan, a new breed, Spiti is being tried at the moment.

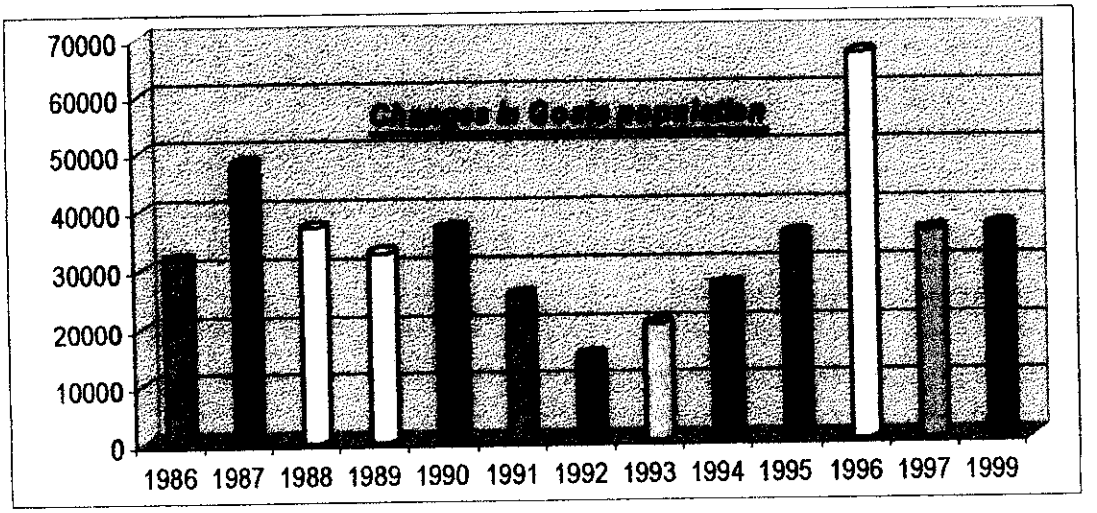
h). Dog

Dogs are the most common forms of domestic biodiversity. For the yak and sheepherders dogs are very important as they provide security and protection against wild animals. They are also significant from the point of disease transmission

i). Buffalo and Goat

Buffaloes are kept by the farmers for milk and draught purpose in the southern tracts of the country. Not much effort has been put to do any further work on this livestock, although it is believed that it is a descendant of the riverine type. Goats are also significant in terms of their use as meat. There is a considerable section of the community that depends on goat for emergency cash. Not much information is available on goats.

Graph 6. Changes in Goat Population



It is however believed that the type must be Black Bengal and Assam because of the contiguous landmass.

The following box shows the Genetic Diversity of Livestock.

Genetic Diversity of Livestock

Sub-breeds & inter-breeds of livestock

Yak(F) Langu	Y(F) X BS	Langu X YF	Mithun X Thrabam	**Yuta X Donkey**	**Local pig X Exotic**
Zo/ Zom	Zo/ Zom	Zomo	Jatsham/ Jatsha	Yuta X HF	Dogs Gokhi Xsakhi
Toimo/ Toila		Golengmo	Yangkum/ Yangka	Donkey X HF	Dogs Damkhi Xapsoo
Premo/ Prela		Bjomo	Dyobam// Dyob		
Gar		Koi/ Kyo	Dyothram// Dyothra or Drangbams (Thabamin & Thabazing)		
Chuk		Shingkyo			
		Taglangma			
			BS Jatsham/ Jatsha		
			Dyobam/ Jatsham		
			Dyothram/ Jatsham		
			Yangkum// Menchi		
			Nublang X Jersey or BS		

1.6. Threats to Bhutan's Biodiversity

1.6.1. Overview – Threats and Opportunities

In Bhutan, biodiversity is a matter of everyday necessity. All Bhutanese people, especially in the rural areas, depend on the biological resources in one way or the other on a daily basis. This interdependency is so strong that a breakdown in one link can create a chain of disorders with disastrous effects on human well being. Despite the RGOB's efforts directed to nature conservation, the on-ground situation is beset with problems. Threats to the ecological integrity of habitat and the species within them stem from several sources. Some of the main types of threats are

- Land Conversion causing habitat destruction and fragmentation, resulting in the loss of biomes, ecosystems and wildlife species which depend on the habitats particularly in the tropical and sub-tropical zones of the south and the temperate zones of the interior.
- Overexploitation causing habitat degradation and direct attrition or loss of plant and animal species.
- Competition/ Replacement by domestic and /or exotic species and varieties
- Brown sector activities, such as construction of roads, hydropower facilities, industries, urban infrastructure, mining, etc.

1.6.1.1. Threats at Local Level:

- ***Poaching*** of endangered species of plants and animals with high commercial values in the international market (e.g. musk deer, tiger, leopard). Easy money and high prices that are offered for these products of nature has triggered people to take up poaching. Poaching if not controlled can threaten the viability of the species and can have devastating effect on nature.

- ***Human/wildlife conflicts*** refer to damage of agricultural crops by wild animals such as wild boar, deer, and livestock depredation by tigers or leopards. While people are made environmentally conscious, their main source of livelihood is severely affected by their tolerance to wildlife. This leads to poisoning of wildlife, a change in attitudes and a backlash to conservation efforts.

Leopard trapped accidently in a trap set for Wild Boar at Ura, Bumthang

- ***Illegal exploitation*** of timber, non-timber forest products and fishing. Exploitation of these products for commercial purposes may lead to overexploitation.

- ***Overgrazing by livestock***, both in forest and pasture areas, mainly in broadleaf forest, may lead to attrition or loss of species, reduction of productivity and erosion. In forest areas overgrazing leads to loss of reproduction of plant species and vegetation changes.

- ***Unsustainable cropping practices and cropland expansion***, particularly deforestation and encroachment on steep slopes by tseri cultivation. This causes reduced forest areas and loss of biodiversity, and degradation of ecological services such as soil protection and erosion control.

- ***Forest fires***, which are mostly if not entirely caused by humans, and which may cause large scale degradation of forests.

1.6.1.2. Threats at Regional Level:

- ***Economic development projects*** such as road construction, transmission lines and large scale infrastructures, when not carried out in an environmentally friendly way, contribute to destruction and fragmentation of forests, particularly when these cut through protected areas. Economic projects may also causes pollution (e.g. of waters), threatening biodiversity These problems have increased during recent years due to increasing economic development.

- ***Increasing population pressure*** (by 2.5% per year) will lead to increasing pressure on scarce land and other biological values, both within and beyond protected areas. One underlying problem is that of land ownership and use patterns.

- ***Transboundary problems***, implying that users that undertake illegal exploitation of biological resources can freely move in and out of the country. This threat is most acute along the southern border, and involves mainly poaching of mammals and exploitation of medicinal plants. At the northern border yak herders crossing the border contribute to over-grazing, and intensive exploitation of medicinal plants.

- ***Inadequate return of benefits to local people*** e.g. benefits from tourism. While local stakeholders are mainly informed about the restrictions to resource use as a result of a protection status, they receive few or no tangible benefits.

- ***Inadequate environmental awareness***. Although the concept of conservation is embedded in Buddhist values, the essence of ecological integrity and the need to set aside areas for conservation purposes is not understood by the general public.

1.6.1.3. Threats at Institutional Level:

- ***Conflicting policies***, for instance those promoting conservation and those promoting agricultural or forestry development and exploitation of natural resources for economic objectives. This threat also is also related to poor co-ordination between Governmental departments, and inadequate authority of agencies promoting conservation. There is also a problem of overlapping jurisdiction in protected areas, e.g. between conservation and development objectives of dzongkhags.

- ***Weak law enforcement*** of existing legislation, partly due to lack of staff and partly due to inadequate or unclear legislation (e.g. how to deal with poachers). This threat is also related to the absence of clear zonation and boundary demarcation of protected areas, so that users do not know where the protected area is located and certain legislation is appropriate.

- ***Lack of adequate communication between the stakeholders***, e.g. inadequate communication and lack of transparency between the various sectors involved in conservation. As a result an integrated approach to conservation, as required in view of the multiple sectoral interests involved, will be difficult to put in place.

1.6.1.4. Opportunities

In line with the Bhutan 2020, it is important to emphasize that biodiversity and natural resources not only constitute a constraint to development, but first of all an opportunity. The following opportunities were defined and can be classified as ecological, economic, cultural and institutional opportunities[iii]

[iii] *There is a gradual distinction between potentials (as a general positive characteristic) and opportunities (as occurring more limited in time). Note that a potential that has always been there (e.g. rich biodiversity) may become an opportunity when it is being (internationally) recognised and valued.*

1.6.1.5. Ecological Opportunities

- ***The richness in biodiversity and its relatively intact current status*** represent a major opportunity for successful conservation. Bhutan has more than 72% of the country under forest cover, and most of the ecosystems are still relatively intact. Although a small country, the ecological variation is very high as the country's altitude ranges from 150 meters in the sub-tropic to more 7000 meters in the alpine north. An effective protected area system has been established comprising of all representative ecosystems in the country. These protected areas house many rare and endangered flora and fauna species. Surveys revealed that Bhutan is home to more than 700 bird species, 5500 species of vascular plants, 165 mammals, and new species are being discovered on a continuous basis. So while many countries are facing major challenges in trying to restore and reclaim natural areas Bhutan is in a better position of protecting and conserving its biological values.

- ***Internationally endangered species*** are strongly represented by Bhutan's fauna and flora.

1.6.1.6. Economic Opportunities (note that these economic opportunities may develop into threats if being exploited and developed in an unsustainable manner)

- ***Ecotourism and nature based tourism*** is becoming increasingly popular in the world due to changing perceptions within industrialized countries resulting in a growing demand. Bhutan with its relatively intact natural environment has a major potential to benefit from this growing market. The ecotourism incomes may be partly used to support conservation efforts.

- ***Non-timber forest products***, such as mushrooms, caterpillars, medicinal products, bamboos, local handicrafts, etc. constitute a growing market with increasingly good prices as worldwide scarcity increases. There is also a growing demand for ecological nature-based products, with fairly attractive prices mainly in industrialized countries. Bhutan's rich forests may provide a range of these non-timber forest products, with benefits to support conservation efforts through integrated conservation and development projects.

- ***Integrated conservation and development programme*** in Bhutan seem to show that conservation can be strengthened by promoting development for local communities (through services or concrete economic revenues). ICDP's have also contributed to establishing participatory planning approaches in Bhutan, which can be applied elsewhere.

- ***Bioprospecting*** is a growing endeavor that involves the search for new genes or chemicals of value. If carefully undertaken it may offer an opportunity for substantial economic benefits.

- ***Carbon trading*** may generate revenues for forests that remain intact, but these revenues will not be very substantial given the small size of the country.

- ***Hydropower*** has great potential in Bhutan. It constitutes an opportunity to reduce pressure on forests for firewood, provided that it also serves local communities in (often remote) areas within or nearby protected areas.

- ***Water resources*** are plentiful in Bhutan, and this represents a resource of growing economic value in Asia as a whole. The continuous availability and quality of water depends upon proper ecosystem management, and may therefore help promote conservation.

1.6.1.7. Cultural Opportunities

- ***The influence of religion*** is an opportunity since majority of people are Buddhist, a religion based on the principle of reverence for all life forms and a strong influence on the people towards

conservation. Whether still as prominent as in the past, this cultural heritage can be used as basis to maintain or revive environmental awareness.

- ***Growing environmental awareness*** is the result of environmental education, greater involvement of stakeholders in conservation issues at all levels, and through participatory planning and ICDP's. However, concrete benefits from conservation for people involved, or compensations for restricted use, will be required to strengthen and sustain this environmental awareness, if not a reversed trend may occur (see above).

- ***Low population pressure*** can be considered an opportunity, as it is at the basis of overall low pressure on biological values in Bhutan. This is accentuated by dynamics of out-migration from protected areas in certain parts of Bhutan, in spite of overall population growth. However, unless efforts to reduce the population growth rate are successful, this opportunity will become a serious threat.

1.6.1.8. Institutional Opportunities

- ***The existing legislation*** with respect to conservation provides a supportive basis for effective control and management of protected areas.

- ***Political support and commitment for conservation*** has been there ever since. The Royal Government of Bhutan has consistently emphasized the need to conserve the biological values for the benefit of present and future generations. Environmental protection is institutionalized in the planning process of all the agencies involved.

- ***Strong donor support for conservation*** is a consequence of Bhutan's relative richness in biological diversity. Bhutan is being looked upon by several countries as a model for conservation. The international conservation agencies have recognized Bhutan's rich biodiversity as being important for Bhutan as well as for the region and the world at large.

- ***Research opportunities*** are still plentiful given the rich biodiversity and the limited amount of research that has so far been conducted. Given the important numbers of new recent findings there are still plenty of opportunities. Research indirectly contributes to economic benefits.

1.6.2. Threats to Domestic Biodiversity – Plants

In Bhutan, specialized forms of crop production have evolved as a result of the country's geography and climate, but the production systems have been sustainable and capable of meeting most of the food needs. Bhutanese agriculture is essentially a family based farming system, where entire household members are involved. At the same time, there are a number of issues facing Bhutanese agriculture in the years ahead. Due to increase in population, particularly non-farming urban population, and the goal of attaining food self-sufficiency, traditional agricultural practices are yielding to new farming systems, crops and varieties most of which are alien to the country. Hence there is a concern on the erosion of the native plant genetic diversity. The population and animal pressure and the cropping of the marginal lands could lead to a degradation of rangelands causing the loss of useful plant germplasm. The increasing use of modern high yielding varieties results in the loss of landraces and folk varieties and leads to genetic erosion. The narrowing of the genetic base could pose greater risk of crop failures as witnessed elsewhere in the world.

In Bhutan, the importance of protecting traditional crops, wild relatives and wild collected forms of economic uses is just being realized. Conserving landraces has so far been a de facto investment by the traditional farmers under very diverse environmental conditions. The MOA's role has always been geared towards agriculture development through increased productivity, land use intensification and alleviation of biotic and abiotic stresses. In the process, high yielding varieties of many crop species have been introduced into the country. Many local crop and landraces are being replaced by these HYVS, and in extreme cases, traditional germplasms are so rare that they

are in danger of extinction. The general perception is why bother to maintain inferior material when better options are within reach. Traditional crop genetic resources are the products of generations of farmers' experience with informal research and experimentation taking into account the socio-economic, cultural and environmental concerns that influence their vocation. Therefore, they are well suited to the prevailing conditions and serve multiple purposes of fulfilling basic needs. Also, improved varieties coming out of the formal breeding systems originate from such locally developed landraces. Given the immense diversity in geophysical elements and the resulting agro-ecosystems in the country, these landraces hold great potential to contribute profitably to the national system of crop development.

1.6.3 Threats to Domestic Biodiversity – Livestock

The information gathered from the discussions across the country suggests that main threats for most of livestock species are deterioration of original breed due to non-systematic breeding and human habitation. Yaks and sheep, which mostly graze in the alpine pastures, are believed by some to compete with the wild animals like blue sheep, but the overgrazing in these areas is probably more due to patterns of domestic livestock grazing than any possible competition with wild species. There is also fragmentation of families and herds, which contribute to degradation of grazing land.

In the case of Mithun and Siri cattle, inbreeding and deterioration of breed seems to be very apparent. The two species are the basic genetic material for production of suitable animal for milk and draught. Mithun is not the native animal. Hence there should be a continual source of its supply. On the other hand Siri is the base genome for all the crossbreeding. Due to economic competition more and more farmers are going for cross bred or pure bred exotic breeds for higher production and thereby better income.

In the process of crossbreeding there is no selection and recording. As a result some of the quality traits of the local species and breeds are lost.

For sometimes to come, livestock has to depend upon forest grazing. The environmental conservation goal of the RGOB is however in contrast to this tradition. The restriction on forest grazing is therefore a threat to the development and maintenance of domestic animal diversirty.

In the case of pigs and poultry these are mostly reared in the lower valleys and agricultural belts. Some of the indigenous pig breeds have not yet been identified while some poultry breeds are feared to be extinct already. Farmers who choose pig breeds for fattening because of their ability to put fast weight normally take the exotic pig breeds. There are also no piggery development programs locally available.

Proximity of the habitat provides a threat to dilution of breeds because of the infiltration of animals from across the border.

1.7 The Urgency of Biodiversity Conservation, and the Need for Sustainable Development.

Bhutan is at crossroads, where development has accelerated and we are faced with many difficult issues with relation to development, and associated demographic changes. It is clear that Bhutan's conservation of biological diversity must become an integral component of economic development. Threats to the continued integrity of Bhutan's natural resource base are increasingly being felt from a variety of 'developmental' sources including construction of infrastructure, industrial expansion, increasing urbanization, and the growth of foreign tourism. In addition, Bhutan has to deal with the compromising land-use management practices that are an inevitable result of the steady increase in the country's population. Though Bhutan's population density is low, the constraining fact is that land available for cultivation in the country is very limited. Expansion of the agricultural sector is therefore limited.