

Plant Biodiversity and Its Conservation in Institute for Social and Economic Change (ISEC) Campus, Bangalore: A Case Study

Sunil Nautiyal

Centre for Ecological Economics and Natural Resources (CEENR), Institute for Social and Economic Change (ISEC), Dr V K R V Rao Road, Nagarabhavi, Bangalore 560 072, Karnataka, India

KEYWORDS Academic Institutions. Plant Biodiversity Conservation. Ecological Regions. Endangered Species. Landscape Development. *In-Situ* and *Ex-Situ* Conservation

ABSTRACT This study was undertaken to understand that how academic institutions could play a significant role in conserving biodiversity and this study is one of the preliminary efforts in this endeavor. Phytosociological study was carried out for enumeration of plant species on the ISEC campus. Geographical Information System (GIS) and satellite data were also used in developing the land cover maps of the ISEC at two points of time. ISEC campus is home to more than four hundred plant species belonging to 90 different families of the plant kingdom. Several threatened/vulnerable/endangered plant species such as *Santalum album*, *Leptadenia reticulata* and *Ficus benghalensis* var. *krishnae* are being conserved on the campus, and they exhibit a high degree of regeneration potential. This study has its own importance since the survival of numbers of species is in jeopardy. In this regard academic institutions could play a very significant role in conserving biodiversity with minimal effort which might support other institutions concerned with conservation and management of biodiversity. A study of this aspect has its own importance since the existing biodiversity is being lost at an alarming rate and scientists have reported that a significant number of species is expected to be lost in the next couple of decades. This paper discusses how a few additional efforts can save biodiversity and contribute to "promote innovative solutions to reduce threats to biodiversity", one of the objectives of International Year of Biodiversity (IYB) 2010.

INTRODUCTION

There are approximately 3,21,212 plant species on the planet earth comprising flowering plants (87 per cent), non-flowering plants (0.32 per cent), ferns (4.4 per cent), mosses (5 per cent) and red and green algae (3.3 per cent) (International Union for Conservation of Nature 'IUCN' online and IUCN Summary Statistics). As per a report, around 22 to 47 per cent of the world's plant species come under the endangered category (Graham 2002). Studies reported that about 13 per cent of global flora could be on the verge of extinction (Conservation International online; Graham 2002). Several studies indicate mass extinction of valuable species, as we have roughly altered half of the habitable surface of the earth besides impairing and destroying several ecosystems (Raven 1987; Myers 1990; Daily 1995; Singh 2002). However, some of the ecologically sensitive landscapes rich in bio-diversity and known as hotspots cover less than 2.5 per cent of the earth's surface. These biologically rich but most threatened places face extreme threats and have already lost at least 70 percent of its original natural vegetation (Conservation International online). Two such landscapes located in

India, viz., the Western Ghats and the Himalayas are responsible for India being recognised as one of the mega biodiversity countries of the world. These two biodiversity hotspots are home to nearly 16,000 plant species with the Western Ghats having 38 per cent and the Himalayas 62 per cent. About 2.1 per cent of the global plant species is endemic in these two hotspots (Conservation International online). In the present context, the biggest challenge is to conserve plant biodiversity which is threatened by various anthropogenic factors like burgeoning population, over-exploitation to meet the growing demands of various pharmaceutical and aroma-chemical industries in India. Apart from the facts mentioned above, in India, about 200,000 villages are classified as forest villages (Kumar 2006), and hence, the dependence of these communities on forest based resources is very high; a majority of the villages are home to various tribal groups and communities who have been experiencing social, economic and environmental stress and resource constraints because of a variety of factors. Therefore, there is a need to provide opportunities for these people living in harmony with nature to protect the forests they inhabit and simultaneously improve their economy.

Existing Approaches to Biodiversity Conservation

The Government of India, through various timely policy interventions, has been striving hard to conserve the valuable plant biodiversity both *in situ* and *ex situ*. The examples of *in situ* conservation include creation of protected areas as mentioned in IUCN categories (IUCN online) I-IV viz., Strict Nature Reserve: protected area managed mainly for scientific purpose; Wilderness Area: protected area managed mainly for wilderness protection; National Park: protected area managed mainly for ecosystem protection and recreation; Natural Monument: protected area managed mainly for conservation of specific natural features; Habitat/Species Management Area: protected area managed mainly for conservation through management intervention; Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation; Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems (Badman and Bomhard 2008). The IUCN reported 12 per cent of the planet's land surface as protected area, a drastic increase compared to 1962 when only 3 per cent of the earth surface had been estimated as protected landscape (IUCN 2005). Of the world's total protected area, the developing world accounts for 60 per cent (Equatorinitiative online). provides the basis for designing and developing strategies for ensuring the future sustainability of landscapes (Mander and Jongman 1998; Schmidt-Vogt 1998; Roberts et al. 2002). Sustainable landscape development is a crucial issue the world over and a debate is still going on with regard to the approach to be adopted for conservation, that is, a non-segregated or segregated approach. A non-segregated approach towards conservation refers to farm households and individual and common resources that are under integrated land management. In the current context, it can be defined as the landscape without a nature conservation programme. It means that the landscapes do not come under the IUCN category. However, a segregated approach addresses the multiple functions of land resources such as demarcation of areas for conservation, utilisation, preservation and development. In the current context, the IUCN categories of landscape management are implemented but due to complex human and

ecosystem interactions in the developing countries, the segregated landscape approach has failed to bear the desired results (Nautiyal and Kaechele 2007).

On the other hand, establishing botanical and zoological gardens are examples of *ex situ* conservation of biodiversity. Although the *ex situ* conservation has been successful in more often than not, huge economic resources are required to maintain the process.

Basic differences between *in situ* and *ex situ* conservation strategies are given in Table 1.

Genesis of Current Research: Institutional Efforts in Conserving Biodiversity

Although there are some limitations with regard to both the conservation approaches, in view of conserving our valuable biodiversity, we need both the approaches for future sustainability. However, in the meantime, there is a great need for promoting conservation programmes in the academic institutions on India. Indian institutions contributing significantly to conservation and management of valuable biodiversity, have yet gained enough attention. Academic institutions with vast areas can effectively involve themselves in conserving and regenerating the biodiversity of the regions in which they are located. The average area available with academic institutions across the country ranges from 20 - 250 hectares. This is calculated based on the average area available with major and middle level institutions in each State. Thus, we can use some portion of such land out for conservation and management of valuable plant bio-diversity. In this context, a study was undertaken recently at the Institute for Social and Economic Change (ISEC), Bangalore, on the inventorisation of the existing plant bio-diversity (Fig. 1).

METHODOLOGY

The phytosociological study was carried out following the standard method (Cottam and Curtis 1956; Ralhan et al. 1982; Saxena and Singh 1982; Nayak et al. 2000; Lu et al. 2004).

The framework of methodology is given in Figure 2.

The geographical information of the study area was also recorded through the Global Positioning System (GPS) in respect of sample plots drawn randomly at the institute. Plant density was calculated using the following formula.

Table 1: *In situ* and *Ex situ* conservation approach

S. No.	<i>In situ</i> conservation	<i>Ex situ</i> conservation
1	On site conservation	Off-site conservation
2	Conserves biodiversity in the natural habitats thus promoting a natural evolutionary process	Conserve biodiversity outside the natural habitats of species
3	<i>In situ</i> conservation maintains not only a wide range of genetic diversity but also the evolutionary interactions that allow for adaptation continually to the shifting environmental conditions, such as changes in pest populations or climate.	It is the process of protecting an endangered species (plant or animal) outside of its natural habitat; for example, removing part of the population from a threatened habitat and placing it in a new location, which may be a wild area or within the care of humans. The result is that the natural evolutionary process cannot be as strong as in case of <i>in situ</i> conservation.
4	Requires limited resources, but needs a strong policy perspective	More expensive to maintain and thus should be regarded as complementary to <i>in situ</i> conservation methods.
5	<i>In situ</i> conservation takes place in the natural habitats of species (plant/ animal) and thus, in many cases, creates conflicts in the context of peoples' livelihood strategies in the same region.	<i>Ex situ</i> conservation takes place outside of natural habitats and hence does not involve sharing of natural resource with humans. <i>Ex situ</i> conservation could be the only option where <i>in situ</i> conservation is no longer possible.
6	In the developing countries, the debate concerns what should be the spatial extent of <i>in situ</i> conservation. Examples of <i>in situ</i> conservation are: Strict Nature Reserve: protected area managed mainly for scientific purposes; Wilderness Area: protected area managed mainly for wilderness protection; National Park: protected area managed mainly for ecosystem protection and recreation; Natural Monument: protected area managed mainly for conservation of specific natural features; Habitat/Species Management Area: protected area managed	Requires huge energy and monetary resources. In the context of natural disasters, <i>ex situ</i> conservation might play an important role in the regeneration of species. The main role of <i>ex situ</i> means of conservation is to create awareness and educate human beings. There are emergent threats to various sensitive ecosystems such as mountains, alpine, Himalayan ecosystems, Western Ghats, coastal region, fresh water ecosystem due to variety of driving forces such as burgeoning population, pollution, increased concentrations of CO ₂ , climate change etc. The

Table 1: Contd.....

S. No.	<i>In situ</i> conservation	<i>Ex situ</i> conservation
	mainly for conservation through management intervention; Protected Landscape/Seascape: protected area managed mainly for landscape/ seascape conservation and recreation; Managed Resource Protected Area (IUCN 2008)	survival of many species (plant/ animal) is in jeopardy. Thus such circumstances emphasize the role of <i>ex situ</i> methods in conservation, regeneration and breeding programmes of various species. The examples of <i>ex situ</i> conservations are gene banks, botanical gardens, zoological gardens.
	Protected area network, corridors to link fragmented landscapes such as habitats of species etc.	Establishment of botanical gardens, zoological gardens, conservation stands, gene banks, tissue culture etc.

$$d = \frac{xn}{N}$$

d= Density

xn = Total number of individual species in all quadrats

N= Total number of quadrats studied

Satellite imagery was also used for developing the land cover map of the campus over two points of time. This aspect was undertaken after the vegetation structure of the area was studied. The cloud-free satellite data for ISEC was rectified. Image rectification was completed using the ENVI image to map registration method with the help of a toposheet 1:50,000. The ETM+imagery of ISEC was selected as a base map of the study area. Once the coefficients for the equations were determined, the distorted image co-ordinates for map positioning were precisely estimated, in terms of a mathematical notation (Lillesand et al. 2004). The average land area available with academic institutions in India was calculated based on the information from big, medium and small institutions available on internet in all the states of the country and computed country-wise. The information was obtained from secondary sources and from the institution's webpage.

RESULTS

A. Plant-Biodiversity of ISEC Campus

Situated on 16 hectares of land on the outskirts of Bangalore City, ISEC is home to more than 400 plant species. About 320 species have

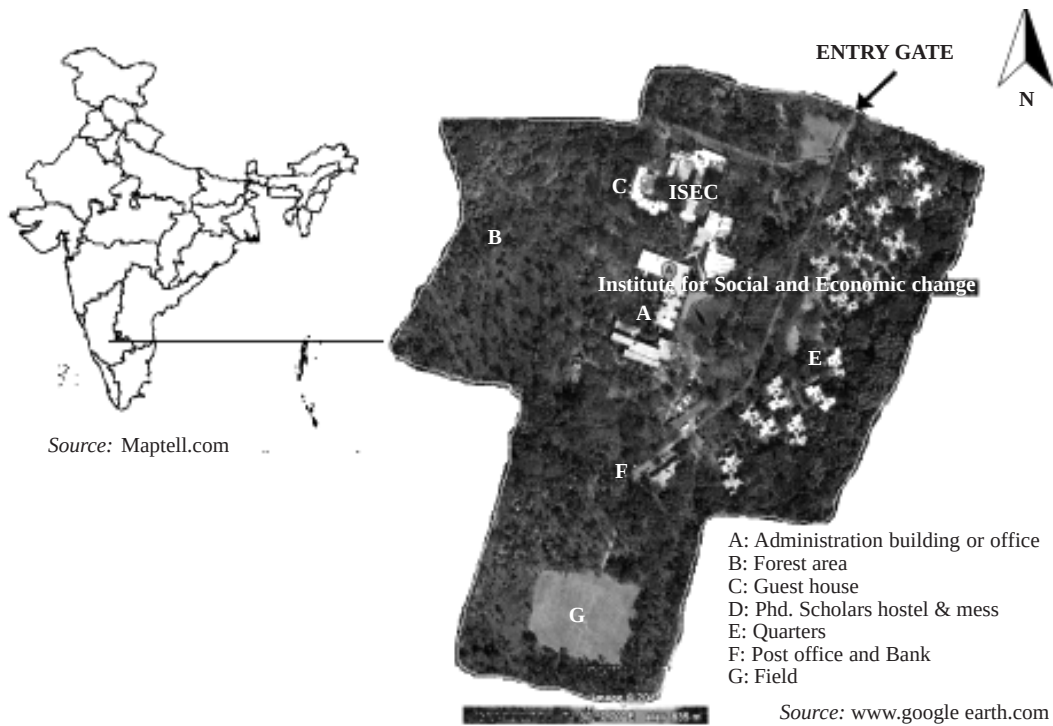


Fig. 1. Institute for Social and Economic Change (I S E C) Campus (www.isec.ac.in)

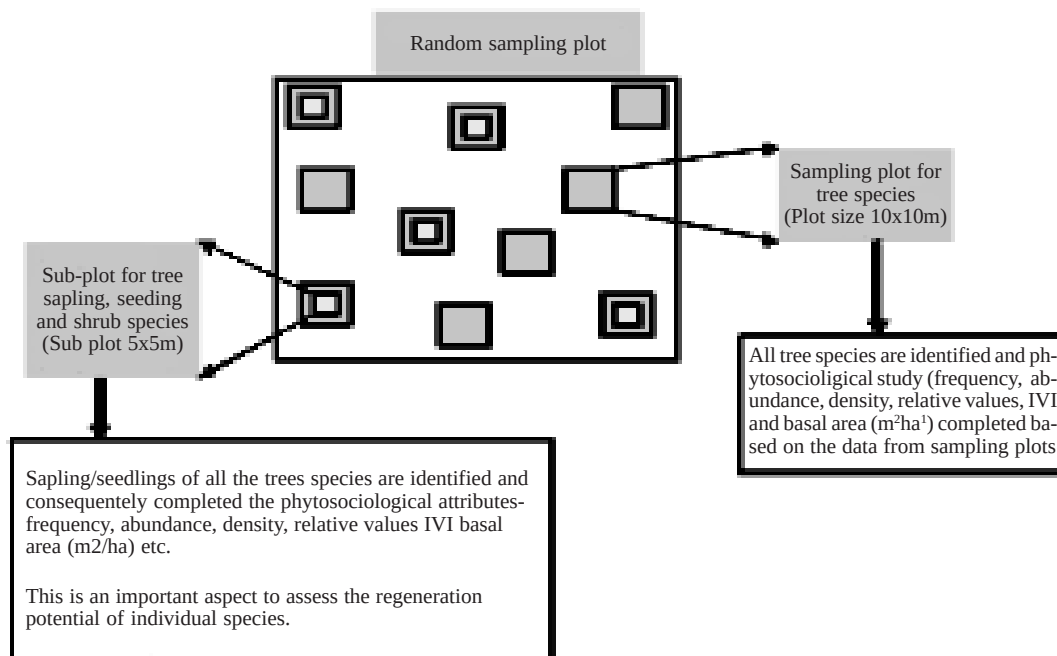


Fig. 2. Framework (standard method in phytosociology) for data collection

been identified comprising 94 trees, 97 shrubs, 69 herbs, 26 creepers and 34 grass varieties (Fig. 3). The flora of ISEC belongs to 90 different families of the plant kingdom with a majority of species belonging to Euphorbiaceae (26 per cent), followed by Poaceae (21 per cent), Asteraceae (13 per cent), Bignoniaceae (8 per cent), Verbinaceae (7 per cent), Apocynaceae, Caesalpiniaceae, Acanthaceae (6 per cent each) and many others. A listing of tree, shrub and herb species is given in Annexure I. Several endangered plant species viz., *Santalum album*, *Leptadenia reticulata*, *Ficus benghalensis* var. *krishnae* species are being conserved on the campus and they exhibit a high degree of regeneration potential. The density in 50m x 50m transect of some important species along with regeneration pattern is given in Figure 4. The economically important species such as *Santalum album* exhibits a very good regeneration pattern and so do other species. As *Santalum album* is highly exploited from the forests for its aroma property and has a huge economic potential. ISEC has created a very good micro-climatic environment for conservation and regeneration of this species. Figure 4 shows the density and regeneration potential of the important tree species at ISEC. The *Santalum album* tree (16), saplings (13) and seedlings (23) showed good density followed by *Acacia leucophloea*, *Pongamia pinnata*, *Phoenix sylvestris* and *Azadirachta indica*. The *Santalum album* (Shree-gandha or chandana) species has been utilised, cultivated and traded for many years, with some cultures placing a great significance on its fragrant and medicinal qualities. For these reasons, it has been extensively exploited, to the point where the wild population is vulnerable to extinction. *Santalum album* is vulnerable as per the IUCN Red List of Threatened Species. It still commands high prices for its essential oil, but due to lack of sizable number of trees, it is no longer used as extensively as before. The plant is widely cultivated and lasts long, although harvest is viable after 40 years. Data shows that ISEC acts as a natural laboratory for *Santalum album*. Likewise, other institutions can also conserve some of the important species of the regions in which they are located. For a glimpse, a land cover map of ISEC over two points of time, that is, 1973 and 2009, is presented in Figure 5a and 5b, respectively. In this classification, Landsat data (TM and ETM) was used. However, the species-wise classifica-

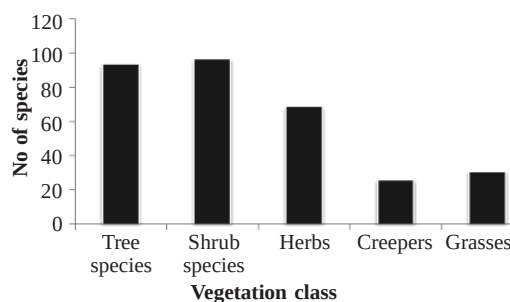


Fig. 3. No of species under different vegetation strata in ISEC Campus

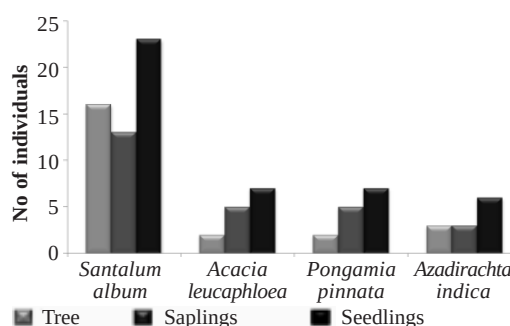


Fig. 4. Density of important tree species on ISEC campus and their regeneration pattern

tion requires high-resolution data (that is, ASTER or QuickBird, LISS-IV). The land cover map of ISEC shows that about three decades ago, the entire land was bare with a small patch under shrubs and a few scattered tree species. However, the Landsat ETM data of 2009 shows the maximum extent of land covered by primary vegetation layer (tree vegetation), followed by land under herbaceous vegetation. ISEC campus is one of the best maintained campuses in Bangalore city.

B. Academic Institutions' Approach to Plant-Biodiversity Conservation

As mentioned in the previous section of the article, the average land area available with academic institutions in India works out to 20 - 250 hectares. If some portion of this land area is planted with threatened/vulnerable/endangered species suited to the ecological zone, then each academic institution will play a significant role in conserving plant-biodiversity. The Planning Commission has demarcated the geographical area of India into 15 agro-climatic regions (<http://www.krishisewa.com/krishi/Azone.html>)

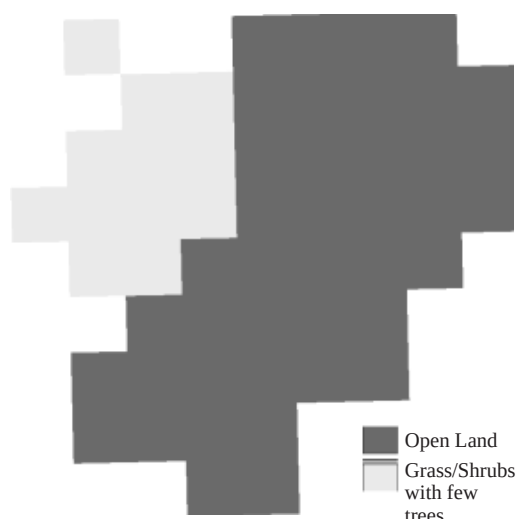


Fig. 5a. ISEC Campus during 1973

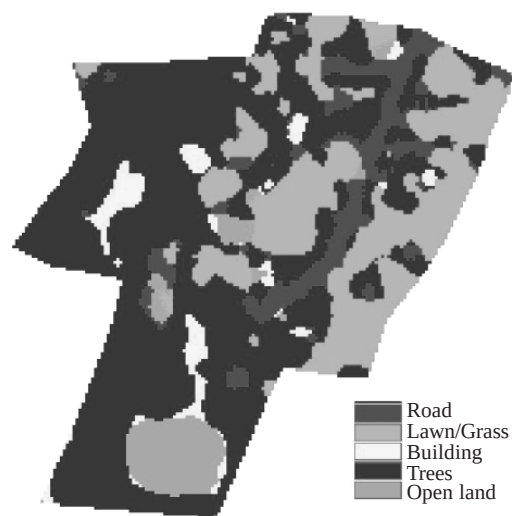


Fig. 5b. ISEC Campus during 2009

viz., 1. Western Himalayan Region: Jammu and Kashmir, Himachal Pradesh, Uttarakhand; 2. Eastern Himalayan Region: Assam, Sikkim, West Bengal and all North-Eastern states; 3. Lower Gangetic Plains Region: West Bengal; 4. Middle Gangetic Plains Region: Uttar Pradesh, Bihar; 5. Upper Gangetic Plains Region: Uttar Pradesh; 6. Trans-Gangetic Plains Region: Punjab, Haryana, Delhi and Rajasthan; 7. Eastern Plateau and Hills Region: Maharashtra, Uttar Pradesh, Orissa and West Bengal; 8. Central Plateau and Hills Region: Madhya Pradesh,

Rajasthan, Uttar Pradesh; 9. Western Plateau and Hills Region: Maharashtra, Madhya Pradesh and Rajasthan; 10. Southern Plateau and Hills Region: Andhra Pradesh, Karnataka, Tamil Nadu; 11. East Coast Plains and Hills Region: Orissa, Andhra Pradesh, Tamil Nadu and Pondicherry; 12. West Coast Plains and Ghat Region: Tamil Nadu, Kerala, Goa, Karnataka, Maharashtra; 13. Gujarat Plains and Hills Region: Gujarat; 14. Western Dry Region: Rajasthan; 15. The Island Regions: Andaman and Nicobar, Lakshadweep (Fig. 6).

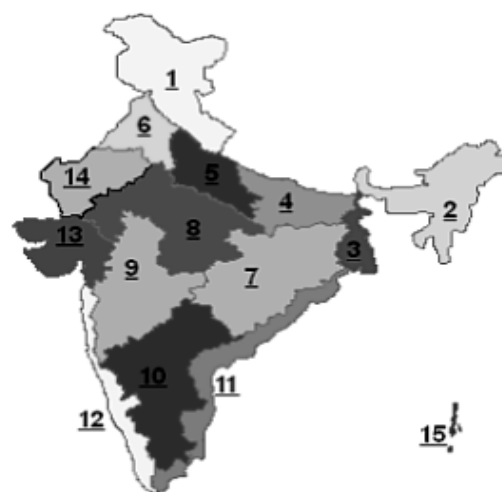


Fig. 6. Agro-ecological zones of India

Source: <http://www.nrcaf.ernet.in/aicrpaf/images/zones.png>.

1. Western Himalayan Region
2. Eastern Himalayan Region
3. Lower Gangetic Plains Region
4. Middle Gangetic Plains Region
5. Upper Gangetic Plains Region
6. Trans-Gangetic Plains Region
7. Eastern Plateau and Hills Region
8. Central Plateau and Hills Region
9. Western Plateau and Hills Region
10. Southern Plateau and Hills Region
11. East Coast Plains and Hills Region
12. West Coast Plains and Ghat Region
13. Gujarat Plains and Hills Region
14. Western Dry Region, and
15. The Islands Region

These agro-ecological regions in India harbour different kinds of plant biodiversity. Many endangered, rare, threatened plant species listed in the red data book are found in each agro-ecological region of the country. The important plant species of each agro-ecological region as re-

corded in the red data book are given in Table 2 (IUCN online accessed for the purpose of this study during 2009 and 2010). However, so far, very limited information is available with regard to the role of academic institutions in terms of conserving plant-biodiversity. Therefore, there is a need to think of utilising the available space in the academic institutions to save our earth's biodiversity. Apart from *in situ* and *ex situ* conservation, academic institutions could prioritise a few (as 4-5 species) of them for conservation through conventional and non-conventional methods for further multiplication in their natural habitats and at the field level improve the livelihoods of farmers, if they are found to have a high economic potential. In this effort, the respective State forest departments could collaborate with the academic institutions in the purchase of seedlings for further activities related to environmental conservation. IUCN data-base was surveyed extensively and species listed in red data book of all the 15 agro-ecological regions of India thus presented in Table 2 (please see IUCN online).

DISCUSSION

The year, 2010, was declared as the International Year of Biodiversity (IYB) by the United Nations. Biodiversity relates to the variety of life forms essential for sustaining the natural living systems or ecosystems that provide us with food, fuel, health, wealth and other vital services. Humans are part of this biodiversity too with the potential to protect or destroy it. Currently, our activities are destroying the biodiversity structure at alarming rates. These losses are irreversible and impoverish us all besides damaging the life support systems we heavily rely on. However, we can prevent it. We need to reflect on our activities and focus on the daunting challenges lying ahead to safeguard the biodiversity. Now is the time to act. Biodiversity is central to our very existence (Natural History Museum online). Worldwide, there are 34 natural laboratories harbouring rich biodiversity – 'hotspots' which cover less than 2.5 per cent of the earth's surface but provide habitat for 90 per cent of the world's biodiversity. These hotspots also support about 20 per cent of the world's population, which is growing certainly at rates higher than the world's average growth rate of population (Conservation International online). Efforts made for

conservation of valuable biodiversity can be traced back to 1875 when the Yellow Stone National Park was established in the United States of America (USA) for *in situ* conservation. Since then, several thousand million hectares of land across the world has been allotted for *in situ* conservation of biodiversity. In India alone, significant land cover has been segregated for protecting our natural landscapes. However, *ex situ* conservation approach was started much earlier than *in situ* conservation, almost dating back to the mid-Nineteenth Century when some great explorers started collecting information on plant biodiversity. Cohen et al. (1991:867-868) have discussed the eras of *ex situ* conservation efforts and development. At present, we are in the phase of 'more efficient use of biodiversity', that is the fourth phase of *ex situ* conservation. In the mid-eighteenth century (1850) *ex situ* conservation was started (first phase) and it extended up to 1950, during which utility was tested under the main theme of plant exploration and introduction. The second phase (1950-1980) was that of conservation, during which the wide spectrum of biodiversity was conserved based on utilisation. In the third phase, more emphasis was placed on international links of plant-biodiversity, long term viability and regeneration of old collections and researching wider gene pools. At present, greater emphasis is placed on efficient utilisation through advanced breeding programmes. Conservation along with biotechnology is increasing and more efficient networks are being established through several international bodies such as the Food and Agricultural Organisation (FAO), the Consultative Group on International Agricultural Research (CGIAR) and the International Board for Plant Genetic Resources (IBPGR) (now International Plant Genetic Resources Institute - IPGRI), etc. (For more details see Cohen et al. 1991). India has made significant strides during this phase of *ex-situ* conservation efforts and India's gene bank is one of the biggest in the world. By contributing over 16,000 varieties of rice, India is the biggest contributor to the rice biodiversity bank (Times of India 2010, 6 April).

These two direct approaches, which are more than a century old, have contributed significantly to the conservation efforts across the entire globe. *In situ* programmes are mostly active in biodiversity hotspots and harbour 90 per cent of life on earth. It means that high diversity could

	Plant species	Agro-ecological regions of India														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Acer hookeri Miq...			✓												
2	Acer oblongum Wall. ex Dc.	✓														
3	Acer osmastonii Gamble	✓		✓												
4	Aconitum deinorrhizum Stapf	✓														
5	Aconitum ferox Wall. Ex Seringe		✓													
6	Aconitum balfourii Stapf	✓														
7	Aconitum falconeri Stapf.	✓														
8	Acorus calamus L.		✓	✓			✓					✓	✓			✓
9	Aegle marmelos (L.) Correa Ex. Schultz				✓	✓		✓	✓	✓				✓	✓	
10	Andrographis paniculata Burm.f.Wallich Ex Nees				✓	✓		✓				✓				
11	Angelica glauca Edgew.	✓														
12	Anogeissus pendula Edgew														✓	
13	Aphyllorchis gollani Duthie		✓													
14	Aquilaria malaccensis Lam.,		✓													
15	Arenaria curvifolia Majumdar	✓														
16	Arenaria ferruginea Sieber ex Spreng	✓														
17	Arnebia benthamii Wall. Ex G.Don Johnston	✓														
18	Atropa acuminata Royle Ex Lindl.	✓														
19	Begonia scutata Wall.			✓												
20	Berberis affinis G.Don	✓														
21	Berberis asiatica Roxb.	✓														
22	Blumea bovei Vatke													✓		
23	Boesenbergia siphonantha Baker M Sabu, Prasanth Kumar & J Skornickova															✓
24	Boswellia ovalifoliolata Balakr. & A.N.Henry.											✓				
25	Bulleyia yunnanensis Schlechter			✓												
26	Butea monosperma var. lutea, Lam. Taub											✓				
27	Calanthe pachystalix Reichb.f.ex Hook.f.	✓														
28	Calygoum polygonoides														✓	
29	Campylanthus ramosissimus Wight												✓			
30	Ceropegia andamanica P.V.Sreekumar, K.Veenakumari & M.Prashanth															✓
31	Ceropegia lawii Hook.f.							✓								
33	Ceropegia mahabalei Hemadri & M.Y.Ansari							✓		✓						
34	Ceropegia odorata Nimmo							✓		✓						
35	Ceropegia panchganiensis Blatter & McCann							✓		✓						
36	Chonemorpha fragrans Moon Alston															✓
37	Cissus spectabilis Hochst.ex Planch.			✓												
38	Cleome gynandra L.														✓	
39	Codonopsis affinis Hook.			✓												
40	Commiphora wightii (Arn.) Bhandari														✓	
41	Corallocarpus conocarpus Benth. & Hook.f.												✓			
42	Costus speciosus Sm.				✓											
43	Cryptocoryne tortuosa Blatter & McCann							✓								
44</																

	Plant species	Agro-ecological regions of India														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
61	<i>Flickingeria hesperis</i> G.Seidenfaden					✓										
62	<i>Frerea indica</i> Dalz.							✓		✓						
63	<i>Fritillaria roylei</i> Hook.	✓							✓							
64	<i>Gentiana kurroo</i> Royle.					✓										
65	<i>Gloriosa superba</i> L				✓	✓		✓	✓	✓				✓	✓	
66	<i>Hedychium spicatum</i> Buch.-Ham.	✓														
67	<i>Hildegardia populfoli</i> Roxb. Schott & Endl.											✓				
68	<i>Hornstaedtia fenzi</i> Kurz K. Schum.															✓
69	<i>Janakia arayalpathra</i> Joseph & Chandrasekaran										✓					
70	<i>Korthalsia rogersii</i> Becc.															✓
71	<i>Lactuca filicina</i> Duthie ex Stebbins	✓														
72	<i>Leptadenia reticulata</i> Retz. Wight. & Arn.						✓								✓	
73	<i>Limonium stocksii</i> Kuntze													✓		
74	<i>Luvunga scandens</i> Blume Kurz.		✓													
75	<i>Macaranga nicobarica</i> N.P.Balakrishnan & P.Chakraborty															✓
76	<i>Mappia foetida</i> Miers.			✓												
77	<i>Meconopsis aculeata</i> Royle								✓							
78	<i>Mitragyna parvifolia</i> Roxb. Korth.						✓									
79	<i>Mitragyna parvifolia</i> Korth.														✓	
80	<i>Myristica andamanica</i> Hook.f.															✓
81	<i>Nardostachys jatamansi</i> Dc.	✓														✓
82	<i>Neonauclea gageana</i> Merrill															✓
83	<i>Nepenthes khasiana</i> KH.F.		✓													
84	<i>Nervilia aragoana</i> Gaud.											✓				
85	<i>Oianthus deccanensis</i> Talb							✓								
86	<i>Ophiorrhiza lurida</i> Hook.f.			✓												
87	<i>Panax pseudoginseng</i> Wall.		✓			✓										
88	<i>Pavonia ceratocarpa</i> Dalz.ex Mast.														✓	
89	<i>Phoenix rupicola</i> T.Anders.			✓												
90	<i>Phyllanthus indofischeri</i> S.S.R.Bennet											✓				
91	<i>Picrorrhiza kurroa</i> Royle Ex Benth	✓														
92	<i>Pimpinella tirupatiensis</i> Bal & Sub											✓				
93	<i>Pimpinella tongloensis</i> P.K.Mukherjee			✓												
94	<i>Piper longum</i> L.		✓	✓	✓			✓		✓	✓	✓	✓	✓		
95	<i>Piper barberi</i> Gamble.												✓			
96	<i>Podophyllum hexandrum</i> Royle	✓														
97	<i>Polygonatum verticillatum</i> L. All.					✓										
98	<i>Przewalskia tangutica</i> Maxim.		✓													
99	<i>Pterocarpus santalinus</i> L.f.											✓				
100	<i>Pterocarpus santalinus</i> L.f.											✓				
101	<i>Pueraria tuberosa</i>															

Table 2: Contd.....

	Plant species	Agro-ecological regions of India														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
122	<i>Tribulus rajasthanensis</i> M.M.Bhandari & V.S.Sharma													√	√	
123	<i>Trichopus zeylanicus</i> Gaertn.												√			
124	<i>Urginea indica</i> Kunth				√											
125	<i>Urginea nagarjunae</i> K.Hemadri & Swahari Sasibhushan											√				
126	<i>Withania coagulans</i> Dun.						√								√	

be maintained in small areas of natural systems. Based on these facts, we can say that academic institutions can play an important role in conserving a significant number of plant species. A study of the flora at ISEC (*All-India Institute for Interdisciplinary Research and Training in the Social Sciences*) is an example of conserving biodiversity across academic institutions. Recently, a study was carried out for inveterisation of plant species in one of the top institutions in India, namely the Indian Institute of Science (IISc) — the vast campus contains more than 800 species of plants, including many indigenous and exotic species (Times of India August 4, 2009). However, very limited work has been done on the inventorisation and potential of academic institutions to provide habitat for important plant species whose survival is in jeopardy. Although significant work has been carried out on *in situ* and *ex situ* conservation, both have their own pros and cons.

As for *in situ* conservation, in a majority of cases, it results in conflicts between local people and the government over the utilization and preservation of resources, if the conservation and community development objectives are inconsistent. This has been creating hurdles in achieving the desired goals. Policy-makers and decision-takers have recognized the importance of biodiversity (flora and fauna) and this has resulted in the segregation (in the form of protected areas) of rich and diverse landscapes for biodiversity conservation. An approach that leads to the conservation of biological diversity is good, but such an approach should also address the concerns of human beings equally because human beings have been residing in areas rich in biodiversity since time immemorial (Hjortso et al. 2006). The experience of top-down conservation programmes in the last three to four decades has been found responsible for the breaking down of local community-nature relationship particularly in the developing countries. It

has increased the hostility of the local people towards conservation/management programmes (Ramakrishnan 2000; Khadka and Nepal 2010). Unfortunately, in some cases, the local livelihoods (mostly of indigenous tribes) in the bio-diverse rich areas have received several setbacks due to the implementation of various conservation policies, though unintentionally. Apart from that, the ecological perspective of such programmes and time series satellite data relating to some of the protected areas show that the temporal pattern of the ecosystem processes has been changing because of the flawed approach and framework of the current policies with respect to hotspots due to change in vegetation dynamics. An integrated approach for ecosystem conservation and strengthening of local institutions for ensuring sustainable ecosystem management in such areas has been brought out by many studies (Ramphal 1993; Colchester 1997; Maikhuri et al. 2001; Hjortso et al. 2006; Caro and Scholte 2007).

Ex situ conservation also plays an important role in the conservation and preservation of biodiversity, but requires huge financial resources. With regard to conservation in natural habitats and conserving biodiversity outside natural habitats excluding zoological and botanical gardens and gene banks, very limited effort has been made to conserve biodiversity by academic institutions.

Academic institutions could play a very crucial role in conserving valuable biodiversity in several ways and that too with minimum financial support. Action oriented research that includes inventorization of the biodiversity, economic valuation, selection of ecologically valuable and economically useful plants for domestication, documentation of TEK (Traditional Ecological Knowledge), demonstration models for medicinal and aromatic plants (herbs, shrubs, trees), germination experiments with regard to various species and workshops for stakeholders

for creating awareness in each region will ensure better conservation and management of valuable plant biodiversity. ISEC also has been conserving some of the threatened and endangered species listed in Table 2. Academic institutions should play a major role in conserving species diversity as many of the species are fast vanishing because of the rapid depletion of the forest cover. Over the last century, erosion of biodiversity has been increasingly observed. Studies show that 30 per cent of all the natural species face extinction by 2050. Of these, about one-eighth of the known plant species are threatened with irreversible extinction. Some research findings report that each year species loss would go up 140,000 (based on Species-area theory) and the researchers working on biodiversity acknowledge that the rate of species loss is several times higher at present than at any point of time in human history (Globaltopia). Various factors are responsible for such a development and climate change is one of the major drivers for the same. Academic institutions should propagate herbal plants. It should also be cultivated on a large scale as main cash crops on agricultural lands. However, shrubs and tree species should be raised on the margins of agricultural fields for the development of agro-forestry models.

At the outset, our main focus should be on raising seedlings of selected plant species (trees, shrubs or herbs). The experimental research in the Master's degree course and Master of Philosophy course of the science discipline should be encouraged for developing farmer-friendly (rural-biotechnology) and cost-effective technologies to raise seedlings on experimental plots. This should be directly linked to the forest department, which should purchase seedlings for wider multiplication. Along with seedlings a 'brochure' on the process, cultivation, economic and ecological use of each plant (written in local language or regional languages), should be distributed to the interested people/farmers. This will help people grow the species of their choice and they will get monetary benefits by selling seedlings to other interested farmers of the region from the very beginning phase. Consequently, the other people/farmers would be influenced to undertake cultivation of ecologically valuable and economically useful species on their main lands. In this innovation, the participation of students and scientists of the study region will be of great importance. They will help educate people in

bringing/domesticating species of socio-ecological importance in their land. This approach will be of importance in community and degraded land rehabilitation programmes. Both scientific and traditional ecological knowledge bases related to various medicinal and aromatic plants should be taken into consideration while developing suitable rural agro-biotechnologies that will improve the livelihood options of the people in different ecological regions and also conserve biodiversity. Scientific and technological developments over the last 7-8 decades have significantly improved the life and livelihoods of a majority of the people worldwide. But many of the benefits of advanced development have not been produced the desired results because of the growing human population. Therefore, the diversity and abundance of many other plant species diminishes year after year. What happens to our biodiversity, to us and the creatures we share the world with in future depends on the actions that we take now (May 2002). Therefore, it would be very encouraging if we utilise the space available with academic institutions for biodiversity conservation. If our approach develops in a similar way, then the stakeholders will be interested and willing to pay for learning lessons on conserving of mother earth's valuable resources on private premises for future generations.

CONCLUSION

The study on plant bio-diversity on ISEC campus reveals that academic institutions could play a significant role in the conservation of biodiversity. ISEC has provided a favorable micro-climate environment for conservation and regeneration of *Santalum album* (Sandalwood) and also to many other important plant species. Thus, this study supports the view that academic institutions could play a very significant role in conserving biodiversity with minimal effort which might support other institutions, such as forest department, in their rehabilitation programmes. Forest departments should ensure a responsible role for academic institutions in their rehabilitation programmes. Academic institutions should demonstrate the effectiveness of models through low-cost scientific interventions for wider dissemination. Although most of the institutions have relatively fair vegetation cover, there is a need to prioritise the species based on their status such as endangered, rare,

threatened or endemic. The Ministry of Environment and Forests, Government of India, and the State level organisations should approach the institutions in their zones to discuss which institute should prioritize which species first and accordingly provide some incentives to encourage young researchers for undertaking short-term research in their academic institutions to further develop techniques and approaches for multiplication of these species under local conditions so that direct benefits may reach the farmers. Apart from marketing, value addition of products of different species can be undertaken to improve the livelihood of the people. This would be a great contribution towards saving our valuable plant biodiversity. If we act now, it would be a real contribution from our side towards conserving and protecting our planet and species.

REFERENCES

- Badman T, Bomhard B 2008. *World Heritage and Protected Areas*. IUCN 2008 Edition.
- Conservation international (online). From <<http://www.biodiversityhotspots.org/xp/hotspots/hotspotsscience/Pages/default>> (Retrieved on 22 December 2007)
- Caro T, Scolte P 2007. When protection falters. *African Journal of Ecology*, 45: 233-235.
- Cohen JI, Williams T, Plucknett DL, Shands H 1991. Ex-situ conservation of plant genetic resources: Global development and environmental concerns. *Science*, 253: 866-872.
- Colchester M 1997. Salvaging nature: Indigenous people and protected areas. In: K B Chimire, M P Pimbert (Eds.): *Social Change and Conservation*. London: Earthscan, pp. 97-130.
- Cottam G, Curtis JT 1956. The use of distance measures in phytosociological sampling. *Ecology*, 37: 451-460.
- Daily GC 1995. Restoring value to the world's degraded lands. *Science*, 269:350-354.
- Equatorinitiative (online) From <<http://www.equatorinitiative.org/>> (Retrieved on 10 February 2010).
- Globaltopia (online). From <<http://globaltopia.org/EARTH.html>> (Retrieved on 15 January 2010).
- Graham S 2002. Global Estimate of Endangered Plant Species Triples. *Scientific American* November 1, 2002. From <<http://www.scientificamerican.com/article.cfm?id=global-estimate-of-endang&print=true>>
- Hjortso CN, Steffen S, Finn H 2006. Applying multi-criteria decision-making to protected areas and buffer zone management: A case study in the Royal Chitwan National Park, Nepal. *Journal of Forest Economics*, 12: 91-108.
- IUCN Summary Statistics. From <http://www.iucnredlist.org/documents/summarystatistics/2010_1RL_Stats_Table_1.pdf> (Retrieved on August 2010).
- IUCN 2008. *World Heritage and Protected Areas*. 2008 Edition. (Retrieved on 10 February 2009).
- IUCN (online). The International Union for Conservation of Nature, From <<http://www.iucn.org/> and <http://www.iucnredlist.org/>> (Retrieved on 24 December 2009).
- IUCN 2005. *Benefits Beyond Boundaries. Proceedings of the Vth World Parks Congress*. IUCN, Gland, Switzerland and Cambridge, UK.
- Khadka D, Nepal SK 2010. Local responses to participatory conservation in Annapurna Conservation Area, Nepal. *Environmental Management*, 45: 351-362.
- Kumar P 2006. Valuation of medicinal plants for pharmaceutical uses. *Current Science*, 86: 930-937.
- Lillesand TM, Kiefer RW, Chipman JW 2004. *Remote Sensing and Image Interpretation*. 5th Edition. New York: JohnWiley & Sons, Inc.
- Lu D, Mausel P, Brondizio E, Moran E 2004. Relationship between forest stand parameters and Landsat TM spectral responses in the Brazilian Amazon Basin. *Forest Ecology and Management*, 198: 149-67.
- Maikhuri RK, Nautiyal S, Rao KS, Saxena KG 2001. Conservation policy and people conflicts: A case study from Nanda Devi Biosphere Reserve (a World Heritage Site), India. *Forest Policy and Economics*, 2: 355-365.
- Mander U, Jongman RHG 1998. Human impact on rural landscapes in central and northern Europe. *Landscape and Urban Planning*, 41: 149-154.
- May RM 2002. The future of biological diversity in a crowded world. *Current Science*, 82: 1325-1330.
- Myers N 1990. Mass extinctions: What can the past tell us about the present and the future? *Global and Planetary Change*, 82: 175-185.
- Natural History Museum (online) From <<http://www.biodiversitylife.net/>> (Retrieved on 14 September 2010).
- Nautiyal S, Kaechele H 2007. Adverse impact of pasture abandonment in Himalayas of India: Testing efficiency of a natural resource management plan (NRMP). *Environmental Impact Assessment Review*, 27: 109-125.
- Nautiyal S, Sugandhini BR, Nejakar D, Bhaskar K 2010. *Flora of ISEC*. Bangalore: Institute for Social and Economic Change.
- Nayak SNV, Swamy HR, Nagaraj BC, Rao U, Chandrashekara UM 2000. Farmers' attitude towards sustainable management of Soppina Betta forests in Sringeri area of the Western Ghats, South India. *Forest Ecology and Management*, 132: 223-241.
- Ralhan PK, Saxena AK, Singh JS 1982. Analysis of forest vegetation at and around Nainital in Kumaun Himalaya. *Proc. Indian National Academy of Science B*, 48: 121-137.
- Ramakrishnan PS 2000. Biodiversity, land use and traditional ecological knowledge: The context. In: PS Ramakrishnan, UM Chandrashekara, C Elouard, CZ Guilmo, RK Maikhuri, KS Rao, S Sankar, KG Saxena (Eds.): *Mountain Biodiversity, Land Use Dynamics, and Traditional Ecological Knowledge*. New Delhi: Oxford & IBH Publication, India (P) Ltd., pp. 3-13.
- Ramphal S 1993. How protected area can meet society's needs: The social economic and political issues. In: V Barzetti (Ed.). *Parks and Progress*. Cambridge: IUCN, pp. 1-33.
- Raven PH 1987. *We are Killing our World: The Global Ecosystem Crisis*. Chicago: MacArthur Foundation.
- Roberts CA, Stallman D, Bieri JA 2002. Modeling complex human-environment interactions: The Grand Canyon

- river trip simulator. *Ecological Modelling*, 153: 181-196.
- Rodgers WA, Panwar HS, Mathur VB Online. Wildlife protected area network in India: A review. From <<http://wiienviis.nic.in/panetworks/panetwork.html>> (Retrieved on 18 October 2010)
- Saxena A K, Singh JS 1982. A phytosociological analysis of woody species in forest communities of a part of Kumaun Himalaya. *Vegetation*, 50: 3-32.
- Schmidt-Vogt D 1998. Defining degradation: The impacts of swidden on forests in northern Thailand. *Mountain Research and Development*, 18:135-149.
- Singh JS 2002. The biodiversity crisis: A multifaceted review. *Current Science*, 82: 638-647.
- Times of India 2009. With 800 species, IISc is a botanical delight. *Times of India*, August 4.
- Times of India. 2010. India is biggest contributor to rice bank. *Times of India*, April 6.

Annexure I: Plant-Diversity of Institute for Social and Economic Change; A - Tree species, B – Shrubs and C – Herbs (Nautiyal et al. 2010)

Scientific name	Family name	Common name (in English)	Vernacular name
A. Tree Species			
<i>Acacia auriculiformis</i> A.Cunn. ex Benth.	Leguminosae	Acacia	***
<i>Acacia farnesiana</i> L. Willd.	Mimosaceae	Needle Bush	Kasturi jaali
<i>Acacia melanoxylon</i> , R. Br.	Mimosaceae	Blackwood	Jali
<i>Achros sapota</i> L.	Sapotaceae	Sapota	Chikku
<i>Aegele marmelos</i> L. Correa.	Rutaceae	Bael tree	Bilvapatre
<i>Aglaia roxburghiana</i> Miq.	Meliaceae	***	Tottilakaayi
<i>Albizia lebbbeck</i> L. Benth.	Leguminosae	Lebbbeck tree	Bagemara
<i>Annona squamosa</i> L.	Annonaceae	Cuastardapple	Seetaphala
<i>Araucaria columnaris</i> J.R.Forst. Hook.	Arucceciaceae	Cooks Pine	***
<i>Atrocarpus heterophyllum</i> Lam.	Moraceae	Jackfruit	Hebhalasu
<i>Azadirachta indica</i> A.Juss.	Meliaceae	Neem tree	Chikkbevu
<i>Bauhinia variegata</i> L.	Caesalpiniaceae	Yellow Bell	Arisina tega
<i>Bixa orellana</i> L.	Bixaceae	Annatto plant	Bangarakayi
<i>Bombax ceiba</i> L.	Bombacaceae	Silk cotton tree	Buragadmara
<i>Bridelia retusa</i> L. Sprengel.	Euphorbiaceae	Asana	Gojemara
<i>Butea monosperma</i> Lam. Taub.	Leguminosae	Flame of the forest	Muthugadamara
<i>Caesalpinia pulcherrima</i> L. Sw.	Caesalpiniaceae	Pecock flower	Kenjigida, Chennakeshavagida
<i>Caesalpinia mexicana</i> A.Gray	Caesalpiniaceae	***	***
<i>Calophyllum inophyllum</i> L.	Clusiaceae	Beach mahogany	Pinne
<i>Carica papaya</i> L.	Caricaceae	Papaya	Parangi
<i>Cascabela thevetia</i> L. Lippold	Apocynaceae	Cook tree	Hirehalla
<i>Cassia fistula</i> L.	Caesalpiniaceae	Golden Shower	Kakke mara
<i>Casurina equisetifolia</i> L.	Casurinaceae	Australian oak	Sarvemara
<i>Citrus limon</i> L. Burm.f.	Rutaceae	Lemon	Limbe
<i>Citrus reticulata</i> Blanco	Rutaceae	Orange	Kitthale
<i>Cocos nucifera</i> L.	Palmaceae	Coconut	Tengu
<i>Couroupita guianensis</i> Aubl.	Lecythidaceae	Cannonball tree	Nagalinga
<i>Croton malabaricus</i> Bedd.	Euphorbiaceae	Croton	Yettimara
<i>Croton reticulatus</i> Heyne.	Euphorbiaceae	***	***
<i>Croton tiglium</i> L.	Euphorbiaceae	Croton oil seed	Japala
<i>Dalbergia sisso</i> Roxb.	Leguminosae	Shisham	Irukuntimavu
<i>Delonix regia</i> Boj. ex Hook. Raf.	Leguminosae	Gulmohar	Kattikayimara
<i>Diospyros crumenata</i> Thwaites.	Ebenaceae	Persimmon trees	Thumri
<i>Eucalyptus globules</i> Labill.	Myrtaceae	Eucalyptus	Nilgirimara
<i>Eucalyptus mysorensis</i> Murray Bail	Myrtaceae	Eucalyptus	Nilgirimara
<i>Ficus bengalensis</i> L.	Moraceae	Banyan tree	Adamamara
<i>Ficus benjamina</i> L.	Moraceae	Weeping ficus	***
<i>Ficus elastica</i> Roxb.	Moraceae	Indian rubber	Rabar mara
<i>Ficus benghalensis</i> var. <i>krishnae</i>	Moraceae	Makhan Katori,	***
<i>Ficus racemosa</i> Roxb.	Moraceae	Cluster fig	Attimara
<i>Ficus religiosa</i> L.	Moraceae	Peepal tree	Aralimara
<i>Filicium decipiens</i>	Sapindaceae	Fern tree	Kaadu hoovarasi
<i>Gmelina arborea</i> Roxb.	Verbenaceae	Beech wood	Shivani
<i>Grevillea robusta</i> A.Cunn. ex R.Br.	Proteaceae	Silky oak	
<i>Jacaranda mimosifolia</i> D. Don.	Bignoniaceae	Blue Jacaranda,	Neeli padari
		Black Poui	
<i>Kigelia pinnata</i> Jacq. DC.	Bignoniaceae	Kigelia	Kigelia pinnata
<i>Lagerstroemia speciosa</i> L. Pers.	Lythraceae	Queen of the flowers	Hole dasavala

Annexure I: Contd.....

<i>Scientific name</i>	<i>Family name</i>	<i>Common name (in English)</i>	<i>Vernacular name</i>
<i>Limonia acidissima</i> L.	Rutaceae	Wood apple	Beldahannu
<i>Mallotus philippinensis</i> M.	Euphorbiaceae	Monkey face tree	Kunkumada mara
<i>Mangifera indica</i> L.	Anacardiaceae	Mango	Mavinamara
<i>Marcaranga indica</i> Wight.	Euphorbiaceae	Parasol leaf tree	Bettadavare
<i>Markhamia lutea</i> Benth. K.Schum.	Bignoniaceae	Nile tulip tree	***
<i>Melia composita</i> Willd.	Meliaceae	***	Hebbevu
<i>Melia azedarach</i> L.	Meliaceae	Chinaberry tree.	Bevu
<i>Michelia champaka</i> L.	Magnoliaceae	Champaka	Sampige
<i>Millingtonia hortensis</i> L.f.	Bignoniaceae	Tree jasmine	Birate mara
<i>Mimosa leucocephala</i> Lam. de Wit,	Mimosoideae	Subabul	
<i>Moringa oleifera</i> Lam.	Moringaceae	Horse radish tree	Nugeekaii mara
<i>Muntingia calabura</i> L.	Tiliaceae	Japanese cherry	Gasgase mara
<i>Murraya koenigii</i> L.	Rutaceae	Curry tree	Karibevu
<i>Nyctanthes arborea-tristis</i> L.	Oleaceae	Night jasmine	Parijatha
<i>Peltophroum pterocarpum</i> DC. K. Heyne	Leguminaceae	Copper pod	Basavanapada
<i>Phoenix sylvestris</i> L. Roxb.	Arecaceae	Silver date palm	Ichalu
<i>Phyllanthus emblica</i> L.	Euphorbiaceae	Indian goose berry	Nelikaii
<i>Plumeria alba</i> L.	Apocynaceae	White frangipani	Bili kanegale
<i>Polyalthia longifolia</i> Sonn.	Annonaceae	False ashoka	Ashoka Kambadamara
<i>Pongamia glabra</i> Vent.	Leguminosae	Indian Beech Tree	Hongemara
<i>Pongamia pinnata</i> L.Panigrahi	Fabaceae	Indian beech tree	Honge mara
<i>Psidium guajava</i> L.	Myrtaceae	Guava	Seebe or Jamaphala
<i>Salix tetrasperma</i> Roxb.	Salicaceae	Indian willow	
<i>Santalinus pterocarpus</i> L.f.	Fabaceae	Red sandal wood	Raktha chandana
<i>Santalum album</i> L.	Santalaceae	Sandal tree	Sree gandha
<i>Schefflera actinophylla</i> Endl. Harms	Araliaceae	Umbrella tree	
<i>Sclerophyrum pentandrum</i> Dennst. Mabb	Santalaceae	***	Nay kuli
<i>Spathodea companulata</i> P.Beauv.	Bignoniaceae	Fountain tree	Nirukai
<i>Swietenia mahagoni</i> L. Jacq.	Meliaceae	Mahogany	Mahagone
<i>Syzygium hemisphericum</i> Wt. Alston	Myrtaceae	Rose apple	Pannerale
<i>Syzygium jambos</i> L. Alston	Myrtaceae	Rose apple	Jambunerale
<i>Tabebuia impetiginosa</i> Mart. ex DC. Standl.	Bignoniaceae	Brazilwood	***
<i>Tabebuia</i> sp.	Bignoniaceae	***	***
<i>Tamarindus indica</i> L.	Caesalpiniaceae	Tamarind	Hunasemara
<i>Tecoma argentea</i>	Bignoniaceae	Trumpet tree	Gantehu
<i>Tectona grandis</i> L.f.	Verbenaceae	Teak	Sagvani
<i>Terminalia catappa</i> L.	Combretaceae	Indian almond	Kadu badami
<i>Thespesia populnea</i> L. Sol. ex Corrêa	Malvaceae	Tulip tree	Bugurimara
<i>Ziziphus mauritiana</i> Lam.	Rhamnaceae	Indian jujube	***
<i>Zizypus jujube</i> L. H.Karst.	Rhamnaceae	Chines jujube	Yellachi or Yagachi
B. Shrub Species			
<i>Abrus fruticosus</i> , Wall	Fabaceae	***	***
<i>Abrus precatorius</i> L.	Fabaceae	***	***
<i>Abutilon indicum</i> , G. Don.	Malvaceae	Indian Mallow	Tuttigidia
<i>Acalypha fruticosa</i> Forssk	Euphorbiaceae	***	***
<i>Acalypha indica</i> L.	Euphorbiaceae	Indian copper leaf.	Kuppegida
<i>Acalypha wilkasiana</i> L.	Euphorbiaceae	Copper leaf	***
<i>Acalypha wilkesiana</i> , M. Arg	Euphorbiaceae	Jacob's Coat.	***
<i>Adhatoda zeylanica</i> Medikus.	Acanthaceae	Malabar nut tree	Aadusoge
<i>Adiantum capillus</i> L.	Adiantaceae	Maidenhair fern	Hamsa raja
<i>Allamanda chathartica</i> L.	Apocynaceae	Allamanda	Arasinhu
<i>Anthurium angustilaminatum</i> var. <i>gladiatum</i>	Araceae	***	***
<i>Barleria buxifolia</i> L	Acanthaceae	***	Gubbee mullu.
<i>Barleria prionitis</i> L.	Acanthaceae	Porcupine flower	Gorate
<i>Boehmeria nivea</i> L. Gaudich.	Urticaceae	China grass	Kankhura
<i>Boehmeria nivea</i> Gaudich.	Urticaceae	***	***
<i>Bougainvillea glabra</i> , Choisy	Nyctaginaceae	Paper flower	Kagadada hoo gida

Annexure I: Contd.....

Scientific name	Family name	Common name (in English)	Vernacular name
<i>Bougainvillea spectabilis</i> , Willd.	Nyctaginaceae	Paper flower	Kagadada hoo gida
<i>Calotropis gigantea</i> L. W.T.Aiton	Asclepidaceae	Gigantic weed	Yekka
<i>Calotropis procera</i> Aiton R. Br.	Asclepidaceae	Rubber bush,	Bili ekka
<i>Carissa carandas</i> L.	Apocynaceae	Caranda	Kavalikayi gida
<i>Carmona retusa</i> Vahl Masam	Boraginaceae	***	Ele adike soppu
<i>Cassia auriculata</i> L.	Caesalpiniaceae	Tanner's Cassia	Honnavarike
<i>Cassia sophora</i> L.	Caesalpiniaceae	Senna Sophora.	Alvari
<i>Catharanthus pusillus</i>	Apocynaceae	Ctharanthus	Vishakanagilasoppu
<i>Catharanthus pusillus</i> Murray	Apocynaceae	Madagascar Periwinkle	Vishakanagilasoppu
<i>Catunaregam spinosa</i> Thunb.	Rubiaceae	Mountain pomogranate	Karekayii gida
<i>Chromolaena odorata</i> L. King & H. Robinson	Asteraceae	Bitter bush	Communist kale
<i>Clerodendrum phillipinum</i>	Verbenaceae	Chinese glory brower	Mysore mallige
<i>Corchorus capsularis</i> L.	Tiliaceae	White jute	Senabu
<i>Crossandra infundibuliformis</i> L. Nees	Acanthaceae	Firecracker flower	Kanakambra
<i>Crotalaria juncea</i> L.	Fabaceae	Sun hemp	Sanna senabu
<i>Croton aromaticus</i> L.	Euphorbiaceae	Croton	***
<i>Croton caudatus</i> Ges.	Euphorbiaceae	Croton	***
<i>Croton lawianus</i> . Nimmo.(threatened endemic)	Euphorbiaceae	Croton	***
<i>Croton oblongifolius</i> Roxb	Euphorbiaceae	Rush foil	Togarasa
<i>Dracaena reflexa</i> Lam.	Agavaceae	Malaysia dracena	***
<i>Duranta repens</i> L.	Verbenaceae	Golden dew drop	***
<i>Ecbolium ligustrinum</i> (Vahl) Vollesn.	Acanthaceae	Green shrimp plant	Kappu karni
<i>Euphorbia antiquorum</i> L.	Euphorbiaceae	Triangular Spurge	Kontekalli
<i>Euphorbia elegans</i> Sparg.	Euphorbiaceae	***	***
<i>Euphorbia pulcherrima</i> Willd. ex Klotzsch	Euphorbiaceae	Christmas flower	***
<i>Glycyrrhiza glabra</i> L.	Fabaceae	Liquorice	Gobrad gida
<i>Hibiscus arnottianus</i>	Malvaceae	White hibiscus	Bili dasavala
<i>Hibiscus micranthus</i> L. f.	Malvaceae	Hibiscus	Dasaval
<i>Hibiscus rosa-sinensis</i> L.	Malvaceae	Rose mallow	Dasvala
<i>Iresine herbstii</i> Hook. ex Lindl.	Amaranthaceae	Blood leaf	***
<i>Jasminum</i> spp.	Oleaceae	***	***
<i>Jasminum ovalifolium</i> , Wight.	Oleaceae	Royal Jasmine	Sanna mallige
<i>Jasminum sambac</i> L. Aiton	Oleaceae	Arabian jasmine	Ellusuttu mallige
<i>Justicia adhatoda</i> L.	Acanthaceae	Malabar nut	Atarush
<i>Lantana camara</i> L.	Verbinaceae	Lantanas	Chadarang
<i>Lantana indica</i> Roxb.	Verbinaceae	***	***
<i>Lantana trifolia</i> L.	Verbinaceae	***	***
<i>Leptadenia reticulata</i> (Retz.) blt.and Am. (endangered)	Asclepidaceae	Jiwanti	Hiriyahalle.
<i>Lawsonia inermis</i> L.	Lythraceae	Mehendi	Gorante
<i>Manihot esculenta</i> Crantz.	Euphorbiaceae	Cassava	Margenasu
<i>Meyna laxiflora</i> Robyns	Rubiaceae	Muyana	Mullu kare
<i>Musa paradisiaca</i> L.	Musaceae	Banana	Bale
<i>Mussaenda frondosa</i> L.	Rubiaceae	Mussaenda	Hastygida
<i>Nerium oleander</i> Calysa	Apocynaceae	Rose bay	Kanagilu
<i>Opuntia monacantha</i> Haw.	Cactaceae	Prickly pear	***
<i>Pandanus fascicularis</i> Lam.	Pandanaceae	Screwpine	***
<i>Pseuderanthemum carruthersii</i> Seem. Guillaumin	Acanthaceae	Jacobs coat	***
<i>Punica granatum</i> L.	Punicaceae	Pomegranate	Dalimbe
<i>Ricinus communis</i> L.	Euphorbiaceae	Castor	Haralu
<i>Rosa leschenautiana</i>	Rosaceae	Rose	Gulabi gida
<i>Schefflera arboricola</i> Hayata Kanehira	Araliaceae	Drawf umbrella tree	***
<i>Schefflera arboricola</i> var. <i>varigata</i>	Araliaceae	Drawf umbrella tree	***
<i>Solanum torvum</i> Sw.	Solanaceae	Turkey berry	Kadusonde
<i>Synadenium grantii</i>	Euphorbiaceae	African milk bush	***
<i>Tabernaemontana divaricata</i> L.	Apocynaceae	Crape jasmine	Nandibattalu
<i>Tarenna asiatica</i> L.	Rubiaceae	Indian Wild Flowers	Papati
<i>Tecoma stans</i> (L.)	Bignoniaceae	Yellow bells	Gantehu
<i>Triumfetta rhomboidea</i> Jacq.	Tiliaceae	Diamond burr bark	Kadu bende
<i>Triumfetta rotundifolia</i> Lam.	Tiliaceae	Birdwing	Mena mallige
<i>Urena lobata</i> L.	Malvaceae	Caesarweed	Otte
<i>Urena sinuata</i> L.	Malvaceae	Burr Mallow	Otte
<i>Vallis solanaceae</i> (Roth.) Kuntze.	Apocynaceae	Bread flower	Isamungari
<i>Vitex negundo</i> L.	Verbenaceae	Vitex	Lakki gidda

Annexure I: Contd.....

Scientific name	Family name	Common name (in English)	Vernacular name
C. Herb Species			
<i>Aerva lanata</i> (L.) Juss. ex Schultes	Amaranthaceae	***	Bili huli
<i>Ageratum conyzoides</i> L.	Asteraceae	Billy goat weed	Urhaal gida
<i>Alternanthera sessilis</i> (L.) R.Br	Amaranthaceae	***	***
<i>Anaphalis margaritacea</i> L. Benth. & Hook.f. (1873)	Asteraceae	Western pearly everlasting	***
<i>Andrographis serpyllifolia</i> , W.	Acanthaceae	***	Sardaalgida
<i>Argemone mexicana</i> L.	Papveraceae	Mexican prickly poppy	Datturigidda
<i>Asparagus densiflorus</i> Kunth Jessop	Liliaceae	Emarland fern	***
<i>Bambusa arundinacea</i> (Retz.) Roxb.	Poaceae	Bidaru	Ande bidiru
<i>Biophytum Sentivum</i> (L.) DC.Var.sensitivum	Oxalidaceae	Little Tree Plant	Akkigida,
<i>Boerhavia diffusa</i> L.	Nyctanginaceae	Pig weed	Kommagida
<i>Bryophyllum pinnatum</i> Lam. Oken.	Crassulaceae	Air plant	***
<i>Cajanus cajana</i> L. MILLSP.	Fabaceae	Pigeon pea	Togari gida
<i>Canna indica</i> L.	Cannaceae	Indian shot plant	***
<i>Capsicum annum</i> L.	Solanaceae	Chilli	Menasinakaii
<i>Cassia tora</i> L.	Caesalpinaceae	Sickle pod	Chagache
<i>Celosia argentea</i>	Amaranthaceae	Cockscomb	Annesoppu
<i>Centratherum anthelminticum</i> L. Kuntze.	Asteraceae	Ipecac	Kari jirige
<i>Chlorophytum bonnie</i>	Liliaceae	Spider plant	***
<i>Cissus quadraangularis</i> L.	Vitaceae	Seasonvine	Amlavetasah
<i>Cleome monophylla</i> L.	Capparridaceae	Spider flower	Koli kalinagide
<i>Colocasia antiquorum</i> . Schott	Araceae	Colocasia	Kesavu
<i>Colocasia esculenta</i> L. Scott.	Araceae	Colocasia	Kesave dantu
<i>Corchorus aestuans</i> L.	Tiliaceae	Ruderal herb.	Chunchu
<i>Crinum asiaticum</i> L.	Liliaceae	Crinum lily	***
<i>Croton banplandianum</i> Baill.	Euphorbiaceae	Kala bhangra	Alpha bedhi soppu
<i>Croton lacciferus</i> L.	Euphorbiaceae	Croton	***
<i>Croton sparsiflorus</i> , Mor	Euphorbiaceae	Garden croton	***
<i>Curculige orchioides</i> Gaertner	Hypoxidaceae	***	***
<i>Curcuma domestica</i> Valetton.	Zingiberaceae	Turmeric	Arishina
<i>Curcuma zeodaria</i> Rosc	Zingiberaceae	White turmeric	Ambe haladi
<i>Cyanotis tuberosa</i> Roxb. Schultes and Schultes f.	Commelinaceae	Greater Cat Ears	Achchumullu
<i>Dieffenbachia compacta</i>	Araceae	Dumb cane	Beedi soppu
<i>Euphorbia heterophylla</i> L.	Euphorbiaceae	Fire plant	Accegida
<i>Euphorbia hirta</i> L.	Euphorbiaceae	Snake weed	
<i>Geranium nepalense</i> Sweet	Geraniaceae	Nepalese cranes bill	
<i>Gloriosa superba</i> L.	Liliaceae	Flame lily	Huliyuguru
<i>Hybantus enneaspermus</i> L. F. v. Muell.	Violaceae	Pink ladies slipper	Purusha ratna
<i>Lagascea mollis</i> Cav.	Compositae	Silk leaf	***
<i>Lepidium sativum</i> L.	Brassicaceae	Pepper Grass	Allibija
<i>Leucas aspera</i> Spr.	Lamiaceae	Doranapuspi	Uttarani
<i>Linum usitatissimum</i> Linnaeus.	Linaceae	Common flax	Agasi
<i>Lycoperscion esculentum</i> L.	Solanaceae	Tomato	Capparbadane
<i>Nephrolepis cordifolia</i>	Polypodiaceae	Fish bone fern	***
<i>Nephrolepis falcata</i> Cav.C	Oleandraceae	***	***
<i>Nephrolepis falcata</i> Cav. C. Chr.	Polypodiaceae	Fishtail fern, Fancy frill fern	***
<i>Nephrolepis</i> sp.	Polypodiaceae	***	***
<i>Nephrolepis</i> sp.	Polypodiaceae	***	***
<i>Oxalis corniculata</i> L.	Oxalidaceae	Indian sorral	Ulisoppu
<i>Phyllanthus amarus</i> Schumarch. & Thonn.	Euphorbiaceae	Stone breaker	Nelnalli
<i>Plectranthus amboinicus</i> (Lour.) Sprengel	Lamiaceae	Coleus	Doddapathe gidida
<i>Plumbago zeylanica</i> L.	Plumbaginaceae	White flowered lead-wort	Chitramila
<i>Ruta chalenpensis</i> L.	Rutaceae	Garden rue	Nagadali soppu
<i>Sacodexis multiflorus</i> Martyn Raf.	Amarylloidaceae	Fireball lily	***
<i>Salvia coccinea</i> Buc'hoz ex Etl.	labiateae	Scarlet sage	***
<i>Sanseviaria trifasciata</i> Prain., 1903	Agavaceae	Snake plant	***
<i>Solanum melongena</i> L.	Solanaceae	Eggplant	Badanekaii
<i>Sonchus oleraceus</i> L.	Astraceae	Common sowthistle	Chakravati,

Annexure I: Contd.....

<i>Scientific name</i>	<i>Family name</i>	<i>Common name (in English)</i>	<i>Vernacular name</i>
<i>Spathiphyllum wallisii</i>	Araceae	Peace lily	***
<i>Stachytarpheta jamaicensis</i> Vahl.	Lamiaceae	Snake weed	Kaadu uttaraani,
<i>Sterlitizia regine</i> Aiton	Sterlitziaceae	Bird of Paradise	***
<i>Tagetes erecta</i> L.	Asteraceae	Marigold	Cheendu huvu
<i>Tagetes patula</i> L.	Asteraceae	Marigold	Chenndu huvu
<i>Tagia bicolor</i> Miq	Euphorbiaceae	***	***
<i>Tridax procumbens</i> L.	Asteraceae	Coat buttons	Addike soppu
<i>Trigonella foenum-graecum</i> L.	Fabaceae	Menti plant	Menthe
<i>Wedelia trilobata</i>	Astraceae	Yellow dots	***
<i>Zingiber zerumbet</i> Roscoe. ex Smith.	Zingiberaceae	Shampoo Ginger	Agalu shunthi

D. Creepers

<i>Asparagus racemosus</i> Wild	Liliaceae	Shatavari	Halavu makkala tayi
<i>Basella alba</i> L.	Basellaceae	Caeylon spinach basella	Baselle soppu
<i>Basella rubra</i> L.	Basellaceae	Basella	Dodda basale
<i>Bauhinia vahlii</i> Wight & Arn	Caesalpiniaceae	***	Hepparige
<i>Benincasa hispida</i> Thunb.	Cucurbitaceae	Ash guard	Bili kumbalakaii
<i>Cardiospermum halicabum</i>	Sapindaceae	Baloon vine	Bekkina budde gida
<i>Clitoria ternatea</i> L.(whiteand blue variety)	Fabaceae	Butterfly pea	Shankapushpi
<i>Dioscoria alata</i> L.	Dioscoreaceae	Water yam	Tuna genasu.
<i>Dolichos lablab</i> L. var. typicum Prain	Fabaceae	Hyacinth Bean	Chapparadavare
<i>Gymnema sylvestre</i> Retz. R. Br. ex Schultes.	Asclepidaceae	Gurmar	Madhu nashini
<i>Hemidemis indicus</i> L. R. Br.	Asclepidaceae	Marijuana	Karibandha
<i>Ipomoea alba</i> L.	Convolvulaceae	Moonflower.	Kadu kattikayi
<i>Ipomoea batatas</i> L. Lamk	Convolvulaceae	Sweet potato	Sihigenasu
<i>Ipomoea digitata</i> L.	Convolvulaceae	***	Nela gumbala
<i>Ipomoea obscura</i> L. Ker Gawler	Convolvulaceae	Obscure morningglory	Bokadi
<i>Jasminum angulare</i>	Oleaceae	***	Nitti mallige
<i>Logenaria siceraria</i> Mol. Standley	Cucurbitaceae	Bottle guard	Sore kayi
<i>Momordica balsamina</i> L.	Cucurbitaceae	Balsam apple	Huchu toned balli
<i>Momordica charantia</i> Descourt.	Cucurbitaceae	Bitter guard	Hagala kaii
<i>Passiflora alba</i> Link & Otto	Passifloraceae	Passion flower	***
<i>Piper beetle</i> L.	Piperaceae	Beetle	Vilayadele
<i>Pyrostegia vensuta</i>	Bignoniaceae	Golden shower	***
<i>Scindapsus officinalis</i> Schott	Araceae	Gajapipal	Adkebeeluvalli
<i>Tinospora cardifolia</i> (Willd.) Hook. f. & Thomson.	Menispermaceae	Tinosopra	Amruthaballi
<i>Tagia involucrata</i> L.	Euphorbiaceae	Climbing Nettle	Churachurike gida
<i>Toddalia asiatica</i> (L.) Lam.	Rutaceae	Orange climber	Kindu mullu

E. Grass species

<i>Apluda mutica</i> L. var. <i>aristata</i> (L.) Hackel. ex Baker.	Poaceae	***	Akku hullu
<i>Arundinella pumila</i> , Steud.	Poaceae	***	***
<i>Arundinella setosa</i> , Trin.	Poaceae	***	Hakkivarji hullu
<i>Bothriochloa intermedia</i> (R. Br) A. Camus.	Poaceae	Purple plume grass	Jenukaddi
<i>Bothriochloa pertusa</i> (L.) A. Camus.	Poaceae	Indian blue grass, hurricane grass	Aanekattu hullu
<i>Brachiaria mutica</i> Staf.	Poaceae	Para grass	Emme hullu
<i>Cymbopogon caesius</i> (Hook. & Arn.) Stapf.	Poaceae	Tsauri Grass	Anji hullu
<i>Cymbopogon flexuosus</i> Wats.	Poaceae	Lemon grass	Shunthi hullu
<i>Cyperus aristatus</i> , Rottb	Cyperaceae	***	Jambu hullu
<i>Cyperus rotundus</i> L.	Cyperaceae	***	***
<i>Cyperus triceps</i> (Rottb.) Endl.	Cyperaceae	***	Anantagonde hullu
<i>Dichanthium caricosum</i> (L.) A. Camus.	Poaceae	Roadside bluestem	Kanda Bhattada hullu
<i>Dinebra retroflexa</i> Panz.	Poaceae	Viper Grass	Huligyan hullu
<i>Eleusine indica</i> (L.) Gaertner	Poaceae	Crowsfoot grass	Hakki kalina hullu
<i>Eragrostiella bifaria</i> (Vahl) Bor	Poaceae	***	Jadi hullu
<i>Eragrostis cilianensis</i> (All.) Vign	Poaceae	Sticy grass	Bettada akkabu hullu
<i>Echinochloa colonum</i> (L.) Link	Poaceae	***	Kaduharaka hullu

Annexure I: Contd.....

<i>Scientific name</i>	<i>Family name</i>	<i>Common name (in English)</i>	<i>Vernacular name</i>
<i>Echinochloa crusgalli</i> (L.) P. Beauv.	Poaceae	Barnyard millet	Simpigana hullu
<i>Heteropogon contortus</i> (L.)	Poaceae	Black spear grass, tanglehead or pili	Karivunugada hullu
<i>Imperata cylindrica</i> (L.) P. Beauv.	Poaceae	Cogongrass	Neeruhatti hullu
<i>Ischaemum rugosum</i> Salisb.	Poaceae	Wrinkle duck beak, saromacca grass	Kadukken hullu
<i>Kyllinga nemoralis</i> (Foster).	Cyperaceae	White water sedge	Anantakonde hullu
<i>Oxytenanthera monadelph</i> a (Thwaites).	Poaceae	***	Otte bidiru
<i>Pennisetum americanum</i> (L.) Leek.	Poaceae	Bulrush millet, pearl millet	Kambu hullu
<i>Saccharum officinarum</i> L	Poaceae	Sugar cane	Kabbu
<i>Pennisetum purpureum</i> . Schumach.	Poaceae	Elephant grass	Aane hullu