STATUS OF FOREST INVASIVE SPECIES IN INDIA

1. Country background

1.1 Geographical location

India occupies a strategic position in Asia, looking across the seas to Arabia and Africa on the west and to Myanmar, Malaysia and the Indonesian Archipelago on the east. Geographically, the Himalayan ranges keep India apart from the rest of Asia. India is located to the north of the equator between 8^{o} 4′ and 37^{o} 6′ north latitude and 68^{o} 7′ and 97^{o} 25′ east longitude. It is bounded on the south east by the Bay of Bengal. On the north, north east and north west lies the Himalayan ranges. Kanyakumari constitutes the southern tip of the Indian Peninsula and Indira Point in the Andamans and Nicobar Islands as the southern most tip of India. India measures 3214 km from north to south and 2933 km from east to west. It has a land frontier of 15,200 km and coastline of 7516.5 km. India shares its political borders with Pakistan and Afghanistan on the west and Bangladesh and Myanmar on the east. On the northern boundary are situated China, Tibet, Nepal and Bhutan. In the South, it is separated by Sri Lanka by a narrow channel of sea called Palk Strait and the Gulf of Mannar.

1.2 Area

 The total land area of the country is 328.7 million hectares (mha) which forms 2.4% of the world's total area. There are 28 states and seven union territories administrated through 593 districts. There are 384 Urban Agglomerations (UAs),

5161 towns, 35 million plus UAs and 27 million plus cities. Of the total area of 328.7 mha land use statistics are available for roughly 3.05 m ha accounting for 93% of the total land area. Of this, roughly 264 mha of land is available for agriculture, forestry and related purposes.

1.3 Population

3 As per the census, total population of India as on March 01, 2001 stood at 1027 million which rose by 21.34% during the period from 1991 to 2001. This constitutes 16.7% of world's population. India became only the second country in the world after China to cross the on billion mark. The population density of India is 324 persons per square kilometre. The sex ratio (females per 1000 males) is 933 which rose from 927 as at the 1991 census (Census of India, 2001).

1.4 Economy

4 India is the world's fourth largest economy on purchasing power parity basis with an estimated GDP of US$ 2.2 trillion (2000). The annual growth rate of real GDP during the years 1997-2002 was estimated at 5.4 %, which was one of the highest among major economies of the world in recent years. However, in per capita terms, Indian economy ranks a low 145th in the world. Agriculture and allied sectors play a key role in the economy contributing upto around 20 % of the GDP (GOI, 2002) and accounting for 64% of the employment (GOI, 1999). Another important feature of the economy is that the organized sector accounts for only 27.96 million jobs (19.314 million in the public sector and 8.646 million in the private sector) (GOI, 2002). It means that most of the people work in the unorganized sectors. Despite this growth

rate, about 25% of population still lives below poverty line. There is large variability in the poverty across different states of the country.

1.5 Climate

5 India is mainly a tropical country but due to great altitudinal variations, almost all the climatic conditions from hot deserts to cold deserts exist. There are four seasons in the year: (i) Spring (January-March), (ii) Summer (April-June), (iii) South –west Monsoon (July- September), and (iv) Winter (October-December). The south-west or the summer monsoon is the main source of rainfall in the country providing about 80% of the precipitation though some rains are received in winter months too.

1.6 Topography

6 India's mainland comprises of the following four broad geographical areas:

(a) The Northern Mountains which has the great Himalayas
(b) The vast Indo-Gangetic plains
(c) The Southern (Deccan) Penninsula bounded by the Western and Eastern Ghats and, lastly

(d) The Coastal Plains and Islands Northern Mountains: The northern mountains correspond to the Himalayan Zone, alongside country's northern boundaries including the Jammu and Kashmir (J&K), Himachal Pradesh (HP), north-west Uttar Pradesh (UP), Sikkim, part of Assam, and the North-Eastern States of Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura and Meghalaya. The Himalayas comprise of mountain ranges, which form an indomitable physical barrier, as the world's biggest and largest mountain ranges. The Himalayas also contain the cold deserts and fertile valleys.

Great Plains: Also known as the Indo-Gangetic plains, the Great Plains are formed by the basin of three distinct river systems –the Indus, the Ganges and the Brahmaputra. The plains extend from Rajasthan in the west to the Brahmaputra valley in the east. This region covers the States of Punjab, Haryana, and the Union Territories of Chandigarh and Delhi and major parts of U., Bihar, West Bengal, and parts of Assam. These plains comprise one of the world's greatest stretches of flat and deep alluvium soils and are among the most densely populated areas of the world (456 persons per sq.km). The desert region, with the Great Thar desert, extends from the edge of Rann of Kutch to larger parts of Rajasthan (western) and lower regions of Punjab and Haryana.

Deccan Penninsula: This zone covers the whole of south India which includes the States of Tamilnadu, Karnataka, Andhra Pradesh and Kerala. The region also covers the States of Madhya Pradesh, parts of Bihar, Orissa and Purulia district of West Bengal. Density of population is 202 persons per sq. km. The Indo-Gangetic plains and the peninsular plateau are separated by mountains and hill ranges known as the Aravalli, Vindhya, Satpura, Ajanta and Maikala ranges.

Coastal Plains and Islands: The peninsula is flanked on the two sides by the Eastern and the Western Ghats, respectively. On either side of the ghats outward to the sea, lies a coastal strip. The western coastal plains lie between the Western Ghats and the Arabian sea in the west, whereas the eastern coastal plains face the Bay of Bengal in the east. This is also a region with very high-density of population (349 persons per sq.km).

The country is further divided into ten bio-geographical zones which are Trans-Himalayan, Indian Desert, Semi-arid, Himalayan, Deccan Peninsula, Gangetic Plains, Northeastern, Coastal regions, Western Ghats and Indian Islands.

1.7 Watersheds

7 There are mainly three watersheds in the country

(1) The Himalayan range with its karakoram branch in the north

(2) The Vindhyan and Satpura ranges in Central India, and

(3) The Sahyadari or Western Ghats on the west coast

All the major rivers originate in one or the other of these watersheds.

Rivers

12 rivers are classified as major rivers whose total catchment area is 252.8 mha. The Ganga-Brahamputra-Meghna system is the biggest with a catchment area of about 110 mha.

1.8 Soils

8 India has a wide range of soils, each type being specific to a locality. Alluvial and black cotton soils are the two most important soils groups for agricultural production. Alluvial soils cover about 78 mha (about 24%) of the total land and occur in the great Indo-Gangetic Plains, in the valleys of Narmada and Tapti in Madhya Pradesh and the Cauvery in Tamilnadu. These soils are considered very well for the production of wheat, rice, other cereals, pulses, oil seeds, potato, sugarcane, etc. The black cotton soils cover about 51.8 mha and are found in the states of Maharashtra, Gujarat, Madhya Pradesh, Karnataka, Andhra Pradesh, Tamilnadu, Uttar Pradesh and Rajasthan. These are also considered good for cultivation of cotton, cereals, pulses, oil seeds, citrus fruits, vegetables, etc. In addition, red soils have been estimated to occur in 51.8 mha and are primarily found in Tamilnadu, Karnataka, Kerala, Maharashtra, Andhra Pradesh, Madhya Pradesh, Bihar and West Bengal. These are most suited for rice, ragi (millet), tobacco and vegetable cultivation. Laterite and lateritic soils occur in 12.6 mha. These are not considered good for agriculture. The area of desert soils is about 37 mha. These are also not found suitable for agriculture.

1.9 Forests

1.9.1 National Forest policy

9 The role of India's forests in the national economy and ecology was emphasized in the National Forest Policy, 1988, which focused on ensuring environmental stability, restoring the ecological balance, and preserving the remaining

forests. Other objectives of the policy include meeting the needs of fuel wood, fodder, and small timber of rural and tribal people while recognizing the need to actively involve local people in the management of forest resources. Also during 1988, the Forest (Conservation) Act, 1980, was amended to facilitate stricter conservation measures. The goal is to increase the forest cover to 33 percent of geographical area by 2012 from the then official estimates of 23 percent. In June 1990, the GOI adopted a resolution that envisaged involvement of local communities in management of forests as well as sharing of usufructs with them. The joint forest management has now become central theme of most of the afforestation programmes in all the states.

10 The forests of India are endowed with rich flora and fauna. There are about 45,000 plant species in India which is 12% of the global plant wealth. The animal species are approximately 81,250. There are 92 National Parks and 500 Wildlife Sanctuaries in India. The total extent of protected areas include five designated World Heritage Sites, fourteen Biosphere Reserves, six Ramsar Sites, twenty eight (37761 square km) Project Tiger Reserves and nine Elephant Reserves (Forest and Wildlife Statistics, MoEF, 2004). As such, country has to meet the needs of 16% of the world's population from 1% of the world forest resources. The same forests have also to cater for the 19% of the world's cattle population.

1.9.2 Forest laws

11 The legal framework is provided by four main national laws viz. Indian Forest Act, 1927; Wildlife (Protection) Act, 1972; and Forest (Conservation) Act, 1980 and Biological Diversity Act, 2002. The Indian Forest Act provides the basis for forest administration in the country. The states can also enact their own laws; rules and regulations for administration and management of forests within the overall legal provisions of the central enactments.

Most of the states have enacted their own legislations for management of forests as well as regulations of felling of trees, transportation and trade within the country. The Wildlife (Protection) Act governs the conservation of wildlife and related matters within the Protected Area (PA) network (national parks and sanctuaries, which covers a total area of 15.6 mha) and outside the PA network. The forest (Conservation) Act, 1980regulates the diversion of forest land for non-forestry purposes. The Biological Diversity Act, 2002governs the protection and control of theft of biodiversity and biodiversity related traditional knowledge. Two other major central laws affecting forest administration are the Mines Act, 1952 and the Environmental (Protection) Act, 1986. The provisions of Convention on International trade in Endangered Species of Wild Fauna and Flora (CITES) are implemented through the Foreign Trade (Development and Regulations) Act, 1992.

1.9.2 Extent of forest area

12 As per the State of Forest Report 2003, the total forest cover in the country is 67.83 mha, which constitutes 20.64% of its geographical area. Of this, very dense forests (canopy density above 70%) constitute 5.128 mha (1.56% of geographical area), moderate dense forests (canopy cover between 40-70%), 33.93 mha (10.32%) and open forests constitute 28.77 mha (8.76%). The State of Madhya Pradesh with 7.64 mha of forests has the maximum forest cover among all states/UTs followed by Arunachal Pradesh (6.802 mha) and Chattisgarh (5.59 mha). The total tree cover of the country has been estimated as 9.99 mha (about 3.04%). There has been an increase in forest and tree cover (over the last assessment carried out during 2001) by 2.122 mha which is 0.65 of geographical area. The total growing stock of wood in the country is estimated to be 6,414 million cubic metres (cum) that includes 4,782 million cum inside the forests and 1,632 million cum of trees outside forests.

1.9.3 Forest Types

13 India's forests show greatest variation and range depending upon rainfall, soil, topography and climatic factors. The forests range from tropical rainforests to dry thorn forests and mountain-temperate forests. There are four major forest types (tropical, sub-tropical, temperate, and alpine) and 16 detailed forest types in the country. The detailed forest types are:

1. Tropical Wet Evergreen Forest (Two subgroups)
2. Semi-Evergreen Forest (Two subgroups)
3. Most Deciduous Forest (Three subgroups)
4. Littoral and Swamp Forest (Five subgroups)
5. Dry deciduous Forest (Two subgroups)
6. Thorn Forest (Two subgroups)
7. Dry Evergreen Forest
8. Subtropical Broadleaved Hill Forest (Two subgroups)
9. Subtropical Pine Forest
10. Subtropical Dry Evergreen Forest
11. Montane Wet Temperate Forest (Two subgroups)
12. Himalayan Moist Temperate Forest
13. Himalayan Dry Temperate Forest (Two subgroups)
14. Sub Alpine Forest

15. Moist Alpine Scrub Forest
16. Dry Alpine Scrub Forest

14 More than half of the forest area in India is tropical-moist and dry-deciduous type. Of the 16 forest types in the country, the tropical deciduous forests from the major forest type of India with 38.2% of the total forest area. Other predominant forest type is the moist deciduous forests which cover 30.3% of the forest area. The forests are both a resource and a habitat for the rich flora and fauna found in the country.

1.9.5 Classification of forests, forestland ownership and management authority

15 The forests are classified as 'Reserved', 'Protected' and unclassified forests which are notified by the state/UT governments concerned. Forests are largely under public ownership. In some of the states, mainly the north-eastern states, the local communities also own major chunk of forests. The subject of 'forests and wildlife' is included under the 'Concurrent List' of the Constitution of India and both central and state governments can legislate on forestry related matters though the administrative and technical control on forests remains with the states/UTs. Each state has a State Forest Department (SFD) that functions independently of SFDs in other states. The broad policy framework, laws and management guidelines for all states are framed by the Ministry of Environment and Forests (MoEF), Government of India (GOI) in consultation with the states/UTs.

1.10 Contribution of forests to national and community economies

16 Forests play a vital role in nation's economy. They provide tangible as well as intangible benefits. The tangible benefits include providing fuel wood, timber, non-timber forest products like bamboos, lac, gum, resin, katha, medicinal plants and raw materials for wood based industries like paper, pulp, plywood etc. They also provide materials for defence and communications as well as grazing for cattle. The intangible benefits include conservation of soil fertility and play an important role in the maintenance of the water regime of the land. The forests provide water, perhaps the most important forest product. The organic matter which they yield improves the fertility and increase the water holding capacity of the soil thereby reducing the run-off. The presence of vegetation acts as a physical check to the velocity of the run-off and reduces its soil carrying capacity. Thus forests protect the hilly areas against excessive soil erosion. Similarly, they protect flat lands against desiccation and erosion caused by winds. They exert a beneficial influence on the growth of agricultural crops and on the climate of the region in which they exist.

17 Tribal population and forest fringe dwellers are highly dependent on forests for their livelihood. The forests provide them employment and also NTFPs, fuelwood and fodder. Gross estimates are available for collection of fuel wood & fodder. Sustainable yield of timber from India's forests is estimated at 12 million cum as against the recorded and unrecorded withdrawals of 48.98 million cum at present. Analysis of FSI data reveals that roughly 103 million tonnes of fuel wood is removed annually from forests as against 17 million tonnes available on a sustained basis. Similarly sustainable harvest of fodder from forests is estimated at 65 million tonnes as against the present level of removal of 350 million tonnes annually. Alternative arrangement for procuring 285 million tonnes of fodder would cost USD 4640 millions with an average price of USD 16.3/MT of fodder. Analysis of sustained yield vis-à-vis actual yield of

only three forest produce puts the cost of sustainability at USD 9940 million. However, no systematic studies have been conducted to assess the exact value of the services provided by the forests in the country. (Kishwan & Ratho, 2005).

1.11 Eco-tourism & environmental services

18 Tourism sector in India provides employment to over 8.5 million people. In 1997-1998, it generated foreign exchange of US$ 2530 million. Eco-tourism is being encouraged by the central and the state governments and there is a substantial increase in the number of visitors to national parks and sanctuaries. Eco-tourism forms about 2-4% of the entire tourism industry. The MoEF, GOI is in the process of finalizing the eco-tourism policy for the country. The environmental services include providing water, clean air, carbon sequestration, mitigation of noise pollution and amelioration of climate etc.

2. Forest invasive species background

19 Over the last many decades, a number of Forest Invasive Species (FIS), without realizing the consequences, have been introduced in India knowingly or unknowingly. Checklist of known FIS is appended at **Annexure-I** in the prescribed format. The FIS are further categorized as floral (weeds and plants having national and regional distribution), entomological (insects) and pathogenic (fungi). Approximately, 111 FIS have been identified under the above mentioned categories. No systematic studies have been carried out so far to inventorize the FIS available in its various biogeographial regions. However, India being a vast country, it would be possible to have a detailed inventory through some project support. Many of the invasive species have naturalized in India and are being used for various purpose

ranging from medicinal uses, attachment to religious sentiments to uses in furniture, compositing etc. Appropriate strategies will have to be devised for their control, eradication and management in connection with various stakeholders.

2.1 General background on weeds

20 Weeds of invasive nature growing in the forest vegetation form a category of FIS; they include both indigenous as well as exotic taxa. Weed flora of India is very rich. These plants pose a lot of management problem and adversely affect the productivity besides incurring heavy costs in preventive and damage control measures. It is generally very difficult to distinguish between native and exotic species, as they grow intermixed. Exotic invasive species, however, are usually confined to the areas managed or otherwise influenced by man and his dispersing agencies.

21 Weeds have been classified weeds into the following three categories. (Babu, 1977)

i) Category I: - This group comprises of the species, which are thoroughly naturalized and appear to behave as wild plants. These plants are of tropical American origin and are usually obnoxious. They have Napoleonic ambitions to colonize new areas. Members of *Asteraceae, Amaranthaceae, Solanaceae, Malvaceae, Brassicaceae*, etc. belong to this category.

ii) Category II: - This group includes the plants of cultivated origin that have become naturalized or run wild. These weeds represent the members of the families such as *Solanaceae, Cucurbitaceae, Asteraceae, Apiaceae, Brassicaceae, Fabaceae, Convolvulaceae,* etc.

iii) Category III: - Species falling under this category are exclusively cultivated, and also met with as escapes which include members of *Acanthaceae, Caryophyllaceae, Malvaceae, Asteraceae, Poaceae, Amaryllidaceae,* etc.

Similarly based on his studies of the flora of the Garhwal Himalayas, Gaur (*Flora of the District Garhwal, Northwest Himalaya1*: 1999) has categorized weeds of the northwest Himalayas according to their seasonal appearance e.g.

(i) Weeds appearing in the rainy season, and
(ii) Weeds appearing in the winter and spring season.

22 The weed flora of North-eastern India is very diverse. Weeds of north-east are required to be taxonomically evaluated in terms of their rich genetic and species diversity. Exotic weeds, owing to their aggressive nature can expand their zone of occupancy in quick succession, spread over large tracts, and endanger the natural elements of flora and bring about abrupt changes in floristic composition. With seasonal variations invasive species pass through vigorous reproductive phases without any obstruction and hinder the efforts to eradicate them. Invasive plants have appeared at different times and have always sustained and multiplied at the cost of indigenous species. They have occupied vast areas and have even driven many indigenous species into red data categories. In North-eastern India, there are some recent districts, regional and state level floras in addition to Kanjilal's classic work: *Flora of Assam* but for an accurate and up to date inventorization and taxonomic characterization of weeds, a detailed floristic study is the most desirable proposition. Dutta (*Some Common Weeds of the Tea Estates in North-East India,* 1982) worked on the weed flora of the region but confined himself to the tea estates.

2.2 Impacts of existing FIS:

23 Impact of a few major FIS is explained below

Lantana camara is one of the most obnoxious weeds that has encroached most of the areas under community and reserve forestlands. The outer fragile Himalayas are almost completely encaptured by this rapidly spreading weed. This weed, not only ruins common agricultural and forestlands but also makes shade as well as allopathy impacts on the regeneration of important forestry species. Due to spread of *Lantana*, the yields of crops and pastures get reduced. The harvesting costs have increased manifolds. Heavy expenditure is incurred for afforestation of lands infested with this weed which requires frequent weedings so as to avoid suppression of young seedlings of planted species. Afforestation cost is also increased due to loss of stand and slower growth rate due to weed competition.

Parthenium weed is difficult to control as it seeds prolifically. Seed germinates readily and the plant tolerates a wide variety of conditions. The weed is a menace to agriculture because it has allopathic effect and competes with pastures and reduces their carrying capacity. The weed affects human and animal health by causing respiratory problems, severe dermatitis and tainted milk.

Eupatorium glandulosum is found in the temperate region of the south and the north; ecological disruptions have given way to this weed. This weed spreads fast and checks the regeneration of other species particularly in Western Ghats and has replaced the valued flora at places. It comes in disturbed soils. In most of the goat-travelled paths, it comes up well;

that is why it is locally known as '*goat weed*'. Since the plant has no local or commercial use, it has widely spread in denuded and forestlands.

Ulex europaeus represents a fire hazard to private property in the Western Ghats. It invades watersheds, which supply a substantial amount of drinking water. It is threatening agricultural and grazing lands. Thickets of this weed are impenetrable to humans and have persistent spiny litter.

Acacia mearnsii was introduced in Western Ghats particularly in the Nilgiris to provide fuelwood to the rural people to save the shola forests, which were degraded in the past by human activities. It was also planted in the tea gardens to provide shade to the tea plants but now it has covered most of the shola forests and become menace in the Nilgiri Hills. Regeneration of shola forests is effected due to profuse regeneration and invasive nature of this species.

Mikania micrantha is a perennial fast growing weed of Neotropical origin and has become a major menace to the natural forests, plantations and agricultural systems in North-east and South-west India. This weed spreads very fast in areas where canopy is open.

Cytisus scoparius was introduced from European countries in the Western Ghats for ornamental purposes but now it has become menace in the Nilgiri Hills particularly in the shola forests and grazing lands. It reduces the regeneration of shola species and invades on the grasslands, thus decreases the production of grass for the cattle of Nilgiris. This species spreads fast in the areas distributed by forest fires or other biotic interferences.

Euphorbia royleana in the Himalayan zones comes up profusely and has covered thousands of hectares of land. This plant represents a desert environment. Being cactus in habit, it has no use in conserving or making of soil. similarly, in this zone there are a few other plants viz. *Artemisia vulgaris, Carrisa carander and Dodonea viscosa,* which have spread like weeds and have large areas under their control. *Cannabis sativa* weed has canvassed most of the deforested and community lands, complicating land management.

24 Besides the above, unabated free grazing and intense human activities have led the way to many other plant species having no use in supporting ecology and economy of the region. These are *Agave catula, Ageratum conizoides, Cassia tora, Clerodendron viscosum* etc.

2.3 Cross-sectoral threats

25 The FIS not only affects the productivity of forests but also cause heavy losses to agricultural production, blocking of water bodies, water transport ways, affecting wildlife habitat in the forests and wetlands and commercial activities such as cultivation of medicinal plants etc.

2.4 Current methods/ techniques for prevention of monitoring control of weeds

26 Presently the following species specific methods are being employed for prevention and control of weeds:

Mechanical: Mechanical control involves hoes, cultivators, harrows, rotary weeders, discs, ploughs, scythes, mowers and manual uprooting. The weeds are physically lifted from the soil, cut off or buried. In most of the forestry operations the FIS such as lantana, eupatorium, mikania, mimosa, etc. are uprooted manually and either burnt or buried. In some places, those are being used for making compost.

Chemical: This is one of the most common methods employed for control of FIS. Most chemicals are species specific though their use is not always desirable due to environmental degradation and pollution that they often cause and their effects on other useful species.

Tillage: Tillage helps in the burial of most small annual weeds. If all growing points are buried, most annual weeds will be killed. Tillage also disturbs the rooting system of most of the perennial weeds. The root system is cut to enough depth so that the plant dies from desiccation before it can re-establish its roots. In moist soils or if it rains soon after tillage, the roots may quickly re-establish themselves. In effect one may transplant the weed with little or no injury. Mowing is effective on tall growing plants. Tall annual weeds are mowed or scythed to reduce competition with crop plants and to prevent seed production.

Crop competition: Crop competition is one of the cheapest and most useful methods farmers can use. Often it means using the best crop production methods so favorable to the crop that weeds are crowded out. Actually competition makes full use of one of the oldest laws of nature-"Survival of the fittest". Weeds compete with crop plants for light, soil moisture, nutrients and carbon dioxide. One mustard plant (weed) requires twice as much nitrogen and phosphorus, four times as much potassium, and four times as much water as well developed oat plant. Early weed competition

usually reduces crop yields far more than late season weedy growth. Therefore, early weed control is extremely important. Late weed growth may not seriously reduce yields, but it makes harvesting difficult, reduces crop quality, and reinfests the land with seeds and harbors insects and diseases. In planning a control programme, it is important to know the weed's life cycle. If it is possible to interrupt the cycle it becomes very effective control. In crop production, this may be a shift in planting date or a well-timed chemical spray; thus the crop gets the upper hand or competitive advantage. Smothering with plastics, tar, paper, straw, saw dust or any other similar material is largely a matter of competition for light. Most weed seedlings cannot penetrate the thick coverings and die because of lack of light.

Crop rotation: Certain weeds are more common in some crops than in others. Besides the annual weeds, for the parasitic weeds, such as striga in sorghum and orbanche in tobacco, the hosts are the crop species grown. Rotation of crops is an efficient way to reduce weed growth. A good rotation for weed control usually includes strong competitive crops grown in each part of the rotation. In growing mixed crops as in the tropics; the weed problem is eliminated to a greater extent in most of the irrigated crops.

Biological control: In biological weed control, a 'natural enemy' of the plant is used which is harmless to desired plants. Insects or diseases organisms are the usual natural enemies. Also parasitic plants, selective grazing by livestock, and highly competitive replacement plants are other forms of biological control. The outstanding example of biological weed control is the one on Cactus (*Opuntia spp*.) with a moth borer *Cactoblastic cactorum* and or *Lantana camara* with several kinds of caterpillars and a fly, which damages the berries. Researchers have located and tested numerous biological agents against Parthenium weed. These include a gall forming moth, leaf minor, weevil, beetles and a rust fungus.

2.5 Actions being considered to prevent introduction of FIS

27

i) **Limit soil disturbances:** To limit the establishment of invasive plant infestations, prevent unnecessary soil disturbances, wherever possible.

ii) **Immediate re-vegetation of disturbed sites:** To limit the potential establishment of invasive plants on disturbed ground, re-vegetate the area with approved species through a time bound plan. If the area has a known invasive plant population, it may be better to control the plants prior to re-vegetation.

iii) **Use certified "Weed Free" Seeds for re-vegetation of disturbed sites:** To ensure virtually invasive plant free seed mix, a purchaser should request a "Certificate **of Seed Analysis**". To get a more detailed "Certificate of Seed Analysis" the purchaser can request a larger seed sample analyzed, rather than the typical 25gm sample to improve the confidence of the analysis. Alternatively, one can start with pure seeds and then prepare the seed mix manually.

iv) **Clean equipment and materials:** Practice due diligence by ensuring that all equipment, materials and vehicles are free of invasive plant seeds and plant parts before arriving on site. All agricultural implements or any equipment potentially exposed to invasive plants must be cleaned prior to use. Also equipment, materials and vehicles exposed to weeds are to be cleaned prior to leaving the infested site.

v) **Use of "Weed free" hay bales for erosion control and feed:** The use of straw bales for erosion control is discouraged. Unlike hay, it is very difficult to determine if the straw bales are free of invasive plant seeds. Therefore, certified "weed free" hay bales acquired from producers with a "Certificate of Inspection" should be used for erosion control. Hay imported for feed should as well be certified as "weed free"

vi) **Early detection and eradication:** Because a single plant and small infestations are much easier to control than large infestations, it is important to manage invasive plants proactively through continuous monitoring. To do this effectively, field staff should be trained in the identification of restricted and noxious invasive plants, collection of survey information, and the importance of destroying individual invasive plants and reporting new infestations in a timely manner.

vii) **Pre-activity invasive plant survey:** An invasive plant survey should be completed prior to the commencement of any land disturbing activity to identify potential problem areas. Sites with invasive plants identified should be taken note of in order to alter practices to limit their spread (e.g. control prior to land disturbance, cleaning of equipment and materials before leaving the site). As the pre-activity invasive plant survey acts as a heads up for potential infestations, a follow-up survey should be completed to assess the invasive plant conditions as a result of the activities.

viii) **Limit seed introduction in fill:** Inspect gravel pits, soil stockpiles or other fill sources for invasive plants prior to movement of the material to ensure the product has a low risk of introducing invasive plants.

ix) **Communication:** Communication between various stakeholders and provincial and municipal government agencies is beneficial to transfer information for promoting regional awareness. Information such as the invasive plant history of certain locations or invasive plant infestation locations may be beneficial to all parties.

x) **Incorporate invasive plant management in planning phase:** Inventory of invasive plants should be considered in all operational plans to ensure effective and efficient management. Effective invasive plant management plans should incorporate education, survey, control, and prevention measures.

xi) **Education and awareness:** Invasive plant education and awareness programmes developed co-operatively or individually by companies and agencies are essential in order to put the above prevention measures into practice. The people have to be made aware of the harmful effects of these weeds and how to utilize the eradicated raw materials for economic uses. The invasion of the weeds needs to be controlled and utilize their raw materials for economic uses. For example, the Eichhornia weed is being utilized for electricity generation and eupatorium for preparation of compost. Forest Research Institute has made furniture and buckets from *Lantana camara* wood.

2.6 Technical and financial barriers

28 Some of the FIS have widely spread in almost all the biogeographical regions of the country; many intermingled with commercially valuable plant and animal species. Their biological control may be injurious to other species and the chemical control may result in chemical pollution of the soil and environment. The mechanical control measures prove very time consuming and need a lot of finances. Adequate and thorough research is needed to find out the most cost effective ways to control the FIS.

2.7 Potential future FIS threats

29 Indian economy has major stakes in agriculture, horticulture and forestry activities and is actively engaged in import and export of planting materials and products. India has a well-established quarantine system, which regulates the import and export of these materials to check the entry or exit of the harmful pathogens. But still the possibility of various pathogens being introduced into the country or sent to other countries despite the quarantine regulations cannot be overruled. In the forestry sector, in the last few decades some new pathogens got into India along with some exotic tree species introduced in the plantation programmes.

30 To conserve the forest wealth by protecting trees and timber from bio-deterioration due to microbes, insect pests and marine borers, 'Wood Bio-degradation Division' of Institute of Wood Science and Technology, Bangalore under the Indian Council Of Forestry Research and Education (ICFRE) has been engaged in studies on the diverse groups of

microbes, insect-pests and marine organisms which cause bio-deterioration of trees and timber. In addition to this, the institute is also involved in studies of insect diversity in different forest ecosystems like mangroves in west and east coasts, forests in Western and Eastern Ghats and also in Western and Eastern Plains. Many species have been collected and documented which include both indigenous and bio-invasive species.

Bio-invasions associated with wood imports

31 Insects are major determinants of forests productivity. Periodic outbreaks of insects occur in the natural forests that causes heavy losses. In monocultures, the outbreaks of insect pests are frequent which reduces the productivity of the plantations besides causing mortality in extreme cases.

32 There is a huge gap between demand and supply of timber in the country. As against an annual requirement of 64 million cum (excluding fuel wood), the supply is of the order of 43 million cum from all sources Imports of wood and wood products constitute one of the major sources of supply. The situation is likely to remain the same for some more years to come, as several sections of the society have clear economic incentives to continue importing timber for a variety of uses. The volume of trade is increasing. As volume of trade in forest products increases so do the chances of invasion of alien species that can cause large-scale infestations and possible destruction of forest ecosystems, where natural immunity does not exist. Under the new regulations of World Trade Organization wherein a lot of restrictions have been eased for facilitating free trade, the chances of introduction of FIS are even more.

2.8 National priorities in combating/ controlling FIS

33 Through regulations and strict monitoring, the authorities have been laying emphasis on checking introduction of Invasive Alien Species (IAS) through trade and tourism. Strict checking of import of plant and animal species and products is being ensured at all the entry points. National priorities include considering common regulations for coordination by the various agencies in the country which control major pathways of IAS by one agency and strict checking at all the possible entry points, creating general awareness among the public, policy makers and other authorities, exchange of information among the neighbouring countries through the established international and regional networks, finding adequate financial resources and capacity building of research and development activities for identification, prevention, eradication, control and management of IAS. Details of a case study conducted for investigation of bio-invasion associated with wood are give at **Annexure-II**

2.9 Level of public awareness of existing and potential FIS

34 At present there is not much awareness among the public of the existing and potential threats of the IAS including FIS and also no systematic national level initiative has been made in this direction. However, awareness on the problem is increasing and a few scientific seminars/ workshops on the subject have been organized at the national and states levels. But, much needs to be done in creating awareness among the public, policy makers and academicians about the social-economic effects of FIS. India is party to a number of international and regional convention/institutions/instruments to address the problem of the IAS. Participation in the meetings of these institutions/ instruments and their publicity in the media is also helping in creating awareness among the public.

3. Management and institutional framework

3.1 policies, law, regulations and national and local agencies having lead responsibility

35 India follows international quarantine regulations, which are amended from time to time. Directorate of Plant Protection, Quarantine and Storage, Faridabad under the Ministry of Agriculture, GOI with its network of stations particularly at port of entries, is the nodal agency to enforce the regulations. Two institutes i.e. FRI, Dehradun and Institute of Forest Genetics and Tree Breeding, Coimbatore under the ICFRE are authorized institutions to issue phytosanitary certificates for exporting any products or produce of forest origin.

36 The regional offices for wildlife preservation of the GOI under the Ministry of Environment and Forests (MoEF) established at New Delhi, Mumbai, Chennai and Kolkata with their sub-regional offices at Amritsar, Kochi and Guwahati check and regulate the import and export of wildlife species at airports and sea ports. But with the limited manpower and infrastructure, the measures need a lot of strengthening.

37 The State Forest Departments (SFDs) concerned are solely responsible for managing the forests in the country. The management of weeds in Indian forests encompasses a task of stupendous magnitude, which consumes major chunk of funds allocated to the forestry sector. Organizations like the ICFRE and its institutes, Bitanical Survey of India, Botany Departments of the Universities, State agencies, Van Vigyan Kendras, NGOs, etc.work on different aspects of the forest vegetation but not much on weed control. Indian Council of Agricultural Research (ICAR) with its network of institutes, Agriculture Universities, Krishi Vigyan kendras, etc. have, however, done a lot of work on the management of weeds in

agriculture. Given the challenges that are arising in forest areas due to FIS, further re-orienting the research priorities and strengthening of ICFRE institutes and other similar organizations is required.

38 Nevertheless, in consonance with the provisions of the International Plant Production Convention (IPPC), the GOI issued terms and conditions for inspection and fumigation, distinfection or disinfestations of exportable plants and plant productions for issuance of phytosaniary certificates. Thereafter, the procedures in this regard have been outlined by the Directorate of Plant Protection , Quarantine & Storage in1988. Subsequently, GOI issued the list of the officers in central/state governments authorized to inspect/ treat and issue the phytosanitary certificates, during November, 1993, (Plant Quarantine Manual on Export Certification and Issuance of Phytosanitary Certificates, 1998).

39 India is well aware of the problems of bio-invasion and its obligations towards SPS Agreement and is gearing itself up to meet the challenges. Till recently, there were no separate rules for import of wood and wood products, these being treated as agricultural commodities. During the study period (November 2003), the GOI (Ministry of Agriculture, Department of Agriculture and Cooperation) notified the plant quarantine regulation (Regulation of Import to India Order) (referred to as PQ Order, 2003 in this report) that has generated a great deal of debate. Five amendments followed quickly (up to September 2005), reflecting the importance attached to the problem. The sixth amendment is under consideration.

40 Though India is moving closer to meeting the standards set by International Plant Protection Convention (IPPC), a standard setting organization acceptable to SPS, with a basic framework to meet its obligations, adequate technical

manpower, infrastructural facilities and linkages between enforcement authorities, R&D institutes, industry and other groups are required for effective implementation.

3.2 Barriers for cooperation

41 No barriers exist for soliciting cooperation in the identification, monitoring or control of the FIS.

3.3 Situation of overlapping authority

42 There are no overlapping or conflicting responsibilities for managing the IAS. However, there is need for better coordination.

3.4 Institutions and organizations responsible for research

43 The ICFRE and its institutes, the state forest research institutes, the SFDs and agricultural universities are responsible for undertaking research on various aspects of FIS management.

4. Strategies, mechanisms and measures to control FIS

4.1 National, trans-boundary strategies & mechanisms and quarantine measures

44 The Directorate of Plant Protection, Quarantine & Storage, located at Faridabad, Haryana, under the Ministry of Agriculture (Department of Agriculture and Co-operation) is responsible for implementation of plant quarantine regulations in India and is headed by the Plant Protection Adviser (PPA) to the GOI. Presently, there are 25 plant quarantine stations functioning all over India. The plant quarantine stations at major/minor stations are headed by Plant Protection Officers and are assisted by Technical Officers of Grade-I, II, & III. They are responsible for issuing the Phytosanitary and quarantine certificates as per the regulations.

45 The plant quarantine regulations have been formulated by the Plant Quarantine Organization of India under the Ministry of Agriculture. A copy of the regulations, Plant Quarantine Order, 2003 (PQ Order 2003), is available at *www.plantquarantineindia.org*

46 The regulations specify general conditions of import of plants, plant products, soil, live insects, mites, nematodes and microbial cultures including algae /bio-control agents, timber etc (Chapter II of PQ Order 2003 and Chapter III special conditions for import of plant species of PQ Order 2003). Post entry quarantine measures have also been specified (Chapter III of PQ Order 2003). The order also specifies the formats to be used for various types of permits and contains details regarding import of plant material such as (a) points of entry into the country, (b) list of inland container depots and container freight stations, (c) list of foreign post offices, (d) list of plants/ planting materials and countries from where import is prohibited along with justifications, (e) list of plants and plant materials for restricted import only by authorized institutions, (f) list of plants/ planting materials, where imports are permissible on the basis of phytosanitary certificate issued byexporting country, (g) list of quarantine weed species (Shedule-VIII of PQ Order, 2003, appended as

Annexure-III), (h) list of inspection authorities for certification of post-entry quarantine facilities and inspection of growing plants (Schedule-XI of PQ Order, 2003 appended as **Annexure-IV**).

47 With reference to Schedule-XI of the PQ Order 2003, the GOI is yet to officially designate the State Forest Departments and the ICFRE institutes as authorities for monitoring, control of FIS and implementation of import/ export controls from forest, national parks and other protected areas.

48 **International quarantine regulations are very stringent**. The Cartegna Protocol on Bio-safety entered into force on 11 September, 2003 after it was ratified by 50 governments. Till date 100 governments have ratified the protocol (http: // www.biodiv.org). Its aim is to ensure that recipient countries have both the opportunity and the capacity to asses risks involving the products of modern biotechnology. The Protocol established a harmonized set of international rules and procedures designed to ensure that countries are provided with the relevant information to enable them to make informed decisions before agreeing to the import of Living Modified Organisms (LMOs) via a Bio-safety Clearing House, a mechanism set up to facilitate the exchange of information on and experience with LMOs. In addition, commodities that may contain LMOs are to be clearly labeled as such when being exported. The treaty known as **Advance Informed Agreement** procedure requires countries exporting LMOs to gain consent from importing country, prior to export, and to ensure that exports are accompanied with appropriate documentation. The aim is to ensure that recipient countries have both the opportunity and the capacity to assess risks involving the products of modern biotechnology.

49 Utmost care has to be taken by the countries which export or import the planting material or wood so as to ensure that harmful organisms should not be exported along with the consignment. For this each consignment is free from all injurious organisms. Even then some harmful organisms may be inadvertently introduced in many countries including India. When these organisms enter a new environment free from competitors and life threatening forms, their population increases with likelihood of the organisms turning invasive in due course of time. These invasive organisms including insects cause heavy losses to the forest and products.

4.2 Mechanical, biological and chemical control measures

50 Adequate strategies, mechanisms and measures for the effective control of the weeds of agriculture, horticulture, and floriculture are adopted throughout the length and breadth of the country. These include prevention, control, suppression, eradication, etc. However, information available on management of FIS in forest areas is not adequate. Some of the control measures undertaken for major FIS in India are given at **Annexure V.**

4.3 Mechanisms /institutions for conveying information

51 Presently there is no fool proof system of reporting about the existence of IAS or FIS in India either to the government officials or the general public. Only when a species becomes invasive and starts affecting socio-economically, measures are taken for its eradication and control.

4.4 Mechanisms and partnerships

52 many of the NGOs, universities and private institutions undertake research in collaboration with the government departments and cooperate in monitoring and control of the FIS

5 Facilities and services available for national or regional cooperation

5.1 Tools and information for sharing

53 The information available on various effective control methods FIS, the ongoing projects on management of the FIS and the FIS which got introduced accidently in the recent past or likely to create problems can be shared with the members of the network.

5.2 List of experts/ scientists in the field

54 Information on resource persons having expertise in dealing with the FIS is being obtained from various sources including universities which will be communicated in due course. However, information on a few scientists/ experts is given at **Annexure VI.**

5. 3 Research institutions for undertaking research

55 In India, a number of government institutions are available for undertaking research on FIS. The universities also have well equipped laboratories, training facilities and field sites for undertaking research. Details of some of the institutions are

1) Forest Research Institute (FRI)

56 One of the institutes of the ICFRE is one of the oldest forestry research organizations in South Asia and very well reputed for scientific research in forestry. Several collaborative projects with international organizations have been successfully completed in the past and several more are being implemented currently. With this experience and expertise the Council has immense potential and scope for national and regional co-operation in FIS. Some of the facilities available are highlighted below:

57 Infrastructural, scientific and technical facilities are available in ICFRE and its regional institutes. Besides, the regional institutes maintain herbaria of forest plant and insect species. The plant specimens have been authentically identified and can be utilized as important reference collections for taxonomical and other related studies of invasive species. ICFRE has experienced plant taxonomists, entomologists, and pathologists. The expertise is available on the fungi belonging to Ascomycotina, Deuteromycotina and Basidiomycotina, especially those infecting forest species.

58 The forest pathology division of FRI has all the necessary equipment and space for inoculation, incubation and growth studies, like incubators, autoclaves, growth chambers, laminar flows, ovens, electronic balances, research microscopes, microphotography, pH meter, growth chambers, seed germinators, etc. A glasshouse essentially required

for experiments on the invasive species in isolation is also available in the division. These facilities can be extended to the member countries for collaborative work.

59 The division of forest entomology in FRI maintains an authentic reference collection of insects with more than 22,000 species of insects out of which 1,700 are 'type' specimens. The division provides insect identification services for other organizations. The Institute is recognized by many International organizations such as FAO, IUFRO etc.

2) Himalayan Forest Research Institute, Shimla

60 It has a well equipped laboratory and field station at altitudinal ranges for testing and control of incidences of pest infestations in forest areas.

61 These institutes have conference hall and multimedia facilities along with accommodation for participants for arranging workshop / seminars at both national and international levels

3) Kerala Forest Research Institute (KFRI), Peechi, Kerala

62 KFRI is one of the pioneer institutes which has done quite substantial work on the FIS and has got a number of excellent scientists and facilities for undertaking collaborative projects at international as well as regional levels. Results of some of the research projects undertaken by the KFRI on FIS are given at **Annexure VII**.

Facilities available with the institute which can be shared

Services of experts

63 Experimental sites for conducting surveys and field trails will be available anywhere within the state with the help of the forest department. Moreover, the institute has its own field stations with extensive areas for conducting field testing.

Research infrastructure

65 Glass house net house, inoculation rooms, cold rooms for culture storage, laboratory with excellent microscopes and most modern equipments like atomic absorption spectrophotometer, auto analyzer, and HPLC digestion system. a world class biotechnology laboratory is an added facility.

Conduct of workshops and seminars

66 The institute has been a venue of several national and international seminars and workshops. We have a world class fully air-conditioned auditorium with excellent audio and video facilities, three extra seminars rooms to run concurrent sessions (all air-conditioned), facility for power-point presentation, power backup and other connected facilities.

5.4 Venues for holding workshops / seminars

67 All the institutes mentioned above and a number of other well furnished and equipped venues with air connectivity are available for holding international workshops / seminars. The names of a few such institutions are as below

S. No	**Institutions**	Nearest Airport
1	FRI Dehradun	Delhi 270 Km/ Jolly- Grant 25 Km.
2	IWST, Bangalore	Bangalore
3	KFRI, Peechi	Kochi 55 Km
4	IFGTB, Coimbatore	Coimbatore
5	HFRI, Shimla	Delhi /Shimla
6	TFRI, Jorhat	Guwahati / Jorhat
7	AFRI, Jodhpur	Jodhpur

68 Near to the venues for holding international workshops / seminars, field visit can be conducted for the participants to the sites where FIS control measures have been successfully undertaken.

5.5 International treaties, MOUs and other agreements

69 India is signatory to a number of international Conventions/ Treaties and Agreements dealing with invasive species some of which are mentioned below:

1 Convention on Biological Diversity (Nairobi, 1992)

2 Cartegna Protocol on Biosafety to the Convention on Biological Diversity (Montreal, 2000)

3 United Nations Convention on the Law of the Sea (Montego Bay, 1982)

4 The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, 1971)
5 Convention on Migratory Species of Wild Animals (Bonn, 1979)
6 IUCN-Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive
7 Agenda 21-United nations Conference on Environment and Development (Rio, 1992)
8 Asia Pacific Forest Invasive Species Network, FAO Regional office, Bangkok.

6 Related websites

S. No.	Institute/Organization	Website
1	Directorate of Plant Protection, Quarantine and Storage, Ministry of Agriculture, GOI	www.plantquarantineindia.org
2	Forest Survey of India, Dehradun	www.fsiorg.net
3	Indian Council of Forestry Research & Education, P O New Forest, Dehradun-248 006, Uttaranchal (INDIA)	
4	Kerala Forest Research Institute Peechi-680 653, Kerala, India.	www.kfri.org
5	MoEF, GOI	www.envfor.nic.in

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4 Babu; Herbaceous flora of Dehradun, India, 1977

5 Gaur, Flora of District Garhwal, Northwest Himalayas, 1999

6 Dutta, Some Common Weeds of the Tea Estates inNorth-East India, 1982

7 Kishwan Jagdish & Ratho S K, 'Environmental Security, Livelihoods and Sustainable Forest Management', a paper presented in a workshop on 'Watershed Management for Sustainable Production and Environmental Security held at GB pant University of Agriculture and Technology, Pant Nagay May 19-21, 2001.

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9 Forests and Wildlife Statistics, Ministry of Environmental and Forests, 2004.

SN	Scientific Name	Common name	Origin	Introduction	Likely pathway of spread	Vector	Distribution pattern	Rate of change	Major hosts	Threat level

Annexure-1

Checklist of Forest Invasive Species having National Distributon

1. Floral FIS (Weeds and plants)

				Method	Year						
1	*Acacia farnesiana*	Babool	Australia	-	-	Seeds	Wild animals	Grassland and open forest area creating dense thickets through which livestock cannot move	-	-	National
4	*Ageratina adenophora*	Crofton weed	Mexico	-	-	Air, water	Animals, transport network, nurseries	The weed has occupied vacant places in teak, rubber and other forest plantations and causing serious threat to forests	In Western Ghats, forests & grazing lands, degraded lands, forest areas of Nilgiri hills of South India	In hilly areas of south and north India, it forms dense thickets on grazing lands	-	National
2	*Acacia mearnsii*	Black Wattle	Australia	For tannin, fuel plantations on high altitudes in South India	Early 1800	Animals, water, regenerates rapidly after fire, both by re-sprouting and by growing from a persistent soil seed-bank	Logging, wild animals, commercial nurseries				-	National
3	*Achyranthes aspera*	**Prickly chaff flower, utlihot, ublisoth, bonsodh, upomargo**	India	-	-	Fodder, forage, wind, water run off, transportation of grains and vegetables, etc.	Cattle, animals and man, nursery operations	Commonly available throughout the area.	-	-	National

5	*Ageratum conyzoides*	Goat weed, gondhwa bon, gandhali bon Gandhela, Podina ghas,Mamira ghas, mahkua	Tropical America, naturalized throughout India	Intentional, Contaminated in crop seeds	1860	Air, water	Animals, glaziers and fodder collectors	Wastelands, plantations, pasture and all forest types to 1500 m above sea level	Increasing per year	-	Foot hills of Himalayas ,north-east and southwest India
6	*Ageratum houstonianum*	Gandhela, Podina ghas, Mamira ghas	Tropical America	Intentional	C.1900	Openings mixed with grasslands	Braziers and fodder collectors	Along the outskirts of forests, natural and plantations	-	-	National
8	*Argemone mexicana*	**Prickly poppy, Mexican poppy, kuhumkanto, shial katehi**	Central and Tropical America, West Indies, naturalized throughout	Accidental	-	Fodder, forage, water run off, transportation of grains and vegetables etc.	Animal and human agencies, causes a host of diseases in human	Forests, agricultural fields, orchards, throughout the area			
7	*Alternanthera philoxeroides*	Alligator weed	Indonesia and Myanmar	-	-	Through water ways	Not found	Alligator weed causes major blockages of water flow in waterways such as irrigation canals and rivers	The weed has been reported to accumulate heavy metals causing water pollution.		National

			India					beings, its seeds mixed with mustard seeds.					
9	*Cassia occidentalis*	**Coffee senna, medelwa**	India	-	1840	-	Fodder, forage, water run off, transportation of grains and vegetables etc.	Cattle, animals and man, nursery operations	Not uncommon throughout the area.	-	-	National
11	*Chromolaena Odorata L.*	Siam weed, devil weed	Tropical South and Central America	Via ballast in ships, as an ornamental plant			By wind, spreads rapidly in lands used for forestry, pasture and plantation crops	Wild animals and dispersal of seeds by wind	Spreading in dry open areas of forests, plantations and scrubland. In forest areas of Western Ghats and Eastern Gahts , colonizes mostly in forest clearings and fringes of forests.	-	-	
10	*Cassia tora*	**Tavra, foetid cassia, bon medelwa, alokoni**	India	-	-	-	Fodder, forage, , water run off, transportation of grains and vegetables etc.	Cattle, animals and man, nursery operations	Not uncommon, throughout the area.	-	-	National

12	*Cuscuta spp.*	Dodder	-	-	1965 in West Bengal	Transported through seeds	-	A single plant of cuscuta can produces as high as 50,000 seeds and can grow to a length of 2 km. this weed attaches itself to stems and leaves of a wide variety of host plants and establish a parasitic union.	It is causing severe damage to forest and agricultural crops in India	-	National
14	*Cyperus rotundus*	**Mutha**	India	-	-	Through man, cattle, other animals and water	Through man, cattle, animals and water	Throughout the area.	-	-	
13	*Cyperus pilosus*	**Harkota bon**	India	-	-	Through man, cattle, other animals and water	Through man, cattle, animals and water	Throughout the area.	-	-	National

15	*Cytisus scoparius*	Yellow broom	Europe	Introduced intentionally as ornamental plants	-	Regenerates rapidly after fire, both by re-sprouting and by growing from a persistent soil seed-bank	Wild animals	Covers open areas and forms dense monospecific thickets.	-	-	National
16	*Desmodium laxiflorum*	**Bionic sopota**	India	-	-	Through man, cattle, other animals and water	Through man, animals, cattle, and water	Throughout the area.	-	-	National
20	*Eichornia crassipes*	Water hyacinth, bih meteka	South America (Brazil), naturalized in India	Intentionally introduced by transport through ships	c.1914 - 1916	Through man, cattle, other animals, water transport, spread through stolons	Through man, animals, cattle, and water	Nuisance for aquatic ecosystems as it causes hindrance in navigation, chokes irrigation systems and reduce value of water bodies	Almost all the ecosystems	-	
17	*Dioscorea deltoidea*	**Bonoria kathalu**	India	-	-	Through man, cattle, other animals and water	Through man, cattle, animals and water	Throughout the area.	-	-	National
18	*Dioscorea pentaphylla*	**Paspotia alu**	India	-	-	Through man, animals, cattle, and water	Through man, animals, cattle, and water	Throughout the area.	-	-	National
19	*Eclipta prostrata*	**Kehraj**	Cosmopolitean in warm countries ,India	-	-	Fodder, forage, wind, water run off, transportation of grains and vegetables, etc.	Cattle, animals, man and nursery operations	Common Throughout the area.	-	-	National

21	*Eupatorium glandulosum*	Kala bansa	-	-	1950	From South America	-	Forest areas, plantations, cultivated fields etc.	-	-	National
22	*Euphorbia hirta L*	Garden spunge, Asthma plant	Tropical America	-	-	Air, water	Animals, nurseries	Cultivated lands, gardens, lawns, wastelands	-	-	National
23	*Eupatorium odoratum*	Siam weed sam holok, bagh dhoka, pohu odal, german habi	Central and South America. Naturalized in India	Accidential	-	Fodder, forage, wind, water run off, transportation of grains and vegetables, etc.	Cattle, animals, birds, man and nursery operations.	Common throughout the area.	-	-	National
24	*Fimbristylis miliacea*	**Keya bon**	India	-	-	Through man, cattle, other animals and water	Through man, animals, cattle and water	Throughout the area.	-	-	National
25	*Galinsoga parviflora*	Gallant soldier or yellow weed	Neotropical	-	-	-	-	Covers urban areas, trails, open rocky sites and pasture lands	-	-	

26	*Ichnocarpus frutescens*	**Black creeper, dudh lota, dudh koori**	India	-	-	Through man, cattle, other animals and air.	Through man, animals, cattle and air	Throughout the area.	-	-	National
27	*Mimosa pigra*		Mexico, Central and South America	-	-	Transported through seeds	-	It makes infested areas inaccessible to animals and people, and interferes with stock watering, irrigation and recreational use of waterways.	It invades watercourses and seasonally flooded wetlands in tropical and sub-tropical regions	-	National

28	*Imperata cylindrica*	**Thatch grass, alang alang, cogon grass, Ulu, kher**	Philippines, India	-	1940	Fodder, forage, wind, birds and water run off ,	Cattle, animals, birds and man	Swamps, floodplains, dry scrubs, and sand dunes, as well as the sand hills, roadsides, pastures, utility rights –of-way, and mined lands. Through out the area, not uncommon	-	-	National
29	*Ipomoea carnea*	Bahaya, Sada suhagan	South America	Intentionally introduced as flowering plants, cuttings	Early 20^{th} century	Cutting, aggressive colonizer of riparian zone, transported through seed, escape from gardens and aquariums	Animal, nursery raised cuttings, fuel wood collectors, planting for decoration	It is perennial diffuse or straggling shrub and comes up in water logged areas and is resistant to drought, causes hindrance in navigation and chokes irrigation systems	They are widely seen in roadside and farm ditches, shoreline and river - sides. It has become an obnoxious aquatic weed	-	National
30	*Ipomoea fistulosa*	**Besharam, behaya**	Tropical America, naturalized in India	Accidental or perhaps introduced.	-	Cattle, water run off, wind, garden waste and man	Water channels and disturbed areas in forests, wastelands , fringes of villages etc., throughou	Forest areas, water channels and hedges.	-	-	National

					t the region							
31	*Lantana camera L*	**Lantana, Large leaved Lantana, Podina ghas Kurri Ghaneri (Mar); Pulikampa (Tel); Unnichedi (Tam); Hesike (Kan); Arippu(Mal)**	Tropical America, naturalized throughout India	Introduced as an ornamental plant	1809	Nursery, trade, animal excretion, garden waste,	Animals, birds and human agencies, transport networks, commercial nurseries, etc.	Common throughout the country in the forests, plantations, agricultural land, disturbed areas, grass lands, wetlands, riparian and urban areas.	Areas under Lantana increasing by 700 ha per year (approx.)	-	National

32	*Leucaena leucocephala*	Subabul, Ipil-ipil	Mexico, Central America and West Indies	Forage production and afforestation programmes	1960	Transported through seeds, animals, water	Animals, transport networks, humans	Invades cleared areas, wastelands and forms dense thickets	It forms dense thickets and difficult to eradicate, rendering extensive areas unusable and threaten-ing native plants in most areas.	-	National
34	*Microcystis*	-	China	Introduced for fertility induction	-	Spores spread through water and aquatic animals	-	Invasive weed causing extensive damage to the aquatic ecosystems and affect aquatic biodiversity	-	-	
33	*Melochia corchorifolia*	**Bon mora**	India	Accidental	-	Fodder, forage, wind, water run off, transportatio n of grains and vegetables, etc.	Cattle, animals and man, nursery operations	Common throughout the area.	-	-	National

35	*Mikania micrantha*	Silver bullet, mile- a-minute weed	Tropical and sub tropical zones of North and South America	Introduced as ground cover an air force run way, camouflage during World Wars and cover crop for tea plantations	Early 1900	Air, water, nursery, trade	Wildlife, animal transport network and nurseries	Major menace in natural forests, plantations, agricultural systems in northeast and southwest India, disturbed areas	Spreading fast in South-west and North-east India	*Puccinia Spegazzinii* fungus.	National

36	*Partbenium bysteropborus L*	Carrot weed, congress grass, white top grass, gajarghas Chatakchanda Ni	Mexico, Argentina, Tropical America, invaded large areas in India	Commercial trade from USA, believed to have come with Mexican wheat consignment	1950	Wind, water run off, transport of grains and vegetable, garden waste etc.	By air, cattle, nurseries animals and man.	Agricultural fields, forest areas, grass lands & urban areas, aggressive colonizer of degraded areas with poor ground cover and exposed soil such as fallow wastelands, roadsides and overgrazed pastures between existing plant cover and native weed density	Spreads very fast, it infests about 5million hectares area	*Epiblema strenuana*	
37	*Prosopis cbilensis* (Molina) Stuntz	Vilayati kikkar, Kabuli kikkar(H); Belikaruvel delli mullu (T*am*)	Native of south and central America			Animal excretion; garden waste	Animal excretion	The species is commonly found in plains of Tamil Nadu and Andhra Pradesh and has spread to dry deciduous forest areas.			National

38	*Prosopis juliflora*	Vilayati Babool	Central and South America	Intentionally introduced for greening dry area and for fuel wood purposes	1915-	Fodder, forage, wind, water run off	Cattle, animals, birds and man.	Not uncommon throughout the area.	-	-	National
39	*Saccharum spontaneum*	Kans grass, wild cane, kohua	India	-	-	Water transport, spread through stolones	Animals	Nuisance for aquatic ecosystems and reduces aesthetic value of water bodies	-	-	National
40	*Salvinia molesta*		South America	Accidental	-	Fodder, forage, wind, water run off, transportation of grains and vegetables, etc.	Cattle, animals and man, nursery operations	Common throughout the area.	-	-	National
41	*Sida orientails*	**Snake's tongue, Sonbrial, boriala**	Pantropical . invaded throughout India	Accidental	-	Fodder, forage, wind, water run off, transportation of grains and vegetables, etc.	Cattle, animals and man, nursery operations	Common throughout the area.	-	-	National
42	*Sida orientalis*	**Paroquet bur, sida hemp, broom jute sida, soru sonbrial**	Pantropical . invaded throughout India								

43	*Solanum elaeagnifolium*	Silver leaf night shade, White weed	South west United States and northern Mexico	Ornamental	-	Nursery trade; animal excretion ; garden waste	Seeds, creeping rhizomes and root fragments through agricultural operations	It attacks agricultural crops	It is damaging adjoining forest areas or plants of agricultural crops	-	National
44	*Solanum viarum*		South America	-	-	Seeds	Livestock (cattle) and wildlife	It is an aggressive perennial of most of the areas	-	-	National
45	*Tridax procumbens*	-	Tropical America, naturalized in India	Accidental	-	Fodder, forage, wind, water run off, transportation of grains and vegetables, etc.	Cattle, animals and man, nursery operations	Common throughout the area.	-	-	National
46	*riumfetta rhomboidea*	**Champadang, spiny cocklebur, Bon orora**	India	-	-	Fodder, forage, wind, water run off, transportation of grains and vegetables, etc.	Cattle, animals, birds, man and nursery operations.	Common throughout the area.	-	-	National
47	*Ulex europaeus*	Grose	Europe	Introduced intentionally as an ornamental plant		Seeds, insects, it regenerates rapidly after fire both by re-sprouting and by growing from a persistent soil seed-bank	Wild animals	Covers open areas and forms dense nonspecific thickets.	-	-	National

48	*Urena lobata*	**Aramina, Cadilla, bor sonobrial**	India	-	-	Fodder, forage, wind, water run off, transportation of grains and vegetables, etc.	Cattle, animals, birds, man and nursery operations.	Common throughout the area.	-	-	National
49	*Xanthium strumarium*	**Clot bur, cockle bur, bur weed, Ogora**	Cosmopolitan. naturalized throughout India.	-	-	Fodder, forage, wind, water run off, transportation of grains and vegetables, etc.	Cattle, animals, man and nursery operations.	Common throughout the area.	-	-	National

2. Entomological FIS (Insects)

1.	*Aleurodicus disperses*	Spiraling white fly	Central America	Unintention-ally introduced	1993	Planting materials	Planting stock	Spreading gradually to southern states	-	253 host plants, out of which 34 forest tree Tectona grandis species	National

										including teak	
2.	*Anoplolepis Gracilipes*	Yellow crazy ant	West Africa	Unintention-ally introduced across the tropics as a by product of commerce	-	Nurseries, planted and natural forests	By product of commerce	Distibuted in the tropics and subtropics especially in nurseries, planted and natural forests.	-	No specific to particular host plants but has significant association s with cocoa, coconut, and coffee	National
3.	*Curculio sikkimensis*	Weeilbeetle	-	Endemic	2002	-	-	India, Nepal, Japan, China, Burma and South-East Asia India in Chengalpatu, Tamil Nadu	-	1.*Quercus leucotrichopbora* 2.*Q.dilatata* 3.*Q.glauca*	
4.	*Ectropis deodarae* Prout	Deodar defoliator	-	Sporadic and frequent out break of the paste in deodar forests	2001	Accidental introduction	-	It distributed all along North-West part of India in outer as well inner ranges of Himalayas	-	1.Cedrus deodara 2. Abies pindrow 3. Pinus wallicbiana 4. Pinus gerardiana	
5.	*Heteropsylla cubana*	Jumping lice of Leucaena	Cuba, Central and South America	Unintentionally introduced with *Leucaenaleucocepbala*	1988	Accidental introduction, Planting material	Planting stock	Well established all over India	-	Subabool, *Leucaena Leucocephala*	National

6.	*Icerya purcbasi*	Cottony cushion scale	Australia	Unintentionally introduced	1921	Accidental introduction, planting material	Planting stock	Nilgiris, Anamalai hills, Karnataka, Kerala Tamil Nadu and all parts of India	Spreading rapidly troughout humid regions of India	*Acacia dealbata, A.melanoxylon, A.decurrens, Albizia spp. Cassia spp., Causarinaeqisitifolia, juglans regia, Morus alba, Pinus roxburghii*	National
7.	Insect stem borers complex: a) *Sphaenoptera aterrima* Kerremens (Coleoptera: Buprestidae) b) *Crytorhynchus rufescens* Roeelofs (Coleoptera: Curculionidae) c)*Platypus bifoormis* Chapuis (Coleoptera: Platypodidae) d) *Polygraphus longifolia* Stebbing (Coleoptera: Scolytidae)	Beetles	-	Accidental and their population remains in Chir Pine forests	2000	Accidental introduction	-	Throughout the Chir Pine forests in Himachal Pradesh, Jammu & Kashmir and Uttaranchal	-	Chir Pine trees and associated conifers trees	
8.	*Lymantria Obfuscata*	Indian Gypsy Moth		Accidental and epidemic form	June, 2004	-	-	North-West Himalayas	N.A	1. otricophora 2. Quercus dialatata 3.Alnus nitida 4. Salix alba 5. Salix fragilis Oaks	

9.	Pineus laebis	Adalgid	Europe	Inadvertently	1966	Accidental introduction	-	Armbi, Ootacamund, Topslip		*Pinus patula, P. Kesiya, P.caribaea, P.moltezumae*	National
10.	*Pitogenes scitus* Blanford	Scolitid beetle	-	Accidental and in epidemic forn	-	Accidental introduction	-	Himachal Pradesh and Jammu &Kashmir	-	1. *Pinus wallichiana* 2. *Cedrus deodara* 3. *Picea morinda* 4. *Pinus gerardiana* 5.*Pinus longifolia*	
11.	*Quadraspidiotus perniciosus*	San Jose Scale	China	Unintentionally introduced	1911	Accidental introduction, planting materials	Planting stock	All over India	-	*Aesculus, Alnus, Betula celtis, Fagus, Fraxinus, Morus,Populus, Salix,* Apple, apricot, Loquat, Peach, Pear, Plum, currant, Walnut, fig	National
12.	*Solenopsis geminate*	Fire ant	Central America	Unintentionally introduced through commerce	-	Nurseries, planted and natural forests	Commerce	Distributed throughout New and Old World Tropics and became a pest in India	-	No specific to particular host plants but has significant associations with cocoa and coffee	National
13.	*Teleonemia scrupulosa*	Lantana lace bug	Mexico	intentionally introduced for control of lantana	1941	Planting materials	Planting stock	Distributed all over India	-	*Tectona grandis. Sesamum indicum, Lantana* spp, *Leucophyllum* spp.	National
14.	*Tuberolachnus salignus*	Giant Willow Aphid		Introduced and in epidemic form	2001	-	-	Gharwal range, Kumaon range, Kashmir valley, Lahaul and Spiti valley of Western Himalaya	N.A	1. *Salix alba* 2. *Salix correalua* 3. *Salix babilonica*	National

3. Pathogenic FIS (Fungi)

1.	*Ceratocystis* sp.	-	Europe, USA	Introduced	2000	Import	Cuttings	Uttaranchal	-	*Populus deltoids* G 48	National

2.	*Cercospora pini* densiflorae	Cercospora needle cast of radiate and chir pines	Japan	Accidental occurrence	1913	Infected needles and seed husk	Planting stock, seeds and infected needles	Affecting all exotic pine nurseries.	Spreading throug h out hilly areas of India	*Pinus radiate, P.caribaea, P. oocarpa, P.kesiya, P.roxburghii*	National
3.	*Cryphonectria cubensis*	Cryphonectria stem canker	Cuba	Accidental occurrence	1917	Planting material	Diseased planting stock	Distributed Eucalyptus plantations of Kerala (High rainfall area)	Spreading high rainfall areas of Kerala (Eucalyptus plantation)	*E. grandis, E. tereticornis,E.citriodora, E.torelliana*	National
4.	*Diplodia pinea*	Diplodia die back, Whorl canker	South Africa Cape Region, Europe, USA	Unintentionally introduced	1900	Planting material	planting stock, seeds and infected needles	Affecting exotic pines of Uttaranchal	Spreading throughout hilly areas of India	*P.patula, P.pseudostrobus*	National

5.	*Dothistroma pini*	Dothistroma Blight, Red Band	USSR, Australia, New Zealand	Unintentionally introduced	1911	Planting material (seed husk)	Infected needles & seeds.	Affecting Uttarachal, J&K and southern provenances in nursery and plantations.	Spreading throughout hilly areas of India	Pinus radiate, P.walliachiana & P. roxburghii	National
6.	*Fusarium moniliforme*		Japan	Introduced through rice import		Spores spread through air and insects		Cause 'Foot rot' disease and destroys rice fields in many of the areas		-	National
7.	*Henileia vastatrix*			Introduced through coffee import		Spores spread through air and insects		These cause Rust disease in Coffee plants in north western and southern India		-	National
8.	*Lophodermium pinastri*	Lophodermium needle cast	America, Mexico, South Africa	Accidental occurrence	1962	Infected needles & seed husk	Planting stock, seeds & infected needles	Affecting all exotic pine nurseries	Spreading throughout hilly areas of India	*Pinus radiatia, P. caribaea, P. elliotti, P.kesiya, P. roxburghii*	National

9.	*Monochaetia unicornis*	Nonochaetia canker of Cupressus and Junipers	USA, Keniya Tanzania	Accidental occurrence	1940	Infected needles & seed husk	Planting stock, seeds & infected needles	Affecting all exotic pine nurseries	Major pathogen of cupressus plantations of UP	*Cupressus arizonica, C.lusitanica, C.nacrocarpa*	National
10.	*Oidium heveae*		Brazil/ Cuba	Introduced through coffee import		Spores spread through air and insects		Forms disease named "Powery Mildew" and destroy seedlings and crops		-	National
11.	*Peniopbora gigantean*	-	New Zealand	Introduced	2002	Import	Wood logs, planks	Throughout the country	-	*Pinus* spp.	National
12.	*Pseudoperonospora cubensis, Berk.*		Brazil/ Cuba	Introduced through rubber import		Spores spread through air and insects		Forms Downy Mildews' disease and destroy grapewine, cucurbita and maize crops		-	National

Checklist of Forest Invasive Species having Regional Distribution

1. Floral FIS (Weeds and Plants)

2.

SN	Scientific Name	Common Name	Origin	Introduction		Likely pathway of spread	Vectors	Distribution pattern	Rate of change	Major host	*Threat level*
				Method	Year						
1.	*Argyreia speciosa*	Elephant creeper, tokoria alu	India, Java	-	-	Fodder, forage, water run off, etc.	Cattle, animals and man, nursery Operations.	Common throughout the area.	-	-	*Regional*
2.	*Bidens pilosa*	**Beggers tick, Spanish needle**	Tropical America, Neotropics, naturalized throughout India	Accidental	-	Fodder, forage, water run off, transportation of grains and vegetables, animals, etc.	Cattle, animals and man, nursery operations, transport	Road sides coffee estates, not uncommon throughout the area	-	-	-
3.	Cassia alata	***Ringworm***	*India*	-	-	*Fodder, forage, water run off, transportation of grains and*	*Cattle, animals and man, nursery operations, transport*	*Not uncommon throughout the area*	-	-	*Regional*

						vegetables, animals, etc.					
4.	*Clerodendrum siphonanthus*	**Brahma josthi, akalbih**	India	-	-	Man and animals	Cattle, animals and man, nursery operations	Common throughout the area	-	-	-
5.	*Clerodendrum viscosum*	**Dophat tita, bhet tita**	India	-	-	Man and animals	Cattle, animals and man, nurseries	Common throughout the area	-	-	-
6.	*Commelina benghalensis*	**Day flower, konasimolu**	India	-	-	Through man, cattle, other animals and water	Through man, animals, cattle and water	Occurs in the aquatic habitats	-	-	-
7.	*Crotolaria striata*	**Jhunjhunia, ghonta koron**	India	-	-	Through man, cattle, other animals and water	Through man, animals, cattle and water	Common throughout the area	-	-	-

8.	*Elephantopus scaber*	**Elephant's foot, hati khoje**	India	-	-	Through man, cattle, other animals and water	Through man, animals, cattle and water	Common throughout the area	-	-	-
9.	*Erechthites valerianaefolia*	**Fire weed, pile wort, Bon kopah**	North-eastern India	-	-	Through man, cattle, other animals and water	Through man, animals, cattle and water	Common throughout the area	-	-	Regional
10.	*Eupatorum adenophorum*	-	Central America	Seed	1960	Garden décor	Animals, transport	Along the outskirts of forest roads in hills	Over 20 ha per year		Regional
11.	*Floscopa scadens*	Konasimola	India	-	-	Through man, cattle, other animals and water	Through man, animals, cattle and water	Occurs in the aquatic habitats			-

12.	*Hyptis suaveolens*	Wilayati Tulsi	Tropical America	Medicinal importance	-	Nursery trade, animal excretions, garden waste		Densely populated in forest areas dominating ground vegetation	They are widely seen in forest areas inhibiting the growth of local forest vegetation in N.E and central India		
13.	*Ipomoea hederifolia*	-	Tropical America, naturalized in India	Accidental. Has ornamental appeal	-	Cattle, man , garden waste, etc	Agriculture, horticulture and nurseries, etc.	Forest areas, agricultural fields, orchards and hedges	-	-	Regional
14.	*Ipomoea pestigridis*	Tiger's foot	Tropics. India	-	-	Cattle, man, garden waste, etc	Agriculture, horticulture, nurseries, etc	Forest areas, agricultural fields, orchards and hedges	-	-	-

15.	*Ipomoea quamoclit*	Cypress vine, needle creeper, star glory, kunja lota	Circumtropical. naturalized in India	-	-	Cattle, man, garden waste, etc	Agriculture, horticulture, nurseries, etc.	Forest areas, agricultural fields, orchards and hedges	-	-	
16.	*Leea crispa*	O'u lota	India	-	-	Man, animals, birds and water run off	Human and animal agencies	Forest areas throughout the region	-	-	
17.	*Melastoma malabathricum*	**Phutuka (Ronga)**	India	-	-	Man, animals, birds and water run off	Human and animal agencies	Forest areas throughout the region	-	-	-
18.	*Mikania cordata*	Mikania	Tropical Asia, Philippines, New Guinea and Tropical Africa.			By wind	By wind	Forest areas and forest plantations			-
19.	*Minosa invisa var invisa*	Giant sensitive plant	Tropical America	As a cover crop in rubber, teak, cashew plantations	1950	Animal, nursery trade	Animals commerce nurseries	Road sides moist waste lands	Spreads, fast, North-east and South-west India		Regional

20	*Mimosa pudica*	**Touch-me-not, sensitive plant, humble plant, lajuki bon, nilaji bon;**	Tropical America, naturalized throughout India	-	-	Wind, water run off, transport of grains and vegetables, etc.	Cattle, animals and man. Nurseries	Commonest aggressive weed throughout the area, wastelands lawns	Spreads very fast	-	Regional/Local

		chhui-muie									
21.	*Monochoria hastate*	**Pani meteka**	India. Northeast Africa to Manchuria.	-	-	Through man, cattle, other animals and water	Through man, animals, cattle and water	Occurs in the aquatic habitats	-	-	Local
22.	*Monochoria vaginails*	**Bhat meteka**	India. Northeast Africa to Manchuria.	-	-	Through man, cattle, other animals and water	Through man, animals, cattle and water	Occurs in the aquatic habitats	-	-	Local
23.	*Mucuna pruriens*	**Cowage plant, cowitch horse bean, bandor kekua**	India	-	-	Man, animals, cattle, birds, wind, water run off, etc.	Cattle, animals, man, nurseries, hairs on pod cause intense itching and allergy to men and cattle.	Common throughout the area	-	-	-

24.	*Opunita vulgaris* Mill.	Prickly Pear *(E)* Pattakalli, chapathikalli *(Tam);* Puchikalli *(Tel);* Mullugalli *(Kan);* Chattukakalli *(Mal*)**	Native of America					Colonizing in dry deciduous forest areas and rain shadow portions of Western Ghats and Eastern Ghats			
25.	*Passiflora foetida*	**Passion flower, jhunuka phool**	Brazil. naturalized in India	Accidental	-	Man, cattle, birds and water run off.	Human and animal agencies	Forest fringes, wastelands, agriculture fields, etc.	-	-	regional
26.	*Pothos scandens*	**Hati lota**	-	-	-	Man, animals and water run off.	Human and animal agencies	Forests	-	-	-
27.	*Rubus moluccanus*	**Wild raspberry, black cherry, jutuli poka, jetuli poka**	India, mainly distributed in the Himalayas.	-	-	Man, animals, birds and water run off.	Human and animal agencies	Forest areas throughout the region	-	-	-

28.	*Siegesbeckia orientalis*	**Katampam, lichkura**	Occurs throughout India.	Accidental	-	Cattle and human agency	Cattle, animals and man, nursery operations	Occurs throughout the area	-	-	-
29.	*Solanum hispidum* (Solanaceae)	**-**	Tropical America, naturalized throughout India.	Accidental	-	Fodder, food, forage, water run off, etc.	Cattle, animals, birds, man and nursery operations	Found throughout the area in the forests	-	-	-
30.	*Solanum indicum*	**-**	Palaeotropical	-	-	Fodder, food, forage, water run off, etc.	Cattle, animals, birds, man and nursery operations	Found throughout the area in the forests	-	-	-
31.	*Solanum torvum*	**Hati bhekuri**	Tropical America. naturalized in India.	Accidental	-	Fodder, food, forage, water run off, etc.	Cattle, animals, birds, man and nursery operations	Found throughout the area in the forests	-	-	-
32.	*Solanum viaram*	**Horse nettle, kotahi bengena, kotayen bengena**	India	-	-	Fodder, food, forage, water run off, etc.	Cattle, animals, birds, man and nursery operations	Found throughout the area in the forests	-	-	-

33.	*Spilanthes acmella*	**Karkara**	Tropical, occurs throughout India.	Accidental or for medicinal value.		Cattle, animals, birds and human agency	Cattle, animals, birds, man and nursery operations.	Extremly common in some areas, possesses medicinal properties	-	-	Regional
34.	*Stephania hernandifolia*	**Tabuki lota**	-	-	-	-	-	Common throughout the area	-	-	-
35.	*Tithonia diversifolia*	**-**	Mexico and Central America, almost naturalized in India.	Perhaps introduced as an ornamental plant	-	Fodder, forage, wind, water run off, etc.	Cattle, animals, man and nursery operations	Very common in some forest areas	-	-	-
36.	*Vitex negundo*	**Chaste tree, posotia**	India	-	-	Nursery, trade, animal excretion, garden waste, etc.	Animals, birds, human agencies, transport networks, commercial nurseries, etc.	Common throughout the area in the forests, plantations, fringe areas, field boundaries, disturbed areas, grasslands, wet lands, riparian and urban areas	-	-	Region