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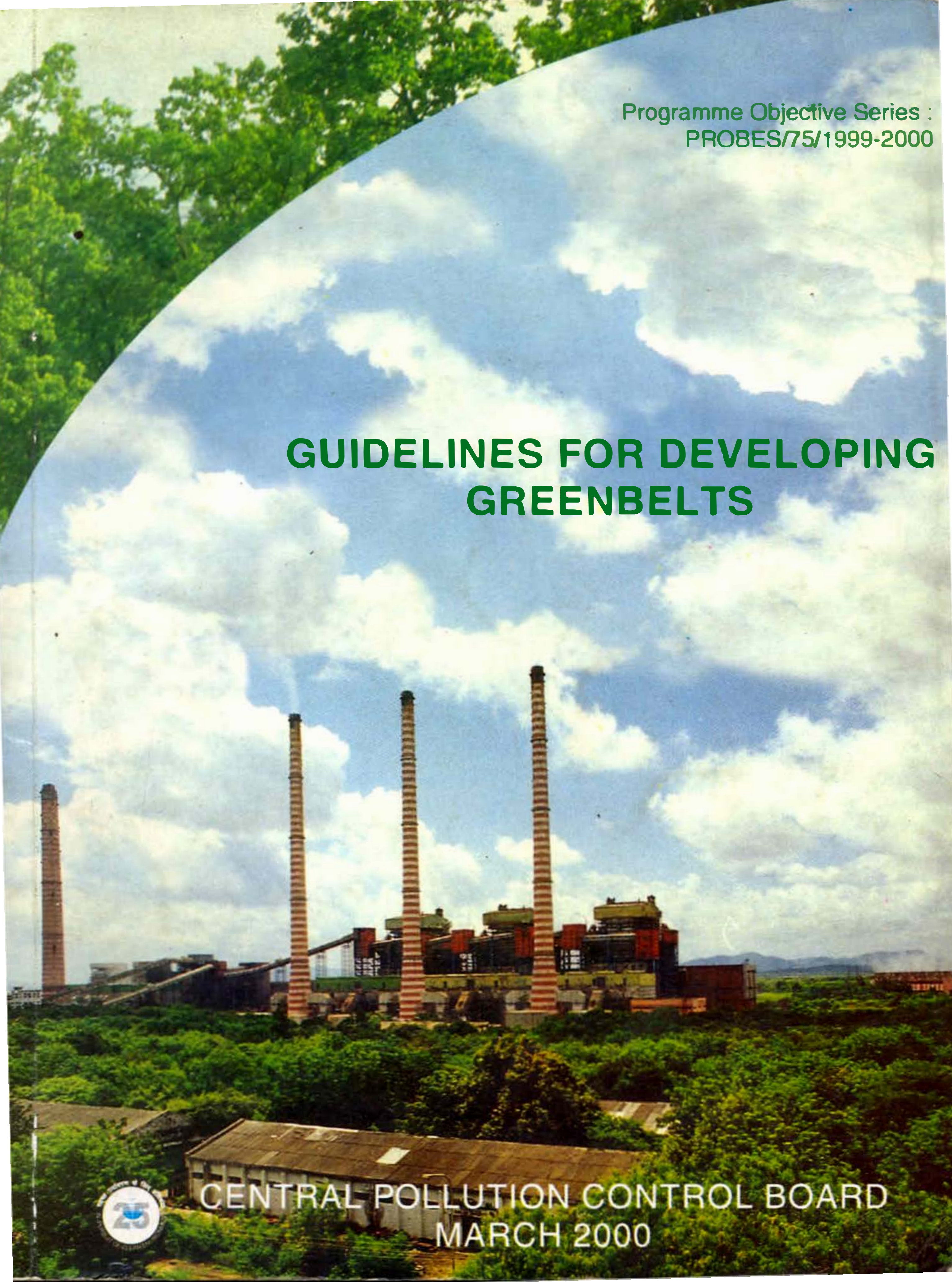
GUIDELINES FOR DEVELOPING GREENBELTS



CENTRAL POLLUTION CONTROL BOARD
MARCH 2000

Programme Objective Series :
PROBES/75/1999-2000

GUIDELINES FOR DEVELOPMENT OF GREENBELTS

CENTRAL POLLUTION CONTROL BOARD
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FOREWORD

Green vegetal cover is not only pleasing to the eyes but also beneficial in many ways such as conservation of bio-diversity, retention of soil moisture, recharge of groundwater and moderation of micro-climate. Yet another important role of vegetal cover, which is not well recognised, relates to containment of pollution. Besides acting as a carbon sink, certain species of plants can even absorb the pollutants while others can thrive in polluted atmosphere.

Raising of green belts with right types of species can serve as a useful buffer to contain the menace of pollution from different sources. With this in view, a study was commissioned by the Central Pollution Control Board (CPCB) for enlisting the plant species suited to various bio-climatic conditions. The study was also intended to evolve a theoretical model for design and development of green belt for optimum attenuation of air pollution. Apart from morphological features affecting the plant response to pollutants, the other important considerations in optimisation of green belt development include : distance from the source of pollution and dispersion of pollutants under different atmospheric stability conditions. An exercise was also made to identify the species which are suitable for revegetation of mine spoils, degraded habitats and stabilisation of fly ash dumps.

The report provides a mathematical model to optimise the specifications of a green belt. The report also contains a list of 200 species recommended for raising of green belt under specific bio-climatic regimes.

I am thankful to Prof. S. B. Chapekar, University of Pune, Shri R. K. Kapur, Nuclear Power Corporation, Mumbai, Shri V. K. Gupta, Atomic Energy Regulatory Board, Mumbai and the team of my colleagues including Dr. B. Sengupta, Shri Lalit Kapur, Dr. Sajeev Paliwal and Shri M. K. Gupta for their collective efforts in bringing out the publication.

Based on the inputs provided by CPCB and information contained in this report, a scheme for raising green belt for pollution abatement and environmental improvement has been launched in Tamil Nadu.

We hope, the guidelines and information contained in this report will be useful to all concerned "with environmental cleaning through greening"

(Dilip Biswas)

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Appendix

EXECUTIVE SUMMARY

Chapter 1 : Introduction

Green belts are recommended for containment of air pollution in the human environment, especially in industrial and urban environs. Improvement of aesthetics is a bonus derived through the presence of greenery in these areas.

Chapter 2 : Plant-Pollutant Interactions

Advantages notwithstanding, green plants are not a panacea for the environmental ills. As living organisms, plants have their limits to tolerate toxicity of air pollutants and to function as pollution ameliorants. Nature and levels of sensitivities of plant species towards anthropogenic air pollutants, are discussed.

Chapter 3 : Theoretical Models for Development of Green Belts

Green belt as a back-up to technological pollution abatement measures could substantially reduce pollution hazard. Mathematical model to optimize dimensions of green belts is presented and explained here.

Chapter 4 : Agro-climatic Zones of India

A vast country encompasses a variety of agro-climates suitable for different types of plant species. Zones and subzones of India are described, along with their soil types (as Appendix A) to assist in selecting plant species for cultivation, suitable to agro-climates.

Chapter 5 : Choice of Plants for Green Belts

Plant species suitable for removal of particulate matter and gaseous pollutants differ in their morphological characteristics. Sizes and shapes of crowns, periodic phenomena like leaf-shedding, also contribute to plant efficiency for pollution abatement. Discussion on these points is followed by description of a large number of plant species (in Appendix B), stressing characters useful for sorption of pollutants. Combining information in chapters 4 and 5, zonewise lists of plants recommended for green belts are presented (in Appendix C).

Chapter 6 : Stabilization of Fly-ash with Plants

Coal is likely to be used on an increasing scale for power generation, and will lead to aggravation of pollution problem due to fly-ash. Stabilisation of ash with plants provides aviable solution. Strategies for achieving the same, are discussed in this chapter.

CHAPTER-1

INTRODUCTION

Most of the human activities generate pollution of one or other types and of different magnitudes, to which all the organisms are exposed. More often than not, exposures to some pollution types are considered unavoidable. Resistance of organisms help them overcome the hazards caused by such exposures. At the same time, organisms, especially animals tend to avoid, or move away, from pollution. By avoidance or by tolerance, organisms struggle and survive in polluted environments.

Such survival however, is hardly desirable and has limitations, in terms of health and vitality of organisms. Hence, it is imperative that pollution is controlled at the source itself. Numerous mechanical devices are available for controlling pollution at the process level itself. Some trace amount however, is still likely to get released. This is especially true of air pollutants from thermal power plants, swelling and refining processes, autoexhausts, mining and quarrying, etc. It is often stated that zero pollution process is only hypothetical. With more than 99% efficiency of pollution abatement machinery, some amount of pollution still gets released in the atmosphere. Such pollution too is of wide occurrence.

Green belts are thought to be effective in such scenarios, where green plants form a surface capable of sorbing air pollutants and forming sinks for pollutants. Leaves with their vast area in a tree crown, sorbs pollutants on their surface, thus effectively reduce their concentrations in the ambient air. Often, the sorbed pollutants are incorporated in metabolic stream and thus the air is purified. Plants grown in such a way as to function as pollutant sinks are collectively referred to as green belts.

An important aspect of a green belt, some times overlooked, is that the plants constituting green belts are living organisms, with limits to their tolerance towards air pollutants. As a result, crossing the threshold limits in terms of pollution load, would lead to injury to plants causing death of tissues and reducing their absorption potential. Sink efficiency of unhealthy and dead tissues and leaves is known to be extremely low, thus defeating the very purpose of a green belt. In short, a green belt is effective as pollution sink only within the tolerance limits of constituent plants.

Species of plants are studied for their relative sensitivities towards different air pollutants. Thus, we recognise species sensitive to SO_2, species sensitive to O_3, or sensitive to HF, etc. In terms of tolerances however, it is difficult to identify species that are selectively tolerant to pollutant species. Statements like HF-sensitive gladiolus is tolerant to SO_2, is obviously not accurate. Moreover, an industrial or urban scene invariably consists of several pollutants rather than a single pollutant. Pollution sinks hence, aim at cultivating plants that are tolerant to air pollutants in general, rather than tolerant to SO_2, to HF, or to O_3, etc. Scattering of a few known sensitive plants, (including selectively sensitive species) within a green belt however, do carry out an important function of indicating the presence of pollutants which the tolerants would not indicate.

Two types of approaches are recognised while designing green belts - i) Source oriented approach and ii) receptor- oriented approach. Both these approaches have their own advantages and limitations. It is generally felt that the first approach is advantageous where a single industry is situated and the pollutants emitted by the same are sought to be contained. The latter approach is desirable in urban- industrial complexes with multiple sources of pollution in an industrial - urban mix. A very large proportion of polluted areas in this country, where human settlements are intricately mixed with industries, form examples deserving the second approach for green belt designing.

Whereas, it is easy to state that tolerant plant species should form green belts, it is very difficult to state confidently about several other aspects about the belts, e.g. i) which bio-geographic regions of the country are suitable for what plant species, ii) what extent soil quality contributes to the sources (or otherwise) of growth of plants in the belts, iii) what should be the distance, width and height of the belt with reference to pollution source, iv) what is the ideal density of plant crowns, and v) what are the limits of pollution dosages upto which green belts would function optimally. Attempts are made in the following chapters, to seek answers to these questions, on the basis of our present knowledge in this field. It is felt that experience gained from functioning of green belts being planned in the country, would give reliable answers.

Apart from functioning as pollutant sinks, green belts would provide other benefits like aesthetic improvement and providing possible habitats for birds and animals, thus re-creating hospitable nature in an otherwise drab urban- industrial scene. One of the worst examples of the latter type of scene is provided by deposits of coal-ash from thermal power plants. The problem is on the rise in the country, where coal is a fuel long-lasting surety of availability. Covering of ash using plants - another type of green belt is recommended to overcome the hazards posed by ash. The last chapter in this report is devoted to the problem of ash stabilization and making ash-dumps environmentally acceptable.

CHAPTER-2

PLANT - POLLUTANT INTERACTIONS

A large amount of information has been generated about the nature of plant-pollution interactions; very little authentic information in Indian context has been generated about the role of plants in absorption of air pollutants. Most of the information available is from "Forest Vegetation as a Sink for Gaseous Contaminants" (Smith, 1981). As per the discussion therein, even sensitive plants like alfalfa have been used for estimation of sink efficiency of plants.

Another point to ponder is about the areas where green belts should be set up. Obviously, since a green belt is expected to neutralize pollutants, their location should aim at screening off the source of pollutants from society. Areas around industrial establishments, residential areas and roadsides, should be the ones targetted for green belts.

Plants are living organisms and hence are prone to suffer toxicity of air pollutants like any other organism. Still, they are expected to scavenge pollutants from the ambient air through the limited capacity they possess for sorption, and neutralize the absorbed pollutants. Major primary pollutants of industrial origin are considered here.

The philosophy is that when primary pollutants are taken care of, formation of secondary pollutants will not reach menacing proportions. Primary pollutants of concern are - SO_2, HF, NO_x, CO, CO_2, NH_3, H_2S, Cl_2, SPM and organics. Industrial and man - made sources of these pollutants are given in Table-2.1. Common secondary pollutants are also included in the same Table.

Since the project aims at mitigation of air pollutants with plants, discussion here is confined to air pollutant interactions with plants. Other forms of life are not considered. Mode of absorption of a pollutant by plants and fate of the pollutant inside plant body are given. Rate at which a pollutant is absorbed, total amount that can be absorbed and form of the pollutant in which it ends inside the plant, determine the success of the scavenging process. It is known that when pollutant is absorbed at a rate higher than the rate of its assimilation, accumulation takes place, resulting in plant injury and ineffectiveness of the green belt.

SO_2 : Though several oxides of sulphur may be the result of industrial processes, SO_2 is considered to be the most important one. Background level of SO_2 in the atmosphere is 0.001 ug L^{-1} or less (Kellogg et. al., 1972). About 10^9 million metric tons (mmt) of SO_2 are estimated to be added to the earth's atmosphere every year (Helbwachs, 1983).

Quantities of SO_2 liberated by different types of industries, are given in Table-2.2. Emission of SO_2 by different types of fuels is given in Table-2.3. In India, SO_2 emission was 6.76 mmt in 1979 and is expected to reach 13.19 mmt by the turn of this century (Kumar and Upadhyay, 1981).

SO_2 enters plants mainly through the stomatal apertures. Cuticle and wax on leaf epidermis and suberin on stem being impervious, more than 95% of the pollutant enters a plant through the routes of gaseous exchange. Hence stomata, their structure, position and functions are important in the entry of gas in a leaf. Once inside the leaf, it passes into the intercellular spaces of mesophyll and gets absorbed on the wet cell-walls to finally diffuse gradually into the cell sap (Knabe, 1976). Whereas absorption of SO_2 by mesophyll tissue of a leaf is proportional to the stomatal conductance (Winner and Mooney, 1980), diffusion of SO_2 into cell sap is a function of its water solubility, which is fairly high (Table-2.4).

Chemical reactions leading to leaf injury or absorption of S from SO_2 into the metabolic stream have been described variously. A widely accepted view is that SO_2 inside leaf gets oxidised to SO_3, which in turn combines with water to form sulphuric acid.

i) $2\,SO_2 + O_2 \text{ -----> } 2\,SO_3$
ii) $SO_3 + H_2O \text{ ------> } H_2SO_4$

The acid thus formed, upsets the critical balance between inorganic and organic sulphur in plants affecting several metabolic processes, leading to reduction in productivity. Slow absorption of SO_2 on the other hand, especially when the rate of SO_2 absorption equates the rate of S utilization as a nutrient, leads to improvement in productivity. These possibilities of diametrically opposite effects on plant productivity due to SO_2 absorption, are presented in Fig.2.1.

The adverse effect of SO_2 on chlorophyll pigments leading to reduced productivity may be considered under two cellular pH conditions. At pH 2.2 to 3.5, the free H ions generated in the cell from the splitting of H_2SO_3 into SO_3^{2-} and H^+, displace the Mg^{2+} from chlorophyll molecule to degrade the latter into phaeophytin molecule, a non-photo- synthetic brown pigment (Rao and Le Blanc, 1966). At pH above 3.5, SO_2 affects the thylacoid membrane of chloroplast by causing oxidation of carotenoids through generation of O_2^- from HSO_3^- (Pieser and Yang, 1978). The unprotected chlorophyll molecule then is oxidised and lost. Free O_2^- also increases level of H_2O_2 in the presence of SOD (superoxide dismutase), leading to oxidation of chlorophyll molecules. SO_2 is also considered to reduce chlorophyllide synthesis, through its effects on ascorbic acid (Keller and Schwager, 1977).

Initial visual symptom of foliar injury caused by SO_2 is the formation of marginal and interveinal chlorotic, bronzed or necrotic areas, starting with dark green or dull colouration, with water-soaked appearance. Necrotic areas extend and are visible on both epidermal surfaces. Older leaves having just attained full expansion are the most susceptible ones.

NO_x : Three types of oxides of nitrogen are collectively referred as NO_x. These are N_2O (Nitrous oxide), NO (Nitric oxide) and NO_2 (Nitrogen dioxide). High temperature reactions in the presence of air lead to oxidation of atmospheric nitrogen, giving rise to oxides of nitrogen. Whereas background level of NO_2 is only 1.9 $\mu g\ m^{-3}$, that of N_2O may be as high as 450 $\mu g\ m^{-3}$ (Urone, 1976).

On absorption in leaves across stomatal apertures, NO_x react on cell walls to form HNO_2 and HNO_3, the former being more toxic. pH drop and reaction of acids with unsaturated compounds causing isomerization and free radical formation, lead to toxicity. Nitrosamines are formed, cellular pH is lowered and acetate metabolism inhibited, leading to growth suppression (Mudd, 1973; Taylor et al, 1975; Zeevart, 1976).

Injury symptoms are visible as discoloured spots of gray-green or light brown colour. Bleached or necrotic spots in interveinal areas of leaves is a later development, appearing as stripes in advanced stages.

NO_x are not considered to be of major concern as phyto- toxicants, since several studies suggest that levels sufficient to injure vegetation would be far above known or monitored ambient levels. Importance of NO_x in the atmosphere however, lies in the fact that they are the raw material for formation of important secondary pollutants like O_3, Smog and PAN.

<u>HF</u> : Fluorine is a universally distributed element, hence is to be found in all places-soil, water and air (Treshow, 1970). About 0-05 mgm^{-3} is present in air and in traces in surface waters and in soil. Some parts of Rajasthan are reported to have unusually high concentrations of the element in soils. Combustion of fossil fuels, smelting of ores like bauxite and reduction of phosphatic rock in the manufacture of fetilizers, are some of the industrial processes, responsible for release of HF in the atmosphere. Few to several hundred pounds of fluorine is released into the atmosphere every year, according to several estimates (Treshow, 1970).

Fluoride enters leaf through stomata, and from the intercellular spaces of mesophyll, diffuses into vascular tissues. It moves along transpiration stream towards leaf tips and margins, where accumulation takes place. Due to absence of visible injury, such accumulation goes unnoticed for long. In some sensitive plants, injured tissues in tips and margins have shown values of 50-200 ppm HF concentrations. In tolerant species visible injury was not noticeable even at 500 ppm concentration level.

Chlorosis of leaf tip is the first visible injury. With increasing accumulation, the injury may extend along margins and inwards along veins. Injured, brown or dead areas of leaves become necrotic, leading to premature leaf fall (Weinstein, 1977).

<u>CO and CO_2</u> : Incomplete combustion of fuels including fossil fuels, leads to formation of CO. Automobiles are the commonest source of CO. Oil refineries, metallurgical operations, etc. are other sources of significance. Annual global input of this toxic gas is estimated to be 6 billion tons (Seiler, 1974).

CO is not a phytotoxic gas. Green plants function as natural sinks for CO (or its readily converted form, CO_2). Soil and oceans are also vast sinks for the gas. Since CO gets gradully oxidized to CO_2, which is absorbed and utilized by plants on large scale, and since increase in CO_2 concentration from its normal 300 ppm to higher levels are still non-toxic to plants, CO or CO_2 are not treated as serious phyto-toxicants.

<u>NH_3</u> : Decomposition of organic matter of different origins including excreta, fertilizer breakdown, coal combustion and releases from industries lead to pollution by ammonia. Though localized, ambient concentrations of 20 pphm have been recorded (Cholak, 1952).

Blackening and bleaching of leaves, spotting, brown lesions between veins and colour change of fruits, are symptoms of injury by ammonia.

Generally, emission of NH_3 is of an accidental nature, during transfer and transporation or due to poor maintainance of containers. Best control of NH_3 is achieved through proper care and maintenance at `in house' level.

Cl_2 : This pollutant is also a result of industriali accidents, escape from manufacturing processes and leakages from cylinders and sewage treatment systems. Chlorosis, reddening, stipple and necrosis of leaves are reported to be injury symptoms on plants.

Exposure of sensitive plants like radish and alfalfa to 10 pphm of Cl_2 for 2 hours, showed foliar injury, while plants like tobacco, zinnia, corn and sunflower were injured when exposed to the same concentration for 4 hours (Brennan, et. al., 1965). Chlorosis, stipple, necrosis and reddening were the types of injuries observed on foliage of plants exposed.

Hydrocarbons (HC) : Organic compounds containing carbon and hydrogen are emitted from automobiles, oil refining processes and chemical factories. On reaching ground, the HC are degraded by soil micro-organisms. In traces, HC like ethylene gas acts as a growth hormone by stimulating formation of lateral buds. At pollution levels however, it causes distortion of foliage, excessive curvature in growth, chlorosis, senescence and flower abscission (Smith, 1981).

H_2S : Pattern of injury caused by this pollutant is different from that by others. Necrosis and death of young tissues is reported rather than that of old tissues. Tips of leaves are also injured. Injury at chronic levels of the pollutant is unknown, toxic levels are found to be much above the known ambient concentrations of the gas. The most sensitive plant species have been reported to be injured at 86 ppm (12×10^4 ug m^{-3}) after 5 hours exposure (US EPA, 1976).

SPM : Suspended particulate matter is released during metal refining, by foundries, cement factories and as fly ash from thermal power plants, mine tailings, etc. and autoexhausts. Heavier particles, above 1 u diameter size, tend to settle while finer and lighter particles remain airborne for days together and travel for hundreds of kilometers over wind currents. Chemical dusts are more injurious and under humid conditions, their phytotoxicity increases further (Chaphekar, 1972).

Finer particles clog stomatal apertures and prevent gaseous exchange by leaves. Physical weight on foliage and a film of dust causing rise in leaf surface temperature are other hazardous situations for plants. Dust particles deposited on stigmatic surfaces of flowers reduce effective pollination and hence fruit yields.

Dust is captured by leaves of plants, leaf epidermal outgrowths like hairs and scales, hairy axils of stems and leaf bases, etc. (Das, 1981).

Mixtures of pollutants : In India, as in several other places, many industries are located in the same region and the air is a mix of several pollutant gases. A large number of studies indicate synergistic nature of pollutant mixture effects on plants. It is practically impossible to assess the pollutant removal efficiency of plants under the numerous possible combinations of mixing proportions of different pollutants detected. Bearing in mind however, the synergistic nature of the reactions, it is again emphasized that the concentrations of ambient pollutants have to be well below the threshold limits of tolerance (e.g. as cited in Table 2.5), for plants to function effectively for removal of pollutants.

The sensitive plants indicate injury symptoms due to air pollution, that are specific to the type of pollutant. Ranges of dosage of the pollutants to which sensitive plants respond, are given in Table-2.5.

A large amount of research has been carried out in India, during the last two decades. Compilation of this work has been presented in a comprehensive Table 2.6.

Within their limits of tolerance, plants absorb pollutants and to that extent remove the same from ambient air. The plant uptake of air pollutants as investigated by Hill (1971) and Bennett and Hill (1973, 1975), appeared to follow the following order :

$HF > SO_2 > Cl > NO_2 > O_3 > PAN > NO > CO$.

The rate of pollutant removal is found to increase linearly as the concentration of the pollutant increased over the ranges of concentration that are encountered in ambient air and which are low enough not to cause stomatal closure. Pollutants are absorbed most efficiently by plant foliage near the canopy surface where diffusion process is high due to favourable light conditions. An example of the magnitude of absorption of pollutants by seedlings of plants is given in Table-2.7.

Smith (1981) has given estimated abbsorption of gaseous pollutants by dry soil and vegetative surfaces to emphasize relative differences in their efficiencies to remove pollutants (Table 2.8). He also assessed pollutants removal efficiency of a 'Model Forest Hectare' developed by U.S. EPA, in which composition of plant species is as follows:

Species	No. of trees Planted	Tree surface area (m^2)	Total vegetative area (m^2)
Maple	69	36.8	2.54×10^3
Oak	69	36.1	2.50×10^3
Poplar	69	52.5	3.63×10^3
Linden	69	23.0	1.56×10^3
Birch	69	27.2	1.88×10^3
Pines	700	4.2	2.90×10^3

This hectare, consisting of 5-year old plants, is estimated to remove gaseous pollutants annually in quantities as :

O_3 - 9.6×10^4, SO_2 - 748, CO - 2.2, NO_x - 0.38 and PAN - 0.17 (all values in tonnes).

Fig. 2.1 Summary diagramatic representation of the effects of sulphur dioxide on plants

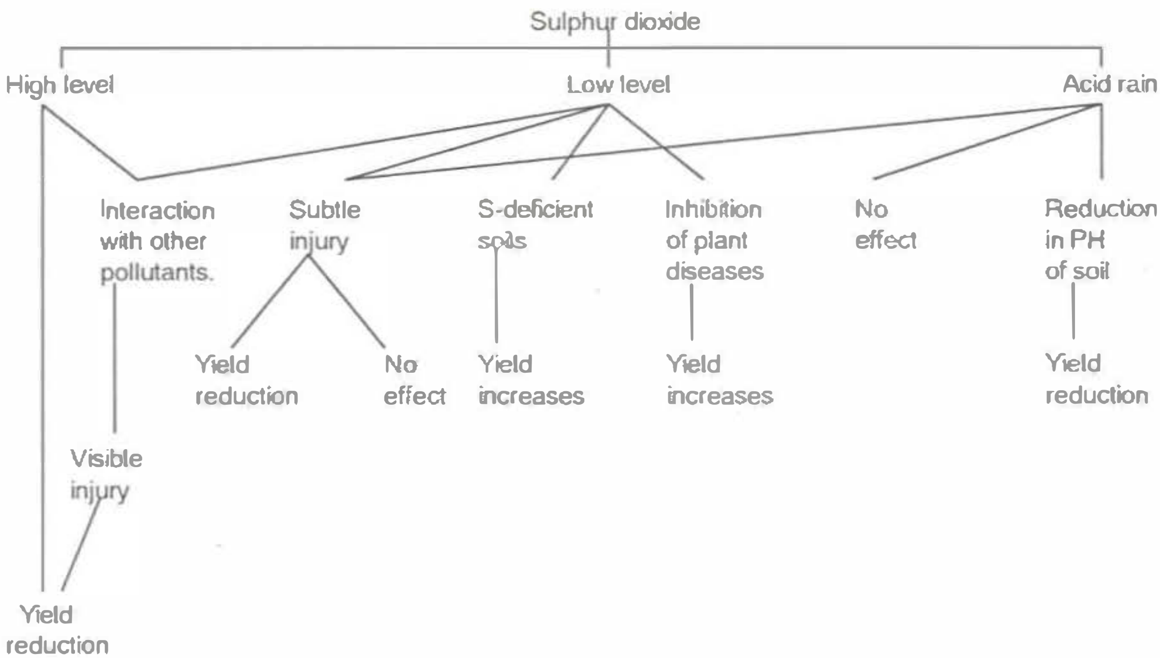

Table 2.1 Industrial sources of major air pollutants

S.No.	Pollutant	Sources
01	Sulphur dioxide (SO_2)	Coal, fuel oil and petroleum combustion.
02	Nitrogen dioxide (NO_2)	High temp. combustion of coal, oil, gas and gasoline in power plants and internal combustion engines.
03	Hydrogen fluoride (HF)	Phosphate rock processing, aluminium industry, iron smelting, brick and ceramic works, and fibreglass manufacturing.
04	Chlorine (Cl)	Leaks in chlorine storage tanks, hydrochloric acid mist.
05	Ammonia(NH_3)	Leakages in fertilizer manufacturing factories, transfers and transport of the chemical.
06	Hydrogen sulphide (H_2S)	Decay and decomposition of organic wastes, dumps, sewage, etc.
07	Carbon oxides (CO and CO_2)	Products of combustion of fuels- incomplete combustion/Organic respiration.
08	Ethylene (C_2H_4)	Incomplete combustion of coal, gas, and oil for heating, and automobile and truck exhaust.
09	Particulates (SPM)	Combustion (esp. incomplete) processes, Fly ash, Thermal power plants, Cement factories, Automobiles, etc.
10 *	Ozone(O_3)	Dissociation of NO_2 (NO_2 ---> NO+O) (O_2+O --> O_3)
11 *	Peroxyacetyl	Ozonated olefin nitrate (PAN)
12 *	Smog	Combination of fine particulates and NO_x in air
13 *	Acid precipitates	Combination of NO_2 and / or SO_2 with water vapour in the atmosphere

(Source : Painter D.E. 1974, except for * No. 10-13).

Table 2.2 Quantities of SO_2 liberated during different types of industrial activities

Source	SO_2 emission factor (in kg)
Combustion of coal	4.536 per 1000 kg coal (Variable).
Combustion of fuel oil	9.9 per 10,000 L oil (Variable).
Municipal incineration	0.544 - 0.907 per 1000 kg refuse.
Sulpuric acid manufacture	9.07 - 3.75 per 1000 kg 80% acid.
Cu smelting (Primary)	635.04 per 1000 kg conc. ore.
Pb smelting (Primary)	299.376 per 1000 kg conc. ore.
Pb smelting (Sec. cupola)	29.03 per 1000 kg metal changed.
Zn smelting (Primary)	494.424 per 1000 kg conc. ore.
Kraft mill recovery furnace	1.088 - 1.078 per 1000 kg air dry pulp.
Sulphite mill recovery furnace (assuming 90% recovery)	18.144 per 1000 kg air dry pulp.

(Source : Kumar and Prakash, 1978.)

Table 2.3 Amount of SO_2 emitted by burning different types of fuels

Fuel	SO_2 emission in kg per tonne of fuel
Firewood	20
Coal	6 to 15.0
Oil	6 to 7.6
LPG	0.0002 to 0.008
Natural Gas	0.2
Petrol	5.4
Diesel	5 to 6

(Source : Kumar and Prakash, 1978.)

Table 2.4 Solubilities of pollutant gases in water

Pollutant	Solubility at 20°C (cm^3 gas ml^{-1} H_2O)
CO	0.02
NO	0.05
CO_2	0.88
PAN	--
O_3	0.26
NO_2	Decomposes
Cl_2	2.30
SO_2	39.40
HF	446

(Source : Hill and Chamberlain, 1974.)

Table 2.5 Injury symptoms and pollution dose thresholds of tolerance by sensitive species of plants

S. No.	Pollutants	Threshold dose	Plant injury symptoms
1.	Sulphur dioxide	0.70 ppm (1820 $\mu g\ m^{-3}$) for 1 hr.; 0.18 ppm (468 $\mu g\ m^{-3}$) for 8 hr.; 0.008-0.017 ppm (21/44 $\mu g\ m^{-3}$) for growing season. (Linzon 1978)	Interveinal necrotic blotches. Red brown dieback or banding in pines.
2.	Nitrogen oxides	20 ppm (38 x 10^3 $\mu g\ m^{-3}$) for 1 hr.; 1.6 - 2.6 ppm (3000-5000 $\mu g\ m^{-3}$) for 48 hr.; 1 ppm (1900 $\mu g\ m^{-3}$) for 100 hr.; (National Academy of Sciences, 1977)	Interveinal necrotic blotches similar to those by SO_2. Red brown distal necrosis in pines.
3.	Fluoride	< 100 $\mu g\ g^{-1}$) fluoride (Weinstein1977)	Tip and margin necrosis,
4.	Ammonia	55 ppm (38 x 10^3 $\mu g\ m^{-3}$) for i hr.;	Interveinal necrotic blotches similar to those by SO_2. Distal necrosis in pines.
5.	Chlorine	0.5 - 1.5 ppm (1400 - 4530 $\mu g\ m^{-3}$) for 0.5 - 3 hr.	Chlorosis, upper surface fleck similar to O_3. Distal necrosis in pines.
6.	Ethylene	Variable, undetermined	Chlorosis, necrosis, abscission, Dwarfing, premature defoliation.
7.	Hydrogen sulphide	100 ppm (14 x 10^4 $\mu g\ m^{-3}$) for 5 hr.; (U.S. Environ. Protection Agency 1976)	Interveinal necrotic blotches. Distal necrosis in pines.
8.	Trace metals	Variable, undetermined	Interveinal chlorosis, tip and margin necrosis, Distal necrosis.
9.	Ozone	0.20 - 0.30 ppm (392 - 588 $\mu g\ m^{-3}$) for 2-4 hr.; Some conifers 0.08 ppm (157 $\mu g\ m^{-3}$) for 12-13 hr. (National Academy of Sciences 1977b)	Upper surface flecks Distal necrosis and stunted needles in pines.
10.	Peroxy acetyl nitrate	0.20 - 0.80 ppm (989-3958 $\mu g\ m^{-3}$) for 8 hr. (Davis 1975)	Lower surface bronzing, Chlorosis, early senescence.
11.	Acid rain	pH < 3.0	Necrotic spots, Distal necrosis pines.

(Source ; Smith W.H. 1981.)

Table 2.6 Compilation of research in India indicating sensitive and tolerant species, with reference to industrial pollutants

Name of Plant	Sensitive	Tolerant	Reference
Mangifera indica	Coal dust		
Citrus lemon		Coal dust	Rao, 1971
Phasaeolus aureus (Green gram)	Petro cake		Prasad and Rao (1981)
Zea mays	Cement dust		Sree Rangaswamy et al, (1973)
Syzygium cuminii	Cement dust		Jafri et al, (1979)
Psidium guyava	Cement dust		Yunus and Ahmed (1980)
Triticum aestivum	Cement dust		Singh and Rao (1980 a)
Calotropis procera	Cement dust		Yusuf and Vyas (1982)
Cassia fistula	Cement dust		
Dalbergia sissoo	Cement dust		
Withania somnifera	Cement dust		
Glycine max	Cement dust		Singh and Rao (1978 a)
Hordeum vulgare Portulaca sp.		5% fly ash	Bhatia (1978)
Triticum aestivum	above 20% Fly ash		Pawar and Dubey (1982)
Tritichum aestivam		$6g/m^2/day$ fly ash $4g/m^2/day$ fly ash	Dubey et al, (1982)
Dolichos lablab		$4g/m^2/day$ fly - ash	Pawar et al, (bean) (1983)
Abelmoschus esculantus Var Pusa savani	Cement and Coal dust	fly - ash	Pawar et al, (1982)
Commelina benghalensis	Air borne dust		Chaphekar et al, (1980)
Brassica oleraceae Chenopodium album Cicer arietinum Dolichos lablab Sonchus asper Withania somnifera.	Urban air		Garg and Varshney (1980)
Tabernaemontana coronaria	Polluted environment		Srivastava et al, (1980)
Calotropis procera		Polluted conditions	Yunus and Ahmed(1981)

(Contd.....)

Table 2.6 (*Contd.....*)

Name of Plant	Sensitive	Tolerant	Reference
Calotropis gigantea	Polluted areas		Bhirava Murthy and Kumar (1983)
Baro paddy. Var. Ratna	Urban dust		Das and Pattanayak (1978)
Mangifera indica		Dust Collector	Shetye and
Thespesia populnea			Chaphekar (1980)
Erythrina indica	Poor dust Collector		---"---
Polyalthia longifolia			
Ficus benghalensis Ficus infectoria Ficus religiosa Mangifera indica Tectona grandis Polyalthia longifolia Shorea robusta Terminalia arjuna		Dust Collector	Das 1981 and Das et al. (1981)
Cassia fistula Poinciana regia Sesbania sp.	Poor dust Collector.		Das (1981) and Das et al. (1981)
Pithecolobium dulce Argyrea speciosa Leucaena leucocephala		Better dust collector.	Rao (1971)
Melilotus alba	Polluted area		Ghouse and Khan (1983)
Banana Crop.	SO_2 and dust From brick Kiln		Bedi et al. (1982)
Lycopersicum esculentum	SO_2 and dust from brick Kiln		Bell and Bedi (1981)
Mangifera indica	SO_2		Rao 1972 Shetye 1979 Giridhar (an published data) Pawar and Dubey (1983)
Helianthus annus Crotalaria juncea Commelina benghalensis Cyamopsis tetragonoloba	To pollute areas		Chaphekar et al, (1980 a)
Cicer arietinum	Fly ash SO_2		Dubey et al, (1982)

(*Contd.....*)

Table 2.6 *(Contd.....)*

Name of Plant	Sensitive	Tolerant	Reference
Medicago sativa (Alfa-alfa)	SO_2		Singh and Rao (1979, 1980)
Sorghum vulgara var CSH - 1	SO_2		Boralkar and Chaphekar (1978)
Glycine max	SO_2		Pandey and Rao (1979). Prasad and Rao (1982)
Phaseolus aureus	SO_2		Singh and Rao (1980)
Arachis hypogea	SO_2		Mishra (1980)
Dolichos lablab	SO_2		Banerjee and Chaphekar (1978)
Phaseolus aureus Var. Vaishakhee	SO_2		Boralkar and Chaphekar (1980)
Trigonella foenum-graecum	SO_2		Boralkar and Chaphekar (1983)
Pisum sativum	SO_2		Varshney and Varshney (1978)
Crossandra undulaefolia Mirabilis jalapa	SO_2		Chaphekar and Karbhari (1974)
Amaranthus spinosus Spinacea olercea	SO_2		Boralkar and Chaphekar (1980)
Raphanus sativus Commeling benghalensis Erythrina indica	SO_2		Banerjee and Chaphekar (1978)
Barley, Cotton, Wheat, Aster, Cosmos, Verbena, Zinnia, Sweat Pea, Ipomoea purpurea, 4 o'clock plant, Bean Beet, Carrot, Chilli, Pumpkin, Radish Bhendi, Sunflower etc.	SO_2		Pandey and Vaidya (1979)
Most trees		SO_2	Pandey and Vaidya (1979)
Mangifera indica Terminalia catappa Malachra capitata Dahlia	SO_2		Chaphekar (1972)
Croton, Plumeria Opuntia, Nerium		SO_2	Chaphekar (1972)
Dahlia, Petunia, Alfalfa, cotton Barley	SO_2		Vaishnavi (1975)

(Contd.....)

Table 2.6 *(Contd.....)*

Name of Plant	Sensitive	Tolerant	Reference
Dalbergia sissoo	SO_2		Yunus and Ahmed (1979)
Terminalia arjuna			
Cassia fistula			
Cedrela toona			
Syzygium cuminii Oat, Pea, Brinjel, Potato Cucurbit			
Azadirachta indica		SO_2	Yunus and Ahmed (1979)
Ficus religiosa			
Pithecolobium dulce			
Calotropis procera			
Trees, Bushes, crops of those areas.			
Phaseolus aureus	SO_2,O_3,SO_2+O_3		Agrawal and Rao (1983)
Cicer arietinum		SO_2,O_3,SO_2+O_3	
Oryza sativa	SO_2,O_3,SO_2+O_3		
Panicum miliaceum		SO_3,O_3,SO_2+O_3	
Solanum melongena	SO_2,O_3,SO_2+O_3		
Vicia faba	SO_2,O_3,SO_2+O_3		
Abelmoschus esculentus. Var. Pusa savani	SO_2,O_3,SO_2+O_3		
Abelmoschus esculentus	SO_2, O_3, SO_2+O_3,		Bolalkar and Shinde (1983)
Phaseolus aureus	SO_2, HF,		Sharma (1981)
Triticum aestivum	SO_2+HF		
Brassica juncea			
Triticum aestivum	NO_2		Prasad and Rao (1979)
Triticum aestivum	NO_2+SO_2		Prasad (1980)
Dalbergia sissoo	SO_2		Rao et al, (1983)
Madhuca indica			
Pisum sativum var. Bonneville,	NaF		
Pisum sativum var. T163			
Hordeum vulgare			
Zea mays			
Lycoopersicum esculentum	NaF		Arya (1971)
Terminalia tomentosa	HF		Pandey (1979)
Buchanania lanzan			
Zea mays	HF		Rao and Pal (1978 b)
Gladiolus sp.	HF		Pandey and Rao (1980 a)

(Contd.....)

Table 2.6 (*Contd.....*)

Name of Plant	Sensitive	Tolerant	Reference
Spinacia oleracea	Gasoline Vapour.		Prasad (1980)
Abelmoschus esculantus Cyamopsis tetragonoloba Crotalaria juncea Trigonella foenum-graecum	Ammonia		Chaphekar and Boralkar (1979)
Nerium indicum	SO_2		Varshney, (Unpublished)
Cynodon dactylon	HF		Meenakshy et al (1981)
Cicer arietinum Nasturtium indicum Petunia alba Tradescantia axillaris	SO_2		Varshney and Varshney (1981)
Madhuca indica	SO_2, fly-ash		Agrawal M (1989)
Cassia siamea Delonix regia Shorea robusta	-- " --		
Acacia arabica		SO_2, fly-ash	
Acacia catechu Zizyphus sp.			
Mangifera indica		Dust	Agrawal & Khanam (1989)
Ficus benghalensis L Ficus infectoria Roxb Holoptelia integrifolia Planch Ipomoea fistulosa Mart ex choisy Lagerstroemia sp. Nyctanthes arbortristis L Peltophorum pterocarpum (DC) K.Heyne		Dust	Ahmad Yunus et al (1991)
Tectona grandis L Terminalia arjuna W & A Thevetia nerifolia Jass Acacia arabica Willd Bougainvillea spectabilis Willd Hibiscus rosa sinensis Willd Morus alba		Dust	Ahmad Yunus et al (1991)

(*Contd.....*)

Table 2.6 *(Contd.....)*

Name of Plant	Sensitive	Tolerant	Reference
Nerium indicum Mill		Cement dust	
Thevetia nerifolia juss			
Dalbergia sissoo Roxb			
Azadirachta indica A.Juss	Cement dust		Pandey, Misra et al (1994)
Brassica campestris L			
Citrus aurantium L			
Delonix regia Raffin			
Syzygium cuminii (L) skeel			
Mangifera indica L			
Pisum sativum L			
Tabernaemontana coronaria Willd			
Triticum aestivum L			
Zizyphus mauritiana Lamk			
Helianthus annus L		fly ash	
Opuntia monocantha		SO_2	Raza S.H., Shylaja G. (1992)
Opuntia dillenia			
Kalanchoe marmorata			
Crassula			
Bryophyllum	SO_2		
Aloe			
Bryophyllum tabiflorum			
Euphorbia cattamindoios			
Caesalpinia pulcherima		SO_2	Murthy M.S.R. et al (1990)
Euginia jambolana			
Polyalthia longifolia	SO_2		Raza S.H. et al (1991)
Pongamia pinnata			
Caesalpinia pulcherima		Dust	
Pithecolobium dulce			
Cassia fistula			
Pongamia globra	Dust		
Polyalthia longifolia			
Pithecolobium dulce		SO_2	Raza S.H. et al (1989)
Caesalpinia pulcherrima			
Polyalthia longifolia	SO_2		
Pongamia pinnata			

Table 2.7 Absorption of SO_2 by seedlings fumigated at 1.0 ppm for 1 hour in a controlled chamber (27 ± 1°C, 51 ± 7 R.H., 1300 fc)

Species	SO_2 uptake	
	mg SO_2 $dm^{-2}hr^{-1}$	mg SO_2 $g^{-1}hr^{-1}$
Red maple	0.088	0.260
White birch	0.086	0.268
Sweetgum	0.074	0.267
Firethorn	0.072	0.213
Privet	0.068	0.134
Rhododendron	0.056	0.079
White ash	0.046	0.118
Azalea	0.044	0.072

(Scurce : Roberts 1974.)

Table 2.8 Guesstimated gaseous pollutant flux rates for dry soil and vegetative surfaces

Pollutant	$\mu g\ m^{-2}\ hr^{-1}$	
	Soil surface	Vegetative surface
CO	1.9×10^4	2.6×10^3
NO_x	2.0×10^2	2.3×10^3
O_3	1.0×10^9	6.2×10^4
PAN	----	1.2×10^3
SO_2	7.7×10^6	4.1×10^4

(Source : US EPA 1976.)

CHAPTER-3

THEORETICAL MODELS FOR DEVELOPMENT OF GREEN BELT

Introduction

The air pollution emitted by industries settles on the ground and vegetation of surrounding area. The plants interact with both gaseous and particulate pollutants and to great extent absorb them and thus, remove them from the atmosphere. This pollution removall property of the plants has been known for a long time. For several years tree planting has been promoted by USSR scientists and city planners for the purpose of reducing ground level air pollution. Many scientists have also suggested the use of green belt, which is rows of trees, for reducing the pollution originating from industrial operations. (Kalyushnyi et al., 1952; Flemming 1967; Hanson and Throne, 1970; Warren 1973; Ganguly, 1976).

The capability of plants to act as a sink for air contaminants has been addressed by a number of reviews. (USEPA, 1976; Smith and Dochinger 1976, Bennett and Hill 1975; Hill 1971; Environmental Health Science Centre 1975; Keller 1978). All these studies indicate that the surface of vegetation provides a major filtration and reaction surface to the atmosphere for removing pollutants from the atmosphere.

Mechanism of Deposition

Interaction of pollution with vegetation has always been expressed by a common parameter known as the deposition velocity of the pollutants. The concept of deposition velocity has also been widely used in agriculture to calculate the dose of fertilizer and pesticides for crop growth and its protection. The deposition velocity is defined as follows :

$$\text{Deposition Velocity (Vd)} = \frac{\text{Amount of pollutant deposited per unit area of surface per second}}{\text{Concentration of pollution per unit volume above surface}}$$

It has dimension of Ms^{-1} (see McMohan & Denison 1979 for values of Vd for commonly released pollutants).

Particulates are deposited on plant surface by three processes - sedimentation by the gravity action, impaction under the influence of eddy currents, and deposition under the influence of precipitation.

Sedimentation usually results in the deposition of the particles on the upper surfaces of the plant and is most important for large particles. Sedimentation velocity varies with particle density, shape etc. Impaction occurs when air flows past an obstacle and the air stream divides. The efficiency of collection via impaction increases with decreasing diameter of the collection obstacle and increasing diameter of the particle. It has been suggested that impaction is the principal means of deposition if particle size is of the order of tens of micrometers (um) or greater, obstacle size is of the order of centimeters or less, approach velocity is of the order of meters per second or more and the collecting surface is wet, sticky, hairy, or otherwise retentive. For particles of dimension 1-5 μm, impaction is not efficient and interception by fine hairs on vegetation is possibly the most efficient retentive mechanism. The efficiency of washout of particles by rain is high for particles approximately of 20-30 μm size. The capturing efficiency of rain drops falls off very sharply for particles of 5 μm or less.

The hypothesis that trees are important particulate sinks is supported by evidence obtained from studies dealing with diverse particulates including radioactive, trace element, pollen, spore, salt, precipitation dust and other unspecified particles. So far as gaseous pollutants are concerned, substantial evidence is available to support the fact that plants in general and trees in particular function as sinks for gaseous pollutants. The gaseous pollutants are transferred from the atmosphere to vegetation by the combined forces of diffusion and flowing air movement. Once in contact with the plants, gases may be bound or dissolved on exterior surfaces or taken up by the plants via stomata. If the surface of the plant is wet and if the gas is water soluble, the former process can be very important. When the plant is dry or in the case of gases with relatively low water solubilities, the latter mechanism is assumed to be most important. For example, hydrogen fluoride, sulphur dioxide, nitrogen dioxide and ozone which are soluble and reactive, are readily absorbed, while nitric oxide and carbon monoxide, which are very insoluble, are absorbed relatively slowly or not at all by vegetation. It should be noted that when vegetative surfaces are damp, the pollutant removal rate may increase up to ten fold. Under damp condition, the entire plant surface - leaves, twigs, branches, stems - is available for uptake of gaseous pollutant.

The interaction of these various sized particles and gaseous pollutants with exceedingly diverse vegetative surfaces under conditions of extremely variable microclimate and pollutant source characteristics suggests an enormously complex relationship. These studies have expressed uptake of pollution by plants in terms of deposition velocity. This concept though suitable for estimation of loss of pollutant over a vegetation surface, is hard to apply for a case when pollution travels horizontally through a canopy (e.g. through green belt). The mathematical models so far available in literature for green belt are applicable only for ground level air pollution source. The only theoretical model available for estimation of depletion of pollutants by green belt is developed by Kapoor and Gupta (1984). This model expresses pollution attenuation factor A_f of green belt in terms of different dimensions and characteristics of green belt under various meteorological conditions. The model is described in next section.

About the Model

Mathematical model for the estimation of pollution attenuation by a green belt exits only for a ground level pollution source. Such ground level releases can occur by break in storage vessels and under various conditions such as follows :

(i) Fugitive emissions

(ii) Elevated releases reaching ground level due to
- stack downwash due to low discharge velocity
- effect of obstacles upstream
- short stack near a long flat building
- downwash in the wake of a clift
- fumigation conditions due to breaking up of ground based temperature inversion.

The green belt model introduces the concept of a pollution attenuation coefficient for estimating the removal of pollutant while passing through the green belt. The formulation of pollution attenuation coefficient makes use of parameters such as leaf area density of the tree plantation, deposition velocity of the pollutant on leaf surface and wind speed in the green belt. The model gives the dependence of the pollution attenuation factor A_f of a green belt on various physical parameters of the green belt such as its height, width, distance from the pollution source and on atmospheric stability conditions and hence, the model can be used to optimise the design of the green belt in obtaining the desired degree of attenuation of the pollution around an industry.

The application of model has been made for two different situations viz. a source oriented approach and a receptor oriented approach. In the former case, the model is applied for estimation of pollution attenuation factor of a green belt planted around a source i.e. an industrial establishment. In the latter case, the model has been applied in studying the pollution attenuation by planting green belt around a receptor, which needs to be protected from the effects of the pollution.

The details of the model, its application aspects including its limitations are given in following sections.

Development of the Model

Various field experiments carried out by Raynor et al., (1974) at Brookhaven National Laboratory USA aiming to estimate the deposition of particulates by forest using pollens and spores have indicated that the mass flux of the pollutant decreases almost exponentially with travel distance within the forest. Chamberlain (1970) and Chadwick and Chamberlain (1970) also proposed exponential removal law for removal of pollutants. Hence considering the exponential law, if the mass flux of a pollutant which enters the green belt is Qc, the mass flux Qx at a travel distance X within the green belt is given by

$$Q_x = Q_c e^{-x} \text{ ------------------------- } (1)$$

Where, = pollution attenuation coefficient, m^{-1}.

Because of the non-availability of experimentally measured values for the following relationship for in terms of easily measurable parameters was proposed in the model.

$$= KPt\ Vd/Uc \text{ ------------------------------ } (2)$$

Where Vd = dry deposition velocity of pollutant for vegetative canopy, ms^{-1}

Uc = average wind speed through the green belt, ms^{-1}

P_t = average foliage surface area density of a single tree, of green belt m^2m^{-3}
K = P_c / P_t
P_c = average foliage surface area density of the green belt, m^2m^{-3}

The constant K depends on the spacing of the trees in the green belt and is introduced to consider the overall foliage surface area density. For an ideal green belt, the value of K will be unity when such a green belt has the same foliage surface area density as that of a single tree.

The above formulation of as given in equation (2) has been tested by Kapoor and Gupta (1984) using experimental data and is discussed here. For this testing, it is necessary to demonstrate that the value of as obtained by using equation (2) compares reasonably well with the value estimated using equation (1) for the same set of field measurements. The study conducted by Raynor et al., (1974) regarding the measurements of variation of mass flux of pollens (having size 20 um) with distance provides such a comparison. The average value of obtained from the experiments conducted by Raynor et al using equation (1) is 0.0187 + 0.0047 m^{-1} and for the same set of experiments, the value of calculated by using equation (2) ranges between 0.0088 to 0.0181 m^{-1} which compare reasonably well.

Effectiveness of a green belt

A schematic diagram of the green belt around a pollution source i.e. an industry is given in Fig. 3.1.

The pollution attenuation factor Af gives the effectiveness of a green belt in attenuating pollution. The attenuation factor Af has been defined as the ratio of mass flux of pollutant reaching a given distance in the absence of green belt to the mass flux of pollutant reaching the same distance in the presence of the green belt. Mathematically,

$$Af = \frac{QwB}{QB} \qquad (3)$$

Where, QwB = Mass flux of pollutant reaching at distance in the absence of a green belt

QB = Mass flux of pollutant reaching at the same distance in the presence of the green belt

The value of pollution attenuation factor, Af is calculated in the following five stages.

STAGE-1

Massflux reaching at the inner edge of the green belt

The depletion of pollutant, because of the dry deposition over the travel distance upto the inner edge (X_1) of the green belt and above it (X_2) is obtained using the source depletion model (Chamberlain, 1970). The mass flux QA reaching the location A (as per figure 3.1) can be evaluated by

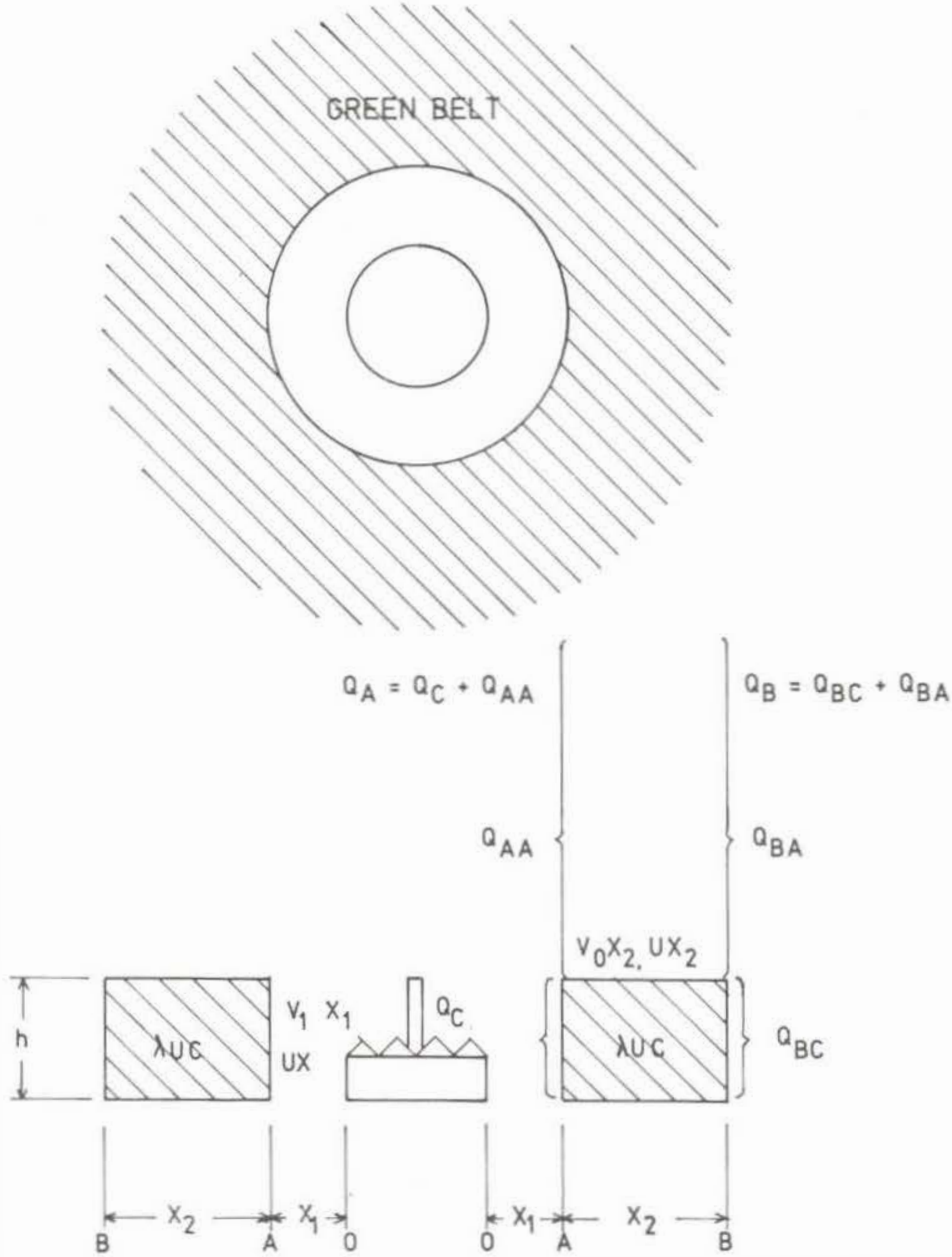

Fig. 3.1 Diagram of a Green Belt Around a Ground Level Pollution Source Illustrating the Parameters of Pollution Attenuation Model

QA = QoFD -- (4)

Where, Qo is the mass flux at the source, and, the FD is the deposition correction factor which is given by :

FD = exp exp dx -------- (5)

Where, H = release height

6z = Standard deviation of concentration distribution in vertical direction

Vd = dry deposition velocity

U = mean wind speed

X = travel distance

Value of FD can be obtained either from equation (5) or from table no. 3.1 (reproduced from Hukkoo et al 1988); which gives the value of FDo for the ratio of Vd/U = 0.01 at various distances under different atmospheric stability conditions). The value of FD for any ratio of Vd/U is given by

$FD = (FDo)\ 100^{Vd/U}$ --------------------------- (6)

The value of QA can thus be obtained with the help of equations (4) and (6).

STAGE-2 :

Fraction of mass flux QA entering the green belt

The material QA is divided into two parts, namely, Qc which passes through the green belt and QAA which passes over it (see figure-3.1). The proportion in which QA is divided into these two parts depends upon the height of trees, distance X_t and atmospheric conditions.

The calculation of Qc involves the effective height h_e of the incident air steam. If the height of the green belt is h, then he is given by

U(z)dz = hUc ------------------------------ (7)

Where U(z) is the wind speed at height Z profile outside the green belt and Uc is average wind speed through green belt. The methodology for calculation of h_e, is given by Kapoor and Gupta (1984) and values of h_e for different heights of trees under different atmospheric stability conditions reproduced from that work is given here in Table 3.2. The quantity Qc is then evaluated as follows.

Qc = QA XU dy dz ------------------------------- (8)

X (X, o, o) the centre line ground level concentration at down wind travel distance X.

Where, concentration C is given by

------------ (9)

Where, y and z are dispersion coefficients and are in fact the standard deviations of concentration distribution in crosswind and vertical directions respectively at down wind distance X. This is a standard atmospheric dispersion equation. More information on this and other atmospheric dispersion models can be obtained from Sutton, 1953; IAEA publications 1980; 1986. Equation (8) after substitution and carrying out the integration over y and z, can be written as,

Qc = QA ---------------- (10)

Where

----—— (11)

The value of the mass flux which passes over the green belt, QAA can thus be obtained using the following relation

QAA = QA - QC -------------------------------------- (12)

Table 3.2 Values of h_e

Tree (m)	Values of h_e (m) for height Atmospheric stability condition A	B	C	D	E	F
10	3.62	3.68	3.04	3.29	3.49	4.52
15	5.04	5.12	4.17	4.42	4.76	6.12
20	6.40	6.49	5.52	5.49	5.95	7.56
25	7.71	7.80	6.29	6.50	7.07	8.91
30	8.99	9.08	7.29	7.48	8.14	10.16

Stage-3

Mass flux Q_{BC} coming out of green belt

The material Qc is depleted in the green belt according to the relation given in equation (1). Value of for the pollutant and applicable to the green belt can be obtained using equation (2).

Thus,

Q_{BC} = Qc exp (- X_2) ------------------------ (13)

Where X_2 is the width of the green belt. The amount of material QAA which passes over the green belt will also get depleted to mass flux Q_{BA} by loss of material at the top surface of the green belt. The value of Q_{BA} is evaluated for travel distance X_2 from (4) and (6) by replacing Qo by QAA.

Stage-4 :

Totalmass fluxQB reachingat the outer edge of the green belt

The totall mass flux QB reaching at the outer edge of the green belt (location B) is thus given by

$$QB = QBC + QBA \text{ ---------------- } (14)$$

Stage-5 :

Calculation of attenuation factor, Af

In the absence of a green belt, the mass flux QWB reaching the distance $X_1 + X_2$ is evaluated using equations (4) and (6). The attenuation factor Af of the green belt at location B is then obtained using equation (3).

Combining all the five above stages and after doing the necessary mathematical simplifications, the pollution attenuation factor, Af is finally given by,

$$FD(X_1+X_2) \quad Af = \text{ ----------------------------- } (15)$$

Where,

$FD(X_1+X_2)$ = deposition correction factor for travel over distance (X_1+X_2)
$FD(X_1)$ = deposition correction factor for travel over distance X_1
$FD(X_2)$ = deposition correction factor for travel over distance X_2

Other parameters have their usual significance as described earlier.

Optimization of Green Belt

In previous section, a model for the development of green belt around pollution sources for reducing pollution levels has been described which can be used for the optimization of the physical dimensions of the green belt. This optimization, methodology is further described below.

It may be reiterated that the model incorporates following parameters for the computation of pollution attenuation factor, Af : (i) physical characteristics of the green belt, e.g., distance from the source, width, height and leaf surface area density; (ii) aerodynamic properties eg., wind speed through green belt and effective height of the incident air stream, (iii) deposition velocity of the pollutant, and (iv) atmospheric stability conditions. The estimated value of attenuation factor, Af for different combinations of green belt parameters i.e. $X_1, X_2, h,$,U under different atmospheric stability conditions can be used to optimise the design of the green belt. The parameters X_1, X_2 and are critical for optimisation. The choice of remaining parameters (h and U) is restricted and decided mostly by the local conditions. For example, it is preferable to have taller trees with high foliage density, but trees of height greater than 20 meters are not common at most sites.

In optimising the physical dimensions of green belt for a ground level source as described above, factors like; the variation in the density of tree plantation and interfacial mass exchange through upper boundary of green belt were not considered. Since, these factors also play important role in effectiveness of green belt, these are discussed in next section.

Effect of Density of Tree plantation

The effect of density of tree plantation on attenuation factor has been dealt in details by Gupta and Kapoor (1992). It has been found out that the value of attenuation factor increases with increase in the density of tree plantation [`K' of equation (2)] upto an optimum value of K but decreases thereafter for X_2 = 4 Km. However, this concept is true only when interfacial mass exchange of pollutants through upper boundary of the green belt is not considered.

The interfacial mass exchange of pollutant in vertical across upper boundary of green belt would modify source mass flux moving through and above it and would thus influence the value of Af. Consideration of interfacial pollutant exchange results in net movement of material from higher pollution region to lower pollution region. Value of Af reduces when pollution moves out of canopy region to the region above. Whereas, when pollution enters from above to within canopy region, Af increases. Reduction in Af is seen for all values of density of tree plantation (K) for X_2 <2 Km and for K <0.7 for X_2> 2Km. A small increase in Af is seen for K = 0.7 for X_2> 2km. These studies help to optimise K for a green belt of given h and X_2 to obtain maximum Af. Optimum value of K giving maximum Af for different X_2 for with and without interfacial mass exchange is given in Table 3.3 (Gupta and Kapoor, 1992).

Table-3.3 Value of maximum Af and optimum K with and without interfacial mass exchange for different widths of green belt for neutral stability condition (category `D').

X_2 (m)	Without interfacial pollutant exchange		With interfacial pollutant exchange	
	Maximum Af	Optimum K	Maximum Af	Optimum K
500	2.17×10^1	0.9	1.87×10^1	0.9
1000	6.64×10^1	0.7	3.10×10^1	0.8
2000	2.13×10^2	0.6	3.84×10^1	0.7
3000	5.87×10^2	0.5	4.67×10^1	0.7
4000	1.46×10^3	0.4	5.67×10^1	0.7
5000	3.76×10^3	0.4	6.88×10^1	0.7

Effect of other parameters

As an illustrative example for optimisation, values of Af are calculated for a few selected values of parameters and the results are discussed here. The calculations are performed for removal of particulate material by a green belt for = 0.02m^{-1} and tree height varying from 10-30m. Amongst the other parameters, value of Vdx_1 and Vdx_2 are assumed to be equal and assigned a value of 0.0156 ms^{-1} (which is the gravitational settling rate for 20 um particle size). Similarly Ux_1 and Ux_2 are assumed to be the same as U(10). The values of U(10) & UC used in these calculations under different atmospheric stability conditions are given below.

Stability condition	:	A	B	C	D	E	F
$U_{(10)}$	:	2	2	4	5.5	3	2
UC	:	0.5	0.5	0.75	1.0	0.6	0.5

Variation of Af with X_1 and X_2

For a fixed height of tree, the value of Af is expected to increase with increase in X_2 and with decrease in X_1. Though it is preferable to plant the green belt as close as possible to the pollution source (i.e, low value of X_1), practical considerations may not permit very low values of X_1. Similarly for fixed value of X_1 and X_2, the value of Af is greater for taller trees. The variation of Af with X_1 and X_2 and h under different atmospheric stability conditions is discussed below.

Unstable condition, A

The variation of Af with X_1 for a fixed value of X_2 = 500 m and with X_2 for a fixed value of X_1 = 50 m for stability condition A are given in figures 3.2 and 3.3 respectively. It can be seen from figure 3.2 that the value of Af is close to unity even for taller trees if X_1 = 300m or more. Reducing the value of X_1 is of advantage only in the case of tall trees and a value of Af = 6 is obtained for 30m tall tree if X_1 is kept at 50 m.

Figure 3.2 shows that the value of Af remains constant beyond a certain value of X_2 depending on the height of trees. This suggests that increasing the value of X_2 more than 300m does not serve any useful purpose for stability condition A for h = 10 to 30 m.

Stable condition, F

Figures 3.4 and 3.5 which are similar to figure 3.1 and 3.2 present the variation of Af in stability condition F. The value of Af, as high as 10^4, is attainable in this stability condition (see fig - 3.4) for trees of height 15m or more for X_2 = 500m and X_1 = 50m. This figure also shows that if the tree height is more than 25m, the value of Af is of the same order even if X_1 is increased to 100m. Figure 3.5 shows that the value of Af increases with X_2 upto a certain distance and thereafter the increase in Af is not significant. This feature of more or less constant value of Af beyond a certain distance helps in estimating the optimum width of the green belt. For the conditions considered in this example, this distance is 500, 700 and 1700m for tree heights 10, 15, and 30 m repectively.

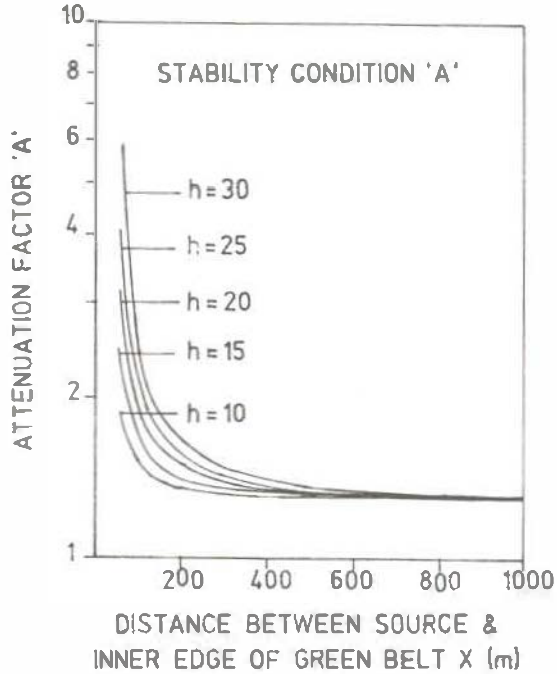

Fig. 3.2 Attenuation Factor as a Function of Distance Between the Source and Inner Edge of Green Belt and the Tree Height, for X_1=500m, λ = 0.02m^{-1} and for Atmospheric Stability Condition A

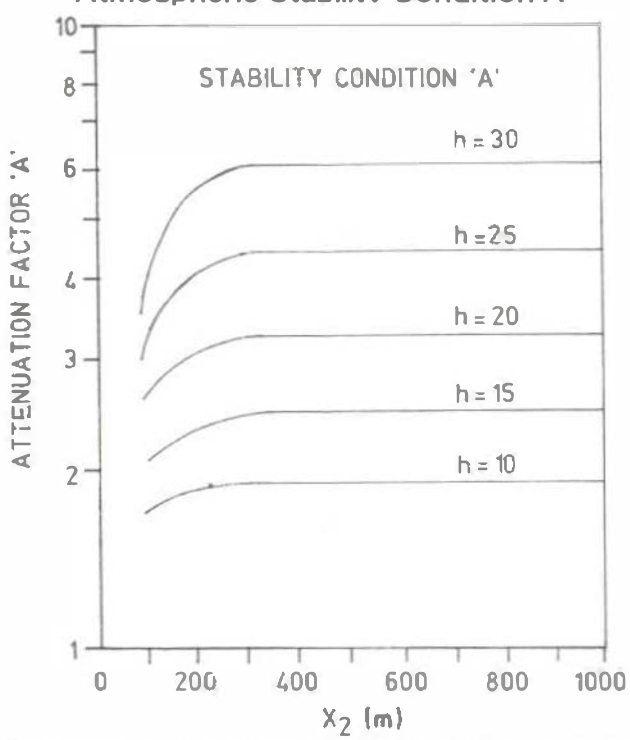

Fig. 3.3 Attenuation Factor as a Function of Width of Green Belt and the Tree Height, for X_1=50m, λ = 0.02m^{-1} and for Atmospheric Stability Condition A

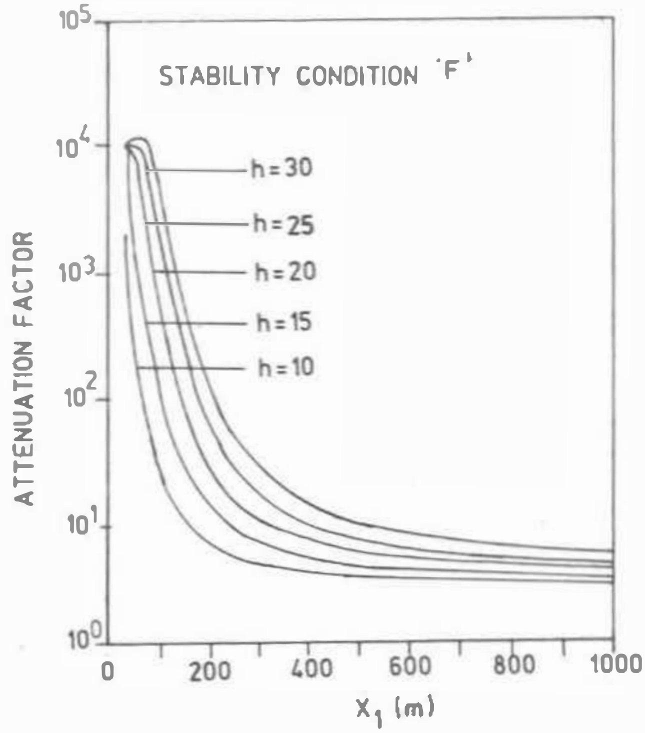

Fig. 3.4 For Atmospheric Stability Condition F

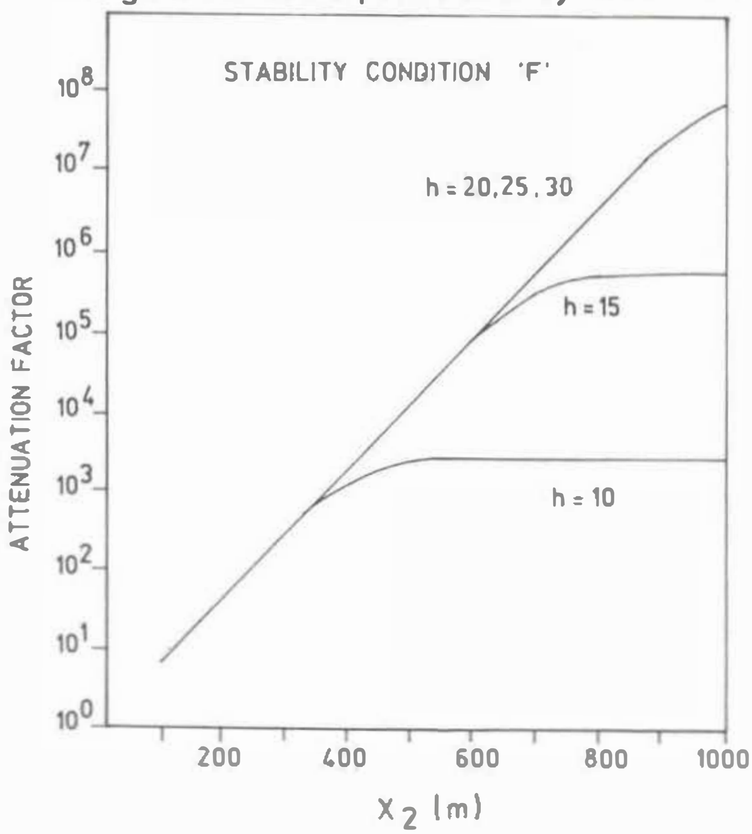

Fig. 3.5 For Atmospheric Stability Condition F

Variation in other Atmospheric stability conditions

The above discussion pertains to only two extreme atmospheric stability conditions. The values of Af for intermediate stability conditions lie mostly in between the two extreme values (Table-3.4). It can be seen from this Table that, for 15m high trees, advantage gained by increasing the width of green belt from 500 to 1000m is not significant in all the stability conditions except for F where Af of more than 10^4 is obtained for X_1 = 50m. However, if the tree height is increased to 30m, an attenuation factor of greater than 10^4 is possible in stability category E also for a green belt width of 1000m, whereas, in stability category D, the attenuation factor obtained is 600. This suggests that a green belt consisting of tall trees around an industry could provide significant attenuation factors for about 50% of the time in a year for the case considered here.

X_2 (m) (m)	A	B	h value of Af for sability class C	D	E	F
500	15	2.5	3.6	4.5	1.7×10^1	1.2×10^2 1.1×10^4
30	6.2	1.4×10^1	2.6×10^1	6.0×10^2	1.4×10^4	1.1×10^4
1000	15	2.5	3.6	4.5	1.7×10^1	1.2×10^2 5.9×10^5
30	6.2	1.5×10^1	2.6×10^1	6.0×10^2	1.1×10^5	8.2×10^7

Application of Green belt Model

The green belt model developed here is applied to two different cases for studying the usefulness of green belt in reducing the impact of pollution. Out of the two applications, one is a source oriented approach and the other is receptor oriented approach. In the source oriented approach, green belt of suitable dimension is planted around a source emitting pollution and studies are made to know the usefulness of green belt in reducing the effects of pollution for ground level releases. In the second case i.e., in the receptor oriented approach, green belt of suitable dimension is planted around an object which is getting deteriorated or likely to get deteriorated as a result of pollution in and around it and studies made to protect it against pollution. These two examples are dealt within a little more detail in the following paragraphs.

Source oriented approach

A nuclear power reactor surrounded by a suitably designed green belt provides an example of the source oriented approach.

Gupta and Kapoor (1985) analysed the consequences of a hypothetical reactor accident, in which a large, cold, ground level release of radioactive nuclides takes place in the presence of a suitably designed green belt around a nuclear power plant. The release of 54 radionuclides from a 1000MWe light water reactor was considered. These radionuclides fall into two main categories : particulates and noble gases. The deposition velocity on vegetation for particulates was taken as 0.01 ms^{-1} and zero for noble gases (being inert in nature). The calculations considered the building wake effect (effect of stagnation of pollutants and subsequent dilution owing to alignment of surrounding structures which give rise to eddy currents) and radio - active decay as well as deposition of radionuclides in the green belt.

The radiological consequences were calculated in terms of early and continued mortalities. The radiation dose to four important body organs (viz. thyroid, lung, gastrointestinal tract, and bone marrow) of persons staying up to 100 kms from the reactor were calculated under different atmospheric stability categories. For calculation of early and continued mortality by the effect of radiation dose, the dose - mortality criteria of WASH 1400 (1975) were adopted.

The reactor accident consequences were calculated without a green belt and compared with the corresponding consequences when the reactor is surrounded by a 15m high green belt of 1500m width. The inner boundary of the green belt was taken as 50 m away from the reactor. Besides the decrease in mortality probability, the impact of green belt on reduction of other important consequences of lesser importance like relocation of population and banning of food produced in contaminated regions were also analysed. The analysis shows that, the benefits of developing a suitably designed green belt around nuclear power plants are as follows :-

(i) The early and continued mortalities are practically eliminated beyond a distance of 3km.

(ii) The relocation of population to protect it from long term external exposure from ground contamination may not be required.

(iii) The supply of food from uncontaminated areas may be needed for populations living between 2 to 20 km only in the affected sector.

Since the siting requirements in many countries require exclusion distance ranging from 0.5 to 3 km from the reactor, it should be possible to develop a green belt around nuclear power plants that will substantially reduce the consequences of the accidents. The green belt would thus serve as another barrier between the nuclear power plant and the public and would strengthen the defense-in -depth philosophy adopted in the design of nuclear power plants. The assured availability of a suitably designed green belt throughout the year could also help in reducing the magnitude of emergency preparedness in the public domain.

Receptor oriented Approach

Mathematically both source and receptor oriented approach are the same, the only difference between the two is the manner in which the green belt is planted. In the source oriented approach, the green belt is planted around the pollution source, whereas in the receptor oriented approach the receptor is protected against pollution by planting a green belt around it. The case of protecting the Taj Mahal against air pollution by a green belt is presented here as an example of receptor oriented approach.

The value of the pollution attenuation factor, Af is computed for different atmospheric stability conditions, different heights, widths of the green belt and also for varying distances of green belt from the receptor. The results of the studies suggest that the green belt is more effective in attenuating pollution in stable atmospheric stability conditions and for smaller distance between source and green belt (X_1). Increasing the height of trees is of advantage in attenuating the pollution only for a smaller value of X_1. Also, it is observed that increasing the width of green belt beyond 200m does not significantly increase the value of Af, for the range of X_1 considered in the study. In general, the study indicates that, the value of Af in the case of Taj Mahal is much smaller than that obtained by a source oriented approach. Significant values of Af occur only for nearby ground level pollution sources and that also in stable atmospheric conditions.

Nomenclature

Symbol	Name	Unit
A_f	Pollution Attenuation Factor	Ratio
F_D	Deposition Correction Factor	Ratio
h	Physical height of green belt	m
he	Effective height of green belt	m
H	Pollution release height	m
K	Density of tree plantation in green belt	Ratio
Q	Mass flux of pollution	kg. S^{-1}
U	Mean wind speed	mS^{-1}
$U_{(z)}$	Wind speed at height Z	mS^{-1}
Uc	Average wind speed through green belt	mS^{-1}
Vd	Pollutants deposition velocity	mS^{-1}
X	Travel distance	m
	Pollution Attenuation coefficient	m^{-1}
Pc	Average foliage surface area density of the green belt	m^2m^{-3}
Pt	Average foliage surface area density of a single tree	m^2m^{-3}
	Standard deviation of concentration in cross-wind direction	m
	Standard deviation of concentration in vertical direction	m
X (x,y,z)	Concentration of pollutant at travel distance x, Crosswind distance y and height z	kg m^{-3}

CHAPTER – 4

AGRO-CLIMATIC ZONES OF INDIA

A country of subcontinental dimensions and varied features of land and rivers, is endowed with a large number of biogeographic zones. Though there were several attempts to classify Indian vegetation types, the most commonly used classification is that by Champion (1938) with modifications. Since the accent of the present effort is on cultivation of plants, rather than on the naturally growing vegetation types, a suitable scheme recognizing bio-climates along with soil types is necessary. Carter (1954) divided India into six climatic regions, from arid to perhumid, based on Thornthwaite's system of climate classification. Krishnan (1988) identified 40 soil climatic zones based on major soil types and moisture index. Planning Commission, Government of India, New Delhi (Alagh, 1990), have recommended a scheme for agro-climatic classification of the country.

According to this scheme, there are 15 agro-climatic regions (Fig.4.1). Each of these regions is further divided into 68 ub-zones, based on detailed characteristic features, such as natural resources, typologies (land productivity level, relative pressure on land and environmental factors) etc.

Subtypes presented in the Planning Commission document further describe ranges of rainfall (Fig. 4.2), general climatic conditions and soil types (Fig. 4.3) prevailing in these regions. The emphasis here is on the development of resources and their optimum utilization in a sustainable manner within the framework of resource constraints and potentials of each region.

Under National Agricultural Research Project (NARP), a 120 sub-zone map has been prepared, based primarily on rainfall, existing cropping pattern and administrative units. More recently, using parameters such as physiography, soils, bioclimates and length of growing period, an agro-ecological map of the country (Fig. 4.4.) has been prepared. This scheme recognizes 6 regions, which are further divided into 20 sub-regions.

A sophistication to agro-climatic classification for kharif crops has been deviced by Chowdhery et al,(1993), employing principal component analysis to agro-climatic variables for delineating India into homogenous zones.

During the present work, the scheme suggested by the Planning Commission has been adopted. Appendix A gives the 15 agro-climatic zones and their 68 sub-zones, for which details such as annual rainfall, climate, soil types and revenue districts covered by them, are given.

It is expected that user of this report refers to Appendix A, for identifying and locating one's area of concern, before proceeding further to the list of plants to be chosen for plantation programme.

LEGEND

1. WESTERN HIMALAYAN
2. EASTERN HIMALAYAN
3. LOWER GANGETIC PLAINS
4. MIDDLE GANGETIC PLAINS
5. UPPER GANGETIC PLAINS
6. TRANS GANGETIC PLAINS
7. EASTERN PLATEAU HILLS
8. CENTRAL PLATEAU HILLS
9. WESTERN PLATEAU - HILLS
10. SOUTHERN PLAREAU HILLS
11. EAST COST PLAINS - HILLS
12. WEST COST PLAINS - HILLS
13. GUJARAT PLAINS - HILLS
14. WESTERN DRY REGION
15. THE ISLANDS REGION

Fig. 4.1 Agro Climatic Zones

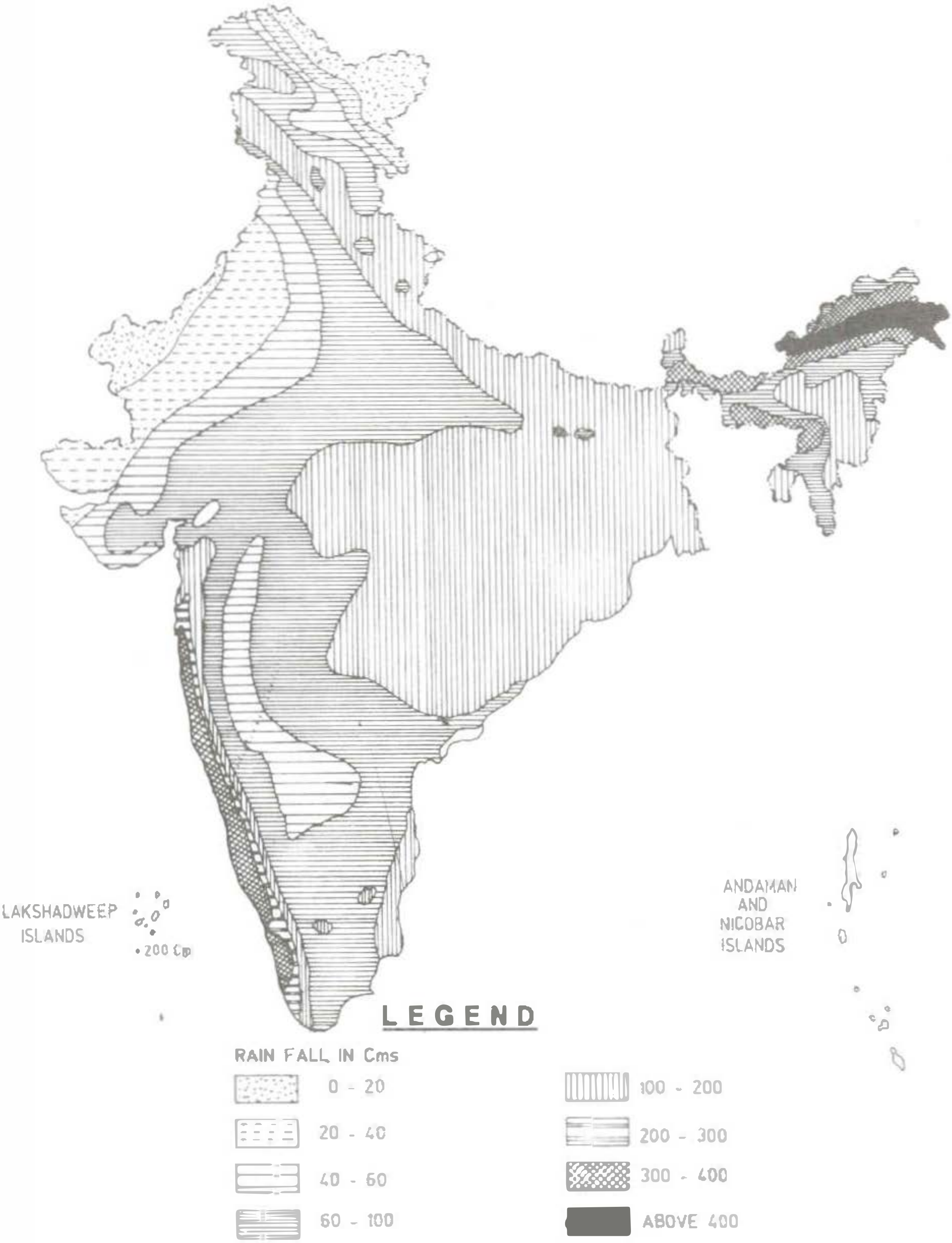

Fig. 4.2 Annual Rainfall

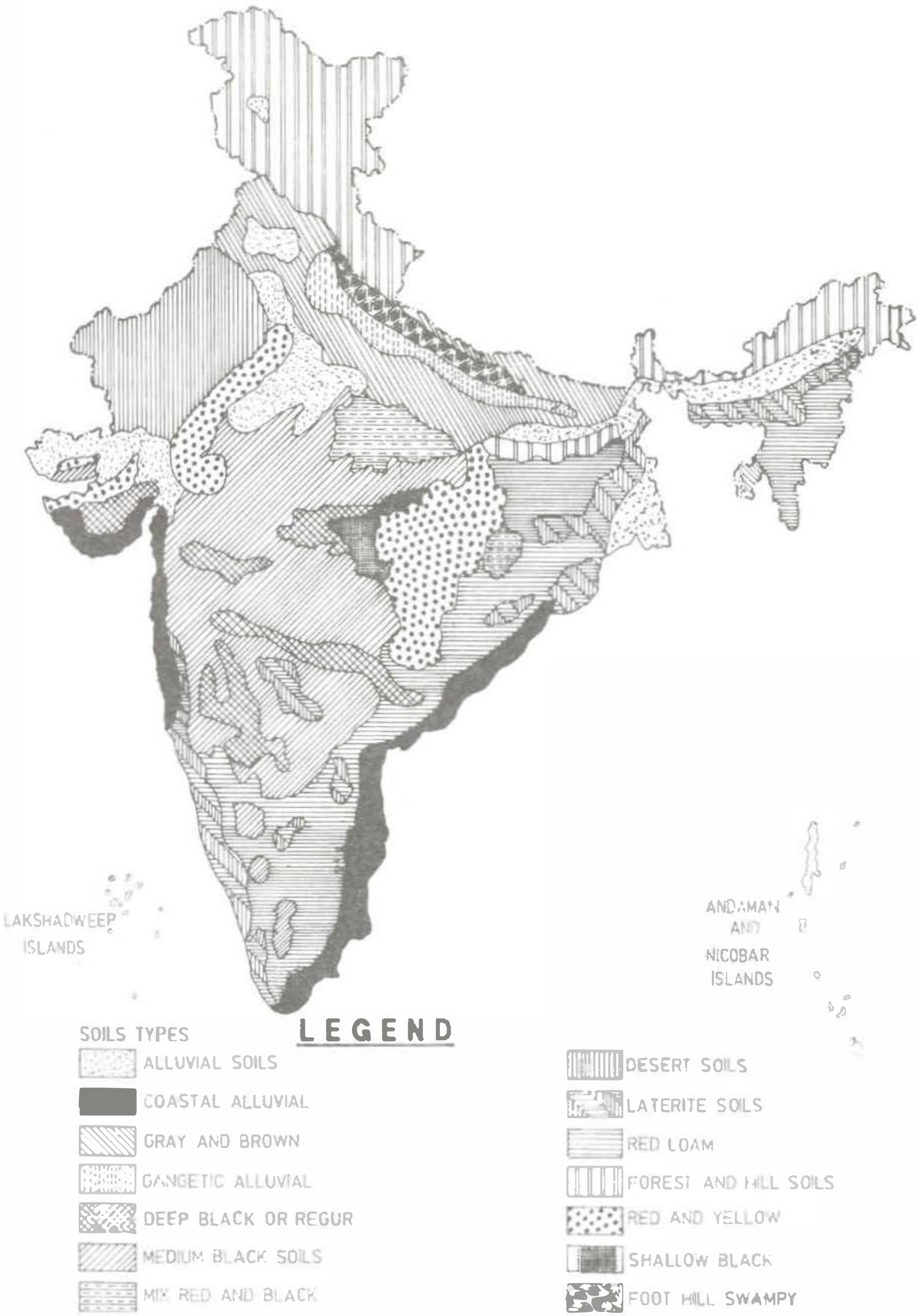
LAKSHADWEEP
ISLANDS
ANDAMAN
AND
NICOBAR
ISLANDS
SOILS TYPES
LEGEND
ALLUVIAL SOILS
COASTAL ALLUVIAL
GRAY AND BROWN
GANGETIC ALLUVIAL
DEEP BLACK OR REGUR
MEDIUM BLACK SOILS
MIX RED AND BLACK
DESERT SOILS
LATERITE SOILS
RED LOAM
FOREST AND HILL SOILS
RED AND YELLOW
SHALLOW BLACK
FOOT HILL SWAMPY

Fig. 4.3 Soils

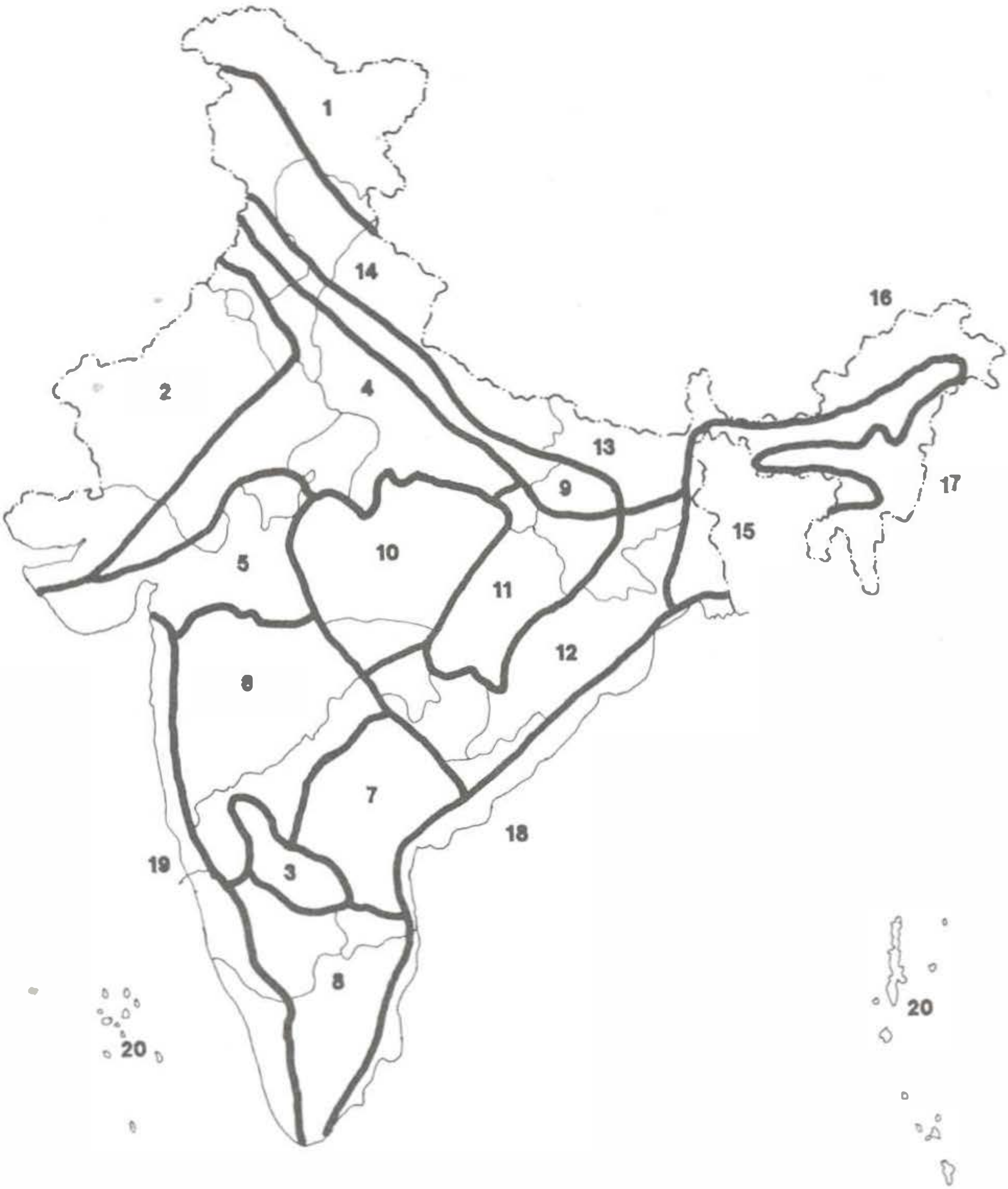

Fig. 4.4 Agro-Economical Regions

CHAPTER - 5

SELECTION OF PLANTS FOR GREEN BELTS

Discussion in earlier chapters indicate the nature of plant-air pollutant interactions and sensitivity indicated by plants. It also brings out the limitations under which plants are to function as scavengers of air pollutants. Other limitations for growing plants are the climatic conditions and soil characters. Of these, the latter get modified when plants are cultivated and grown under care. e.g. A standard horticultural practice involves planting of saplings in pits of substantial dimensions, i.e. 1m x 1m x 1m for big trees and almost half of these dimensions for smaller trees and shrubs. The pits are then filled with earth, sand, silt and manure in pre-determined proportions. Saplings planted in such pits are watered liberally. The growing plants are then cared for the first three years, or for at least two years under favourable conditions of climate and drainage. Nutrients in pits are supplemented and the juveniles provided protection. Hence, it is safe to assume that trees and bushes grown as green belt components in areas under human control, will have overcome the limitations imposed by soil characters to a great extent. Limitations imposed by climatic conditions on the other hand, cannot be overcome and hence will have to be taken into account while selecting species for plantation in different bio-climatic conditions.

While making choice of plant species for cultivation in green belts, weightage has to be given to the natural factor of bio-climate. It is also presumed that the selected plants will be grown as per normal horticultural (or forestry) practice given above and authorities responsible for plantation, will also make adequate provisions for watering and protection of the saplings.

For effective removal of pollutants, it is necessary that (1) plants grow under conditions of adequate nutritional supply (for health and vigour of growth), (2) absence of water stress (to maintain openness of stomatal apertures and form of epidermal structures), and (3) are well-exposed to atmospheric conditions of light and breeze (i.e. away from engineering structures hindering free flow of air) to maintain free interaction with gases.

Characters of plants including shapes of crowns (Fig.5-1) considered necessary for effecting absorption of pollutant gases and removal of dust particles are as follows :

For absorption of gases

1) Tolerance towards pollutants in question, at concentrations, that are not too high to be instantaneously lethal),

2) Longer duration of foliage,

3) Freely exposed foliage, through
   a. Adequate height of crown,
   b. Openness of foliage in canopy,
   c. Big leaves (long and broad laminar surfaces),

d. Large number of stomatal apertures,
e. Stomata well-exposed (in level with the general epidermal surface).

For removal of suspended particulate matter

1. Height and spread of crown,
2. Leaves supported on firm petioles,
3. Abundance of surfaces on bark and foliage, through
   a. Roughness of bark,
   b. Epidermal outgrowths on petioles,
   c. Abundance of axillary hairs,
   d. Hairs or scales on laminar surfaces,
   e. Stomata protected (by wax,arches/rings, hairs, etc.).

Note : All tolerant plants are not necessarily good for green belts. e.g. Xerophytes with sunken stomata can withstand pollution by avoidance but are poor absorbers of pollutants due to low gaseous exchange capacity.

It is unrealistic to expect, barring exceptions, that atmosphere in an industrial area will constitute only one species of air pollutant. More commonly, one comes across several pollutants, especially SO_2, NO_2 and oxidants, and SPM and also HF in the same region. It will hence be advisable to choose for cultivation of a green belt anywhere, plant species capable of sorption of chemicals as well as dust pollutants. Combined efficiency of a variety of species should contribute to reach the goals of green belts.

Models for Attenuation Coefficients given in chapter Three provide guidelines for positioning of plants with reference to particulate emission source at ground level. Width of the belt as presented by the model, may prove difficult for many industries to attain, for one or more reasons. Hence, it becomes necessary to decide to have green belts in places available around the industry (source- oriented plantation) as well as around habitats (receptor- oriented plantation). Lists of plants given in Appendix-C should be seen from this angle for selection of species combinations, in conformity with bioclimatic attributes of respective regions.

Plantation along Roadsides

Automobiles may be considered as ground level, mobile sources of pollution of both types - gaseous as well as particulate. Components of green belts on roadsides hence, should be both absorbers of gases as well as of dust particles, including even lead particulates. Sorption of the latter type has been estimated by Joshi (1990) who found high levels of lead sorption on ornamentals cultivated in traffic islands. Choice of plants for roadside (and traffic island) plantations may be for containment of pollution and for formation of a screen between traffic and roadside residences. This choice of plants should include shrubs of height 1 to 1.5 m and tree of 3 to 5 m height. The intermixing of trees and shrubs should be such that the foliage area density in vertical is almost uniform. A green belt of such a design and having a width of 30 to 50 m will give a pollution attenuation factor of 2 to 100 for unsuitable to plants atmospheric conditions. Thus medium- sized and small trees alternating with shrubs, aimed at sorption of particulates and gases, will be suitable here. Since safety of traffic is a major consideration, shrubs in traffic islands and along road-dividers will have to be short enough to be below the eye-level of motorists. An ideal design for roadside green belt is presented in Fig.5.2. Still, it is necessary to emphasize that each traffic island has its own character and needs to be studied separately for designing its green belt.

A comprehensive list of plants recommended for green belts in the country is presented in Appendix-B. The list consists of latin and common names of plants, natural order to which they belong and a number of relevant characteristic features, viz. tolerance or otherwise towards air pollution, habit, growth rate, flowering phenology, crown shape and approximate surface area, etc.

The list is not complete in itself. Several more species could be added to it. Criteria for inclusion of species in this list include availability, knowledge about their horticultural aspects, particularly propagation methods and growth rates and (sometimes) observed or reported information about their tolerance to air pollution. Numerous species, indigenous to certain regions, may also be included wherever possible. In extreme areas (e.g. where stresses due to water, salinity, salt-sprays, etc. are acute) only tolerant species should be chosen. Appendix C provides lists of plants recommended for cultivation in the six agro-climatic zones and their subzones.

The shapes given here are for convenience only. Many crown shapes range between those identified following, viz. Oblong-Round, Round-Spreading, Conical-Oblong, etc. Some shapes also change with age or emiron mental stresses.

Fig.5.1 TREE CANOPY SHAPES

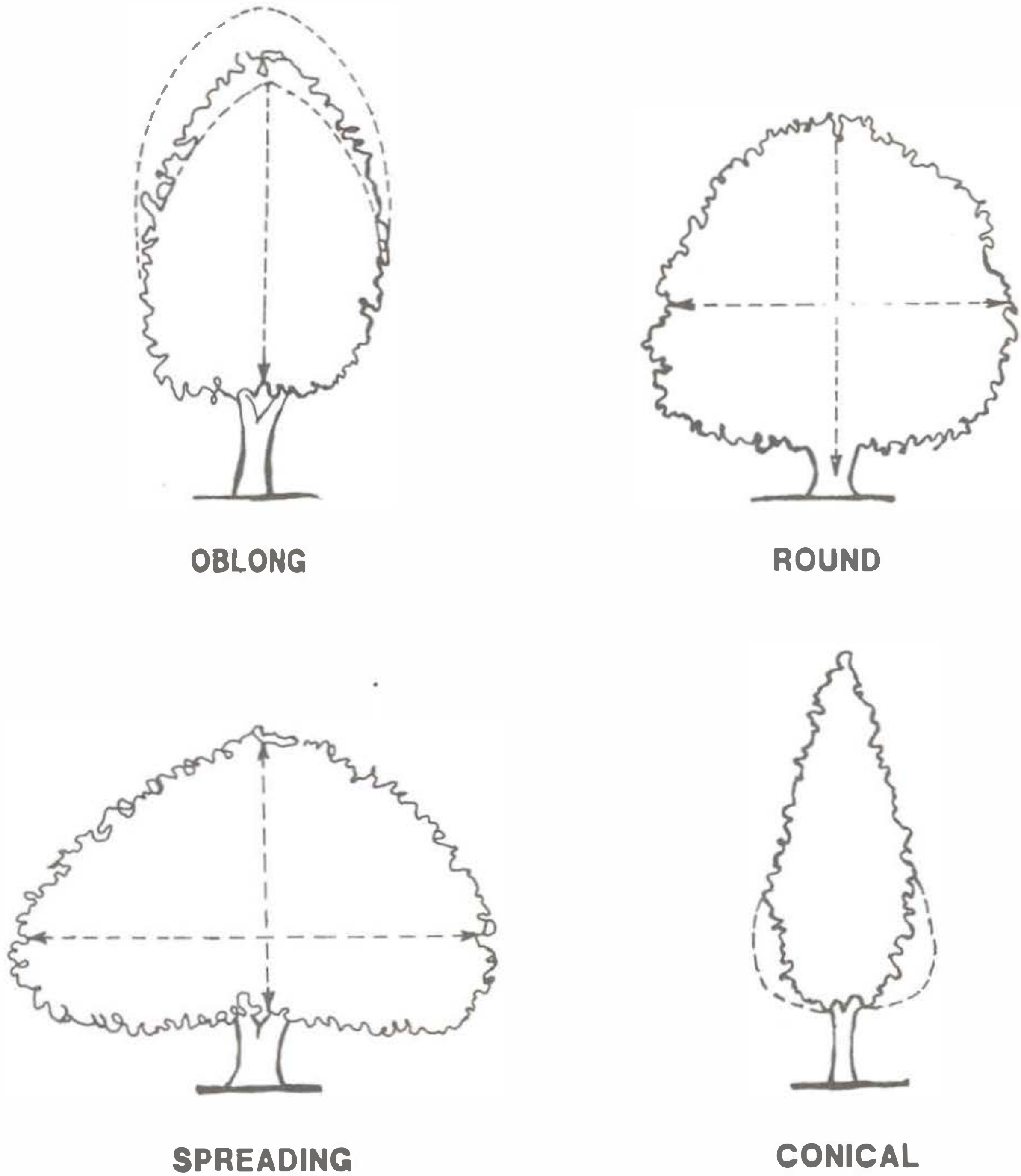

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FIG. 5.1 TREE CANOPY SHAPES

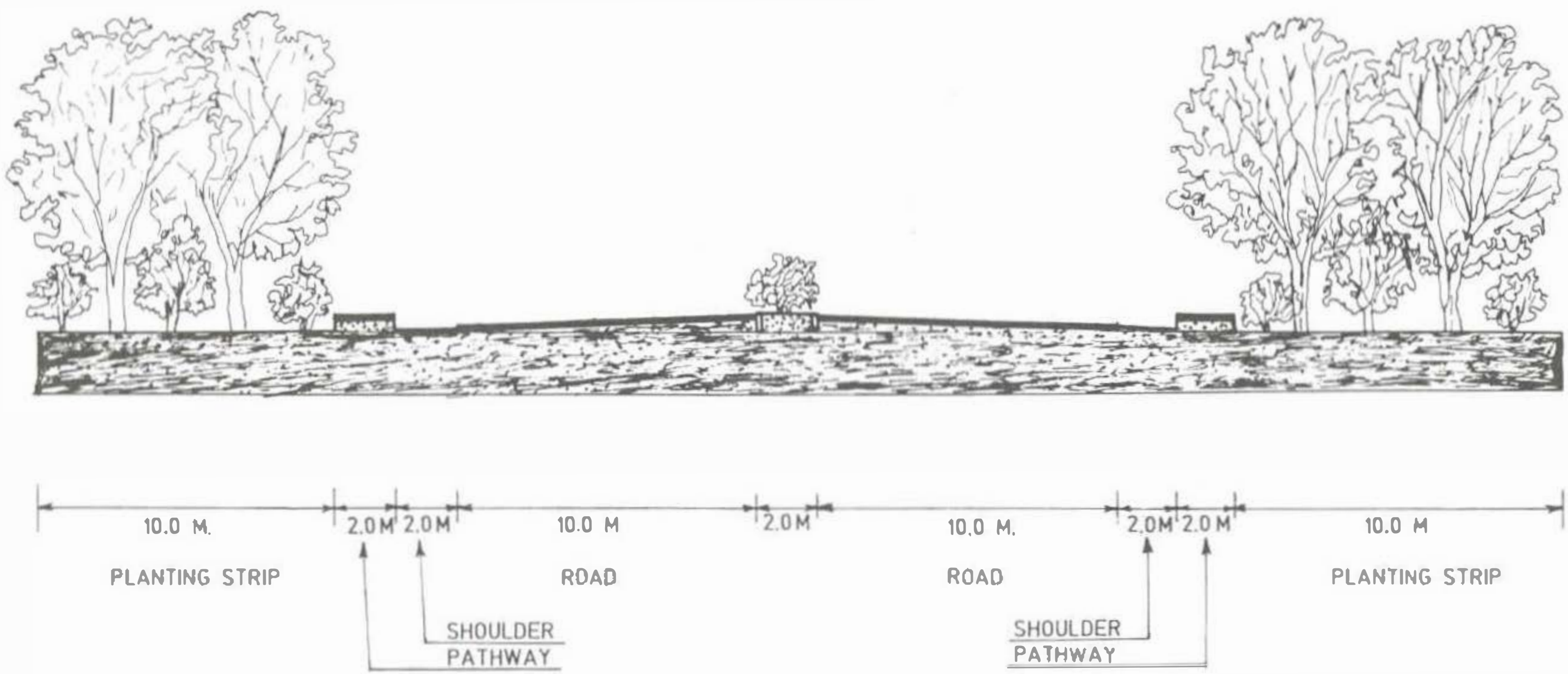

FIG. 5.2 TYPICAL ROAD-SIDE PLANTATION

CHAPTER - 6

STABILIZATION OF FLY - ASH WITH PLANTS

Introduction

Of all the sources of non-muscular energy, coal is the most abundant one (Tandon, 1989). Total stocks of coal in India are 1,70,460.54 million tons of which 49,376.28 million tons are proven ones. Compared to oil and natural gas reserves (16,000 mt potential), coal stocks are more long-lasting and hence more reliable for exploitation. Hydropower is clean but creates other environmental problems through construction of large impoundments. Moreover, most of the hydropower potential in India has already been harnessed, leaving very little scope for further expansion to meet increasing demands of times. Nuclear power potential is vast. Presently meeting only a fraction of countries energy needs. Energy from fusion may provide an answer, when it becomes available on commercial scale, at the required magnitude. By all accounts then, we have to resort to coal for energy production till other power sources can be harnessed satisfactorily.

Environmental hazards of utilization of coal

Of all the fossil fuels, coal is the dirtiest one. All the way - from coal mine to ash dumps, this fuel poses environmental hazards in one or another form. Acidic drainage from coal mines and pit-head dumps are reported repeatedly by several workers (Bradshaw and Chadwick, 1980). Fugitive dust escaping along coal transporation channels, from pit-heads to power plants and at the time of loading - unloading operations has also been observed (Rao, 1971). Once at power plants, every stage of coal utilization creates a different environmental hazard.

Coal arriving in power plant premises is tipped from railway wagons or from conveyors. The tipping and storage areas are the ones where fungitive coal-dust escapes in the immdediate neighbourhood, especially when these operations take place in the open, under dry-weather conditions.

Crushing of coal and conveyance of fine coal to furances is the next stage of fungitive dust emission. Combustion of coal for energy production then takes place, where generation of ash and pollutant gases takes place. A substantial amount of energy also escapes at the same time. Under the present technological scenario, a large proportion of all the three are captured and sought to be nullified, detoxified or ameliorated, from environmental point of view. Considering the magnitude of energy production however, even small proportion of the pollutant output proves to be a major environmental hazard. e.g. A 500 MW TPP using Indian coal (0.5% S, 40% mineral matter) generates 3537 tons of ash, 76 tons of SO_2, every day of its full capacity working. Pollution abatement measures of good capacities (99.8% in respect of dust capture) still permit around 884 g SO_2 and 66 g dust to emit from the high stack, every second. Ash captured before emission from stacks is deposited in pits, valleys or even on flat grounds. It finds its way in air by wind erosion and in water bodies by surface run off. Where deposited, the land by itself is unfit for any primary production process.

Covering of ash dumps

The large proportion of ash (40-47% in Indian coals) is conveyed to deposition areas in pipelines in the form of slurry. Receiving grounds are valleys, flat-lands or pits dug for the purpose. On decantation, or after infiltration of water into the ground, the ash stands exposed to elements - winds and rains. Ash gets blown on winds to get deposited downwind on croplands or on other types of vegetation, smother plants and affects yields (Rao, 1971; Bradshaw and Chadwick, 1980). Ash carried by run - off water forms sediments in nearby waterways causing turbidity problems for aquatic organisms, reduces water quality for drinking or even for irrigation. Cases of accumulation of toxic heavy metals in sediments of rivers are also reported (Evans and Geisey, 1979). Stabilization of ash deposits, hence, is always an urgent necessity.

Examples of successful stabilization of ash dumps and covering the same with plants can be cited (Bradshaw and Chadwick, 1980). Use of stabilized grounds formed by ash deposits for agricultural production has also been done.

The picture in India however, is far from encouraging so far. Though attempts appear to have been made for covering ash by plants, failure of the same was seen in the form of 2-3 year old plants getting chlorotic, bronzed or copper coloured and eventually dyeing. In one reasonably successful operation, where a variety of trees grew successfully for 5-6 years without soil amendments (as reported by the staff), two drawbacks were observed - i) the tall trees (about 4-5 m in height) had started lodging and ii) ash between tree bases had blown away. It is hence necessary to emphasize that a holistic approach to the problem of ash stabilization is desirable. Location of ash dump 'vis a vis' other land- uses in the vicinity, landscaping of the dump, stabilization, detoxification and utilization of the ground created for productive and other purposes should be planned meticulously and simultaneously. The planning process obviouslyshould involve many disciplines. The following suggestions are a part of the planning operation, with a stress on plantation. The suggestions are based on i) experience of countries where productive lands have been formed after ash deposition and ii) working with much more toxic and hazardous tailings with comparable physical properties, from zinc - lead, mines (Chaphekar 1989).

Suggested procedure for Plantation

Fly ash is deficient in plant nutrients like nitrogen and sometimes phosphorus and other minerals and contains toxic metals like copper, cadmium, cobalt, chromium, manganese, molybdenum, nickel, lead, zinc and boron (Tables 6.1 and 6.2). Amendment of ash with nutrients and agents to arrest toxicants are essential for covering it with plants. Some suitable and inexpensive soil additives are given in Table 6.3, along with their properties. Nutrient contents of some commonly used organic manures are given in Table 6.4.

Mixing of farmyard manure (FYM) in 1:4 proportion should serve well as was found with zinc mine tailings (Chaphekar, et al., 1986). For growing grasses, this mix need be in the top soil (upto 15 cm) only, while for tree saplings, pits of suitable dimensions (60x60x60 or 90x90x90 cm) are required with similar mixtures. Watering regimes depend upon local climatic conditions, though in initial stages regular watering - daily for grass and 2-3 times a week for trees is a must.

Nothing compares favourably with the capacity of carpet forming grasses in holding soil in its place, e.g. Cynodon dactylon has conservation value index (CVI) of 94% (Ambasht, 1970). Cultivation of grasses with spreading habit stabilzes the ash surface effectively. Grasses with high turnover rate of shoots contribute subtantially to the organic enrichment of the otherwise nutrient-poor silty ash. Weathered ash is reported to be substantially less toxic than the freshly deposited ash (Bradshaw & Chedwick, 1980). Cultivation of herbaceous legumes enriches the substratum with nitrogen. The stabilized ash then forms suitable ground for other planned utlities like woodland, fuel or fruit-yielding trees, etc. Tables 6.5 (Jha & Singh, 1994) and 6.6 give lists of plants considered suitable for growing on ash dumps for their stabilization. The plants listed are grasses, legumes and MPTs (multi-purpose trees) forming a comprehensive agroforestry system. Possibilities for development of different amenities are numerous, including parks for recreational or educational purposes. Testing of edible parts of plants for toxic heavy metal cotents would help decision-making for deriving agricultural yield from stabilized ash dumps. Experience derived after practicing stabilization efforts along suggested lines, would prove valuable as guidelines for further efforts.

Precautions

There are several variables in the environment and the types in inputs leading to pollution stress. Major variation is in the set of biogeographical conditions - especially climate and topography, as a result of which corresponding modifications in planting strategies become necessary. A large variety of local (climatically adapted) plant species need to be tried in different regions of the country. In case of failure of any of the species to respond as expected, a thorough investiigation (even post- mortern) into the causes of failures, is called for. Such investigations provide guidelines for corrective measures and modifications in plans.

Another important aspect of ameliorative action is evaluation of action taken. Minor drawbacks in execution of plans tend to get amplified with passage of time. Continuous monitoring of plant growth, immediate replacement of casualties, supplementation of nutrients, rescheduling of watering regimes, etc. are important.

Table 6.1 Chemical Composition of Fly-ash

Element	Concentration (Values in %)	Element	Concentration (Values in ppm)
Si	51.94	Co	21
Na	0.49	Ni	86
K	0.60	Cu	68
Mg	0.29	Mo	50
Ca	1.38	Zn	72
Fe	6.13	Cd	5
Al	23.94	As	36
P	0.22		

(Source: D.N.Rao, M.Agrawal, J.Singh, 1990)

Table 6.2 Concentration of Elements in Typical Indian Coal And Fly-Ash Samples

Elements	Concentration in ppm	
	Coal	Fly Ash
Na	300	1300
K	2075	18275
La	47.6	238
Ce	30.2	145
Hg	11.0	48
Pb	1.8	8.1
Th	5.3	25
Cr	62.8	404
Hf	7.1	32.6
Sc	22.9	106
Zn	540	2027
Fe	20890	106670
Ta	1.5	5.1
Co	33.4	128
Eu	1.0	5.6
Sm	0.065	2.29
Au	0.14	0.69

(Source : M.H.Fulekar & J.M.Dave, 1990)

Table 6.3 Soil additives and their properties

Material	pH	Durability	C:N	Application to soil tons ha^{-1}		
				(a)	(b)	(c)
Hay	5.5	1 season	25:1	2	3	4
Manure	6.6	6-12 months	25:1	15	30	40
Sawdust	3.5-7.0	3-5 years	200:1 to 500:1	1	5	10
Leaves (composted)	6.5	1 season	40:1	3	4	5
Refuse	7.5	1 season	45:1 to	20	-	-
Compost	8.5		55:1			

(a) While seeding, (b) for erosion control, (c) around already established plants.

(Source : Bradshaw and Chadwick, 1980)

Table 6.4 Nutrient contents of some types of organic manures

Manure type	Nutrient contents %			Organic matter %
	N	P	K	
Farm yard manure	0.62	0.13	0.49	24
Pig slurry	0.21	0.10	0.18	5
Poultry manure	2.30	0.90	0.65	65
Sewage sludge	1.82	0.43	0.46	39
Mushroom compost	2.80	0.20	0.80	65
Domestic refuse	0.50	0.20	0.30	65
Straw	0.48	1.62	0.85	95

(Source ; Juwarkar. et al., 1989).

Table 6.5 Suggested Multi-Purpose Trees (MPTs) Suitable for Revegetation of Mine Spoils and Degraded Habitats

Acacia catechu
Acacia nilotica
Acaica tortilis
Albizia lebbeck
Albizia procera
Azadirachta indica
Casuarina equisetifolia
Dalbergia sissoo
Dendrocalamus strictus
Dichrostachys cinerea
Gmelina arborea
Holarrhena antidysenterica
Holoptelia integrifolia
Leucaena leucocephala
Madhuca indica
Melia azaderach
Phyllanthus emblica
Pongamia pinnata
Prosopis cineraria
Sesbania aegyptiaca
Shorea robusta
Syzygium cumini
Tamarindus indica
Tectona grandis
Terminalia arjuna
Terminalia bellerica
Zizyphus mauritiana

Adapted from (A.K. Jha & J.S.Singh. 1994)

Table 6.6 List of Grasses, Legumes And Multi-purpose Trees (MPTs) Suggested For Cultivation for Stabilization of Fly-Ash

Grasses
Bothriochloa intermedia
Bothriochloa pertus
Brachiaria mutica
Cenchrus setigerus
Chloris gayana
Chryosopogon fulvus
Cynodon dactylon
Echinochloa colona
Eragrostis cynosuroides
Heteropogon contortus
Paspalidium geminatum
Sacharum bengalense
Sehima nervosum
Sporobolus airoides
Sporobolus coromendelines
Herbaceouss Legumes
Cajanus cajan
Crotalaria juncea
Crotalaria burhia
Desmodium triflorum
Medicago sativa
Phaseolus mungo
Stylosanthes hamata
Trees
Acacia albida
Acacia auriculiformis
Acacia catechu
Acacia holosericea
Acacia nilotica
Acacia senegal
Albizia amara
Albizia lebbeck
Azadirachta indica
Dalbergia sissoo
Eucalyptus hybrid
Erythrina variegata
Gliricidia sepium
Grewia tenax
Hardwickia binata
Leucaena latisiliqua
Pithecellobium dulce
Zizyphus nummularia

(Source : A.K. Jha & J.S. Singh, 1994)

Bioclimatic Zones of India Inclusive of Soil Types and Revenne Districts
I. Western Himalayan Rogian

S. No.	Sub Zone	Rainfal (mm)	Climate	Soils	Districts
1.	High altitude temperate	165	Humid to cold arid	Hill soil mountain meadow, skeletal Tarai.	Chilas, Gilgit, Gilgit Wazarat, Jammu, Kashmir. North (Baramula) Kashmir South (Anantnag, Pulwama,Srinagar, Badgam)Kathua, Ladakh (Kargil, Ladakh.) Mirpar, Muzaffarabad (kupwara.) Poonch, Riasi (Rajauri) Tribal territory. Udhampur (Udhampur Doda) (J and K)
2.	Hill temperate	2000	Humid	Brown Hill	Bilaspur, chamba Hamirpur, Kangra, kinnaur, Kullu, Lahul and spiti Mandi, shimla sirmour, solan, Una (H.P)
3	Valley temperate	400	sub Humid	sub Mountain, Mountain, Meaduw, Skeletal	Chamoil, Dehra Dun Garhwal, Tehri Garhwal Pithoragarh, Almora, Nainital, Uttarkashi
4.	Sub-tropical	1030	Semi-arid to humid	Alluvial (Recent) Brown Hills	

II. Eastern Himalayan Region

S. No.	Sub Zone	Rainfal (mm)	Climate	Soils	Districts
1.	Himalayan Hills	2641	Perhumid to humid	Brown Hills	Darjeeling (W.B.) East sikkim, North Sikkim, South sikkim, West sikkim.
2.	NE, Hills	3528	Per humid to humid	Red sandy Laterite	Karbi Anglong, North Cachar Hills (Assam) Dibang valley, East Kameng. East Siang, Lohit. Lower Subansiri Tirap, Upper Subansiri, West Kameng (Tawang), West Siang (Ar.P) East Garo Hills. East Khasi Hills, Jaintia Hills, West Garo Hills, West Khasi Hills (Meghalaya(Kohima, Mok's kohung. Mon, Phek, Tuensong, Wokha, Zunhebota (Nagaland)
3.	Southern Hill	2052	Per humid to humid	Acidic soil	Bishnupur (Central Manipur) Churachandpur (South Manipur) Imphal (Central Manipur) Senapati (North Manipur) Tamenglong (West Manipur) Chandel (Tengnoupal) Thoubal (Central Manipur) Ukhrul (East Manipur) North Tripura, South Tripura, West Tripura, Aizwal. Chhimtupui Lunmglei (Mizoram)

(Contd.....)

S. No.	Sub Zone	Rainfal (mm)	Climate	Soils	Districts
4.	Lower	1840	Per humid to humid	Alluvial Red loamy	Barpeta Dhubri, Darrang, Goalpara, Kaprup (Nalbari), Kokrajhar (Nagoan), Sonitpur Nowgong (Assam)
5.	Upper	2809	Humid to per Humid	Alluvial Red Loamy	Dibrugarh, Karbi Anglong. Jorhat, Karimgani, Lakhimpur, Sibsagar (Golaghat), Cachar (Silchar, Pragiyotishpur) (Assam), Jalpaiguti Koch Bihar (W.B.)

III. Lower Gangetic Plains (West Bengal)

S. No.	Sub Zone	Rainfal (mm)	Climate	Soils	Districts
1.	Barind Plains	1587	Moist sub humid and sry sub humid	Red and yellow allwvial	Mallah West Dinajpur
2.	Central Alluvial Plains	1449	Moist sub humid to dry sub humid	Red and yellow Deltaic Alluvium, Red Loamy	Barddhaman Haora, Hugli Medinipur (E&W) Murshidabad, Nadia
3.	Alluvial Coastal Saline Plains	1607	Dry sub humid to moist sub humid	Red and yellow deltaic Alluvial	Calcutta, Twenty Four Paragans (North and South)
4.	Rarh Plains	1302	Moist sub humid to Dry sub humid	Red and yellow red loamy	Bankura Birbham.

IV. Middle Gangetic Plains

S. No.	Sub Zone	Rainfal (mm)	Climate	Soils	Districts
1.	North West Alluvial	1211	Moist sub humid to dry sub humid	Alluvial calcarious	Azamgarh, Bahraich, Ballia Basti, Faizabad Gazipur, Gonda, Gorakhpur, Jaunpur. Mirzapur, Deoria, Varanasi (U.P.)
2.	North East Alluvial	1470	Dry Sub humid to Moist sub humid	Alluvial tatai	Aurangabad, Begusarai Bhagalpur, Bhojpur, Darbhanga, Gaya, Gopalganj, Katihar Khagaria, Madhepura, Mudhubani, Munger, Muzzaffarpur, Nalanda, Nawada, Poschim Champaran, Patna, Purba Champaran, Purnia, Rohtas, Saharsa, amsatipur, Saran, Sitamarhi, Siwan, Vaishali (Bihar)

V. Upper Gangetic Plainns (Uttar Pradesh)

S. No.	Sub Zone	Rainfal (mm)	Climate	Soils	Districts
1.	Central Plains	979	Dry sub humid to semi arid	Alluvial	Allahabad, Bara banki, Fatehpur, Hardoi, Kheri Lucknow, Pilibhit, Rae Bareli, Sitapur, Sultanpur, Unnao, Partapgarh
2.	North Western Plains	907	Dry sub humid to semi arid	Alluvial tarai	Bareilly, Bijmor Bulandshahar, Gaziabad, Meerut, Moradabad, Muzaffarnagar, Rampur, Saharanpur, Shahjahanpur
3.	South Western Plains	721	Semi arid	Alluvial	Agra, Aligarh, Badam Etah, Etawah, Farukhabad, Kanpur (Rural), Kanpur (Urban) Manipur, Mathura

VI. Trans Gangetic Plains

S. No.	Sub Zone	Rainfal (mm)	Climate	Soils	Districts
1.	Foot hills of Shivalik and Himalayas	890	Semi-arid to dry sub-humid	Alluvial (Recent) Calcarious	Gurdaspur, Hoshiarpur Rupanagar (Punjab) Ambala, Chandigarh (Haryana)
2.	Plains	561	Semi arid to dry sub humid	Alluvial (Recent) Calcareous	Amritsar, Jalandhar Kapurthala, Ludhiana, Patiala (Punjab), Faribdabad, Gurgaon, Jind, Karnal, Kurukshetra, Rohtak, Sonepat (Haryana) Delhi
3.	Scarce Rainfall arid zone	360	Arid and Extreme arid	Calcareous Sierozemic Alluvial (Recent) Desert	Bathinda, Faridkot, Ferozpur, Sangrur (Punjab), Bhiwani, Hisar, Mahendragarh Sirsa (Haryana) Ganganagar (Rajasthan)

VII. Eastern Plateau and Hills

S. No.	Sub Zone	Rainfal (mm)	Climate	Soils	Districts
1.	Eastern Plain	1271	Dry sub humid	Medium to deep black red and yellow	Bolanagar, Dhenkanal Sambalpur (Orissa) Balaghat, Bilaspur, Durg, Raipur, Raj Nandgaon (M.P.) Bhandara, Chandarapur Garchiroli (Maharashtra
2.	Estern Highland	1436	Moist sub humid to dry sub-humid	Red sandy, Red and Yellow	Keonjhar, Mayurbhanj Sundargarh (Orissa) Rajgarh, Surguja, Shahdol (M.P.)
3.	North Central Plateau	1296	Moist sub humid to dry dub-humid	Red sandy Red and Yellow	Deogarh, Dhanbad, Giridih, Godda, Hazaribag, Sahibganj, Santhal Pargana (Dumka) (Bihar)
4.	Eastern Plateau	1369	Moist sub humid to dry sub humid	Red and Yellow, Red loamy	Puruliya (W.B.) Lahardaga, Palamau Ranchi, Singhabhum (Bihar)
5.	Tribal	1338	Moist sub humid to dry sub humid	Red sandy Red and Yellow, Red loamy	Kalahandi, Koraput Phulbani (Orissa) Bastar (M.P.)

VIII. Central Plateau and Hills

S. No.	Sub Zone	Rainfal (mm)	Climate	Soils	Districts
1.	Bundelkhand	780	Dry sub humid to dry arid	Mixed red and black	Banda, Jalaun, Jhansi, Lalitpur, Hamirpur(U.R.)
2.	Bundelkhand (M.P.)	700	Dry sub humid to semi arid	Mixed red and black	Chhatarpur, Datia, Tikamgarh (M.P.)
3.	North Hills	1570	Moist sub humid to dry sub humid	Red and Yellow	Mandla (M.P.)
4.	Kymore Plateau and Satpura Hills	1100	Dry sub humid	Red & Yellow Medium black	Jabalpur, Panna, Rewa, Satna, Seoni, Sidhi (M.P.)
5.	Vindhya Plateau	1130	Dry sub humid	Medium black	Bhopal, Damoh, Raisen, Sagar, Sehore, Vidisha (M.P.)
6.	Satpura	1220	Dry sub humid	Shallow black Mixed Red and black	Chhindwara, Betul (M.P.)
7.	Central Narmada vally	1300	Dry sub humid	Deep black skeletal	Hoshangabad, Narsimhapur (M.P.)
8.	Gird	670	Semi arid (half drier)	Medium black, Alluvial	Bhind, Guna, Gwalior, Morena (M.P.)
9.	South eastern Plains	760	Semi arid (half drier and water half)	Medium black	Bundi, Kota (Rajasthan)
10.	Southern Plains	760	Semi arid (Water half)	Medium red and grey, brown	Banswara, Dungarpur (Rajasthan)
11.	Transitional Plains	490	Semi arid to arid	Desert soil Grey brown	Pali, Sirohi (Rajasthan)
12.	Southern Plains Aravalli Hills	500	Semi arid (Water Half)	Red and Yellow Grey brown	Bhilwara, Chandigarh, Udaipur (Rajasthan)

S. No.	Sub Zone	Rainfal (mm)	Climate	Soils	Districts
13.	Semi-arid Eastern Plains	500	Semi arid (drier half)	Alluvial	Ajmet, Jaipur, Tonk (Rajasthan)
14.	Flood Prone Eastern Plains	500	Semi arid (Drier half)	Alluvial (Recent)	Alwar, Bharatpur, Sawai Madhopur, Dhaulpur (Rajasthan)

IX. Western Plateau and Hills

S. No.	Sub Zone	Rainfal (mm)	Climate	Soils	Districts
1.	Hill zone	988	Semi-arid	Medium to deep black Shallow red Red loamy	Kalhapur, Nasik, Pune, Satara (Maharashtra) Jhabua (M.P.)
2.	Scarcity zone	602	Semi-arid	Medium black, deep black	Ahmednagar, Dhule, Sangli, Sholapur (Maharashtra)
3.	Plateau zone North	874	Semi-arid (Eetter half)	Medium black, deep black, Mixed red & black Shallow red	Akola, Amaravati, Aurangabad, Beed, Buldana, Jalgaon, Jalana, Latur, Osmanabad, Parbhani (Maharashtra) Dewas, Dhar, East Nimar, Indore, Mandsaur, Rajgarh, Ratlam, Shajapur, Ujjain, West Nimar (M.P.) Jhalawar (Rajasthan)
4.	Plateau zone South	1040	Semi-arid to dry sub humid	Medium black, Shallow, black	Nagpur, Nanded, Warsha, Yavatma (Maharashtra)

X. Suthern Plateau and Hills Region

S. No.	Sub Zone	Rainfal (mm)	Climate	Soils	Districts
1.	Sub zone-1	769	Semi-arid & arid	Medium black, Laterite deep black, Red loamy	Belgaum, Ballary, Bidar, Bijapur, Dharwad, Gulbarga, Raichur (Karnataka)
2.	Sub zone-2	677	Semi-arid	Red loamy medium black, Red sandy, coastal alluvium, laterite	Anantpur, Chittor, Cuddapah, Kurnool (A.P.) Banglore, Chitradurga, Kolar, Tumkur (Karnataka)
3.	Sub zone-3	725	Semi-arid & arid	Red sandy, Medium to deeo black	Hyderabad, Mahbubnagar, Nalgonda, Rangareddi (A.P.)
4.	Sub zone-4	1001	Semi-arid (Wetter half)	Deep black, Medium black	Adilabad, Karimnagar, Khammam, Medak, Nizamabad, Warangal (A.P.)
5.	Sub zone-5	865	Semi-arid	Red loamy, Red sandy	Mandya, Mysore (Karnataka) Dharmapuri (Tamilnadu) Hasan (Karnataka)
6.	Sub zone-6	841	Semi-arid to dry sub humid	Mixed red & black red loamy, Deltaic alluvium	Coimbatore, Madurai (Anna) Tiruchirapalli, Periyar, Pudukkotai (Tamil Nadu)

XI. East Coast Plains and Hills Region

S. No.	Sub Zone	Rainfal (mm)	Climate	Soils	Districts
1.	North Orissa Coast	1287	Moist sub humid	Deltaic alluvial, Coastal alluvial Laterite, Red Loamy	Baleshwar, Cuttack Puri (Orissa)
2.	North coastal Andhra	1128	Dry sub humid	Red loamy Laterite, Medium black, red sandy, coastal alluvial	Srikakulam, Vishakhapatnam, Vizianagaram (A.P.)
3.	South coastal Andhra	996	Semi-arid	Deltaic, Alluvium Deep black Red sandy Red and black	East Godavari, Guntur, Krishna, Prakasam, West Godavari (A.P.) Yanam (Pondicherry)
4.	North coastal Temil Nadu	1036	Semi-arid	Red loamy Red sandy, coastal alluvium	Nellore (A.P.) Chengalpattu, Madras, North Arcot, South Arcot (Tamil Nadu) Pondicherry)
5.	Tenjavur	1113	Semi-arid to dry sub humid	Deltaic alluvium Red loamy	Thanjavur (Tamil) Karaikal (Pondicherry)
6.	South coastal	780	Semi-arid (drier half)	Mixed Red & black coastal Alluvium	Karmarajar, Ramanathapuram Tirunelveli, P. Muthurama Lingam (Ramnathapuram) (Tamil Nadu)

XII. West Coast Plains and Ghat Region

S. No.	Sub Zone	Rainfal (mm)	Climate	Soils	Districts
1.	Coastal Hilly	3640	Per humid & humid	Laterite, Red, loamy Coastal	Uttarkannada (Karanataka) Greater Bombay, Ratnagiri Raigad (Kolaba) Sindhudurg Thane (Maharashtra) Goa
2.	Coastal Midland	3127	Dry sub humid & per humid	Red loamy, Coastal alluvium laterite	Alleppy, Cannanore, Ernakulam Kasargood, Kozhikode, Malappuram Quilion, Trichur, Trivandrum (Kerala) Kanniyakumari (Tamil Nadu) Dakshin Kannada (Karnataka)
3.	Midland	2727	Per humid	Laterite Coastal Alluvium	Kottayam, Palghat, Pathanamittitta (Kerala)
4.	Hilly	2226	Per humid	Red loamy, Mixed Red & black	Iddukki, Wayanad (Kerala), Chikmaglur Kodagur (coorg) Shimoga (karnataka) Nilgiri (Tamil Nadu)

XIII. Gujarat Plains and Hill Regions

S. No.	Sub Zone	Rainfal (mm)	Climate	Soils	Districts
1.	South Gujarat	1793	Semi-arid to dry sub humid	Deep black coastal alluvium	The Dangs, Valsad (Gujarat) Daman Dadra & Nagar Haveli
2.	South Gujarat	974	Semi arid to dry sub humid	Deep black coastal alluvium	Bharuch, Surat (Gujarat)
3.	Middle Gujarat	904	Semi arid	Medium black	Kheda, Ranch – Mahals Vadodara (Gujarat)
4.	North Gujarat	735	Arid to semi arid	Grey brown deltaic alluvium	Ahmedabad, Banaskantha, Mahesana, Sabarkantha (Gujarat)
5.	North West Arid	340	Arid to semi arid	Grey brown deltaic alluvium	Kachchh (Gujarat)
6.	North Sourashtra	537	Dry sub humid	Coastal alluvium Medium black	Amreli, Bhavnagar, Jamnagar, Rajkot, Surendranagar (Gujarat)
7.	South Saurashtra	844	Dry sub humid	Coastal alluvium Medium black	Junagadh

XIV. Western Dry Regions

S. No.	Sub Zone	Rainfal (mm)	Climate	Soils	Districts
1.	Western Dry	395	Arid to extremely arid	Desert soil, Grey Brown	Barmer, Bikaner, Churu, Jaisalmer, Jalor, Jhunjhunu, Jodhpur, Nagaur, Sikar (Rajasthan)

XV. The Island Regions

Andaman, Nicobar & Lakshadweep

	(1)	(2)
	1. Andaman	1. Laksjadweep
	2. Nicobar	

APPENDIX-B

This Appendix consists of names of plants recommended for Green Belts. Abbrevations and order of presentation used in this Appendix are as follows :

No.	-	Serial number in the list,starting with first letter of the generic name.
	-	Latin name of the plant.
Fam.	-	Family.
C.N.	-	Common and vernacular name in different languages of India, Viz. Beng - Bengali, Guj. - Gujrati, Mar. - Marathi, Hin. - Hindi....etc.
S/T	-	Sensitive/Tolerant, (to air pollution)
HA	-	Habit.
HT	-	Height.
GR	-	Growth rate.
R	-	Regeneration.
E/D	-	Evergreen/Deciduous.
DF	-	Duration of foliage.
Flo.S.	-	Flowering season.
CSA	-	Crown surface area (estimated).
CS	-	Crown shape.
LA	-	Leaf area.
SI	-	Stomatal index.

No. A1 Abutilon indicum Linn.

Fam. - Malvaceae

C.N. - Country mallow; Beng. Jhampi; Guj. Khapat; Hin. - Kanghi; Kan - Srimudrigida; Mal. Jhonkaped; Mar - Chakrabhenda; Oriya - Nakochono; Tam - Thuttli; Tel - Botlabenda, Tuttilibenda; Assam - Jhapa; Goa - Petari.

S/T - T

HA - Shrub

HT - 5m

GR - Quick growing

R - Through Seeds.

E/D - Deciduous.

Flos - Most of the year.

CS - Oblong.

No. A2 Acacia auriculiformis A. cunn.

Fam - Mimoseae

C.N. - Australian Wattle, Beng - Akashmone.

S/T. - T

HA - Tree.

HT - 16 m.

GR - Quick growing.

R - By seeds.

E/D - Evergreen

Flo.S. - June - Jan.

CSA - 8548.22 m^2

CS - Oblong

LA - .140.50 cm^2

SI - 10.9

No. A3 Acacia catechu, Willd

Fam - Mimoseae

C.N. - The cutch tree. Sonkhairi, Sans - Khadira, Hin - Khair; Beng - Kuth; Tam - Karangalli, Tel - Khadiramu.

S/T - T

HA - Shrub

HT - 3m

GR - Quick growing

R - By seeds.

E/D - Evergreen.

Flo.S. - May - August

CSA - 108.42 m^2

CS - Oblong.

LA - 109.98 cm^2

SI - 8.24

No. A4 Acacia dealbata Link.

Fam - Mimoseae

C.N. - Silver wattle.

S/T - T

HA - Tree

HT - 15m

GR - Quick growing

R - By seeds

E/D - Evergreen.

Flo.S. - April - June

No. A5 Acacia farnesiana Willd

Fam - Mimoseae

C.N. - The cassia flower.

Hindi - Gandh - babul, Beng - Guya babula, Sans - Arimoedah; Mar - Deobabal, Tam - Kasturivel; Tel - Kasturitumma.

S/T - T

HA - Tree.

HT - 5m.

GR - Quick growing.

R - By seeds.

E/D - Evergreen

Flo.S. - Aug - Mar.

No. A6 Acacia ferruginea DC

Fam - Mimoseae

C.N. - Safed khair.

Sans - Somasara; Tam - Velvelam; Tel - Ansandra.

S/T - T

HA - Tree.

HT - 3-4m.

GR - Quick growing.

R - By seeds

E/D - Evergreen

Flo.S. - Jan - Feb.

No. A7 Acacia leucophloea Willd.

Fam - Mimoseae

C.N. - Distiller's acocia; Beng - Safed bobul

Eng - White bobool; Guj. Haribavol;

Hindi - Safed bobul; Kan - Bilijal;

Mal - Pattacharayamaram; M.P - Viloyati babul;

Mar - Hewar; Raj - Arunj; Sans - Arimedoh;

Tam - Velvayalam; Tel - Tellotumma.

S/T - T

HA - Shrub.

HT - 3 m

GR - Quick growing

R - By seeds.

E/D - Deciduous

Flo.S. - Jan.-Feb.

CSA - 8281.4 m^2

CS - Oblong

LA - 132.52 cm^2

SI - 12.01

No. A8 Acacia mearnsii de Wild.

Fam - Mimoseae.

C.N. - Black wattle, Tam - Chavukku

S/T - T

HA - Tree

HT - 20m

GR - Quick growing.

R - By seeds, Root suckers.

E/D - Evergreen

CS - Spreading.

No. A9 Acacia mellifera (Vahl) Beth.

Fam - Mimoseae

S/T - T

HA - Tree

HT - 8 -10m

GR - Quick growing

R - By seeds

E/D - Deciduous

Flo.S. - Twice in an year

No. A10 Acacia nilotica (Linn) Willd.

Fam - Mimoseae

C.N. - Indian Gum - Arabic tree, Beng, Hindi, Punjab and M.P - Babul; Eng - Babul; Guj - Baval;

Bihar - Babule; Kan - Karijauli, Mal - Karivelan, Mar - Vedibabul; Oriya - Baubra; Sans - Barburah, Vavari; Tam - Karuvelamaram; Tel - Nallatumma.

S/T - T
HA - Tree
HT - 8m
GR - Quick growing
R - By seeds
E/D - Evergreen
Flo.S. - Aug - Jan.
CSA - 8293.74 m^2
CS - Spreading.
LA - 135.70 cm^2
SI - 11.23

No. A11 Acacia pennata Willd

Fam - Mimoseae
C.N. - Hin - Biswal; Kumaon - Agla; Beng - Kuchui; Sans - Ari; Tam - Indu; Tel - Karusikaya.
S/T - T
HA - Shrub
HT - 8m
GR - Quick growing
R - By seeds
E/D - Evergreen
Flo.S. - June - Aug.
CS - Round

No. A12 Acacia polyacantha Willd.

Fam - Mimoseae
S/T - T
HA - Tree

HT	-	10m
GR	-	Quick growing
R	-	By seeds
E/D	-	Semi - deciduous.
Flo.S.	-	May - June, Oct - Nov.
CS	-	Flat crown

No. A13 Acacia senegal Willd.

Fam	-	Mimoseae
C.N.	-	Sans - Svetakhadira; Rajasthan - Kumta
S/T	-	T
HA	-	Tree
HT	-	5m
GR	-	Quick growing
R	-	By seeds.
E/D	-	Deciduous
Flo.S.	-	Aug - Mid Sept, Nov. - Mar.
CS	-	Feathery spreading crown

No. A14 Acacia sinuata (Lour) Merrill

Fam	-	Mimoseae
C.N.	-	Beng - Banritha; Guj and Mar - Shikakai; Hin - Kochi; Kan - Sige; Mal - Chikaka; Tam - Shikakai; Tel Sikaayai.
S/T	-	T
HA	-	Tree
HT	-	10m
GR	-	Quick growing.
R	-	By seeds.

No. A15 Acacia tortilis Hayne

Fam	-	Mimoseae
C.N.	-	The Umbrella thorn tree.

S/T - T

HA - Tree

HT - Bm

GR - Quick growing.

R - By seeds.

E/D - Evergreen

No. A16 Acer campbellii Hook F. and Thoms.

Fam - Aceraceae.

C.N. - Himalayan maple. Beng - Kabashi Lepcha - Daom, Yatlikung.

S/T - S

HA - Tree

HT - 12m

GR - Quick growing.

R - By seeds.

E/D - Deciduous.

CS - Spreading

No. A17 Acer negundo Linn

Fam - Aceroceae

C.N. - Ash - leaved maple, Boxeldes.

S/T - S

HA - Tree

HT - 12m

GR - Quick growing

R - By seeds.

E/D - Deciduous.

CS - Spreading

No. A18 Achras sapota Linn

Fom - Sapotaceae.

C.N. - Sapota; Tam - Shimai - elluppai Mar - Chikoo

S/T - T

HA - Tree.

HT - 10m

GR - Slow growing during early stages.

R - Grafting.

E/D - Evergreen

Fla.S. - Round the year in coastal districts.
Sept. - Dec. in other areas.

CSA - 309.021 m^2

CS - Spreading.

LA - 108.02 cm^2

SI - 25.78

No. A19 Actinodaphne angustifolia Nees.

Fam - Lauraceae.

C.N. - Mar - Pisa; Mal - Malavirinya, Tam - Tali

S/T - T

HA - Tree

HT - 13m

GR - Slow

R - By seeds

E/D - Evergreen.

Fla.S. - May - June, Nov.

CS - Round

No. A20 Adenanthera pavonina Linn.

Fam Mimoseae

C.N. Coral - or red wood. Beng - Rakta Kambal;
Guj - Badigumehi;
Kan and Mal - Manjadi; Mar.- Tharligunj;
Oriya - Girid; Sans - Kunchandana;
Tam - Anaikundumani, Tel - Bandiguruvenda.

S/T - T

HA	-	Tree
HT	-	20m
GR	-	Quick growing
R	-	By seeds
E/D	-	Deciduous
Flo.S.	-	Mar - Aug.
CS	-	Spreading

No. A21 Adina cordifolia Roxb.

Fam	-	Rubiaceae.
C.N.	-	Sons - Dhorakadamba; Hindi - Haldu; Beng - Keli, Kodam; Tam and Mal - Monja, Kadamba; Tel - Pasupa - Kadamba
S/T	-	T
HA	-	Tree
HT	-	20m
GR	-	Slow growing
R	-	By seeds.
E/D	-	Deciduous
Flo.S.	-	June - Sept.
CSA	-	148, 490.1 m^2
CS	-	Oblong / Round.
LA.	-	268.54 cm^2
SI	-	29.63

No. A22 Aegle marmelos (Linn) Correa.

Fam	-	Rutoceae.
C.N.	-	Beal tree, Holy fruit tree; Beng, Hindi, Mar and Assam - Boel; Guj - Bili; Kan - Bilvo; Mal - Koovolom, Kukomlo. Oriyo - Belo; Son - Bilva, vilvah; Tom - Vilvam, Kuvilom; Tel - Maaredu, Urdu - Bel.
S/T	-	T

HA - Tree
HT - 12m
GR - Slow growing
R - By seeds, root cuttings.
E/D - Evergreen
Flo.S. - May - July
CSA - 26547.19 m^2
CS - Oblong
LA - 57.72 cm^2
SI - 24.08

No. A23 Aesculus indica Hook
Fam - Sapindaceae
C.N. - Himalayan chestnut, Indian Horse - chestnut; Hindi - Bankhar; Jaunsar Pu; Kashmir - Hanedun; Kumaun - Pangar; Punjab - Bankhar.
S/T - S
HA - Tree
HT - 20m
GR - Quick growing
R - By seeds, root suckers.
E/D - Deciduous
Flo.S. - Apr - June.
CS - Spreading

No. A24 Ailanthus altissimo (Mill) Swingle
Fam - Simarubaceae.
C.N. - Ailanto
S/T - T
HA - Tree
HT - 12m
GR - Quick growing
R - By seeds.

C/D - Deciduous

Flo.S. - Sept - Nov.

CS - Spreading

No. A25 <u>Ailanthus excelsa</u> Roxb.

Fam - Simarubaceae.

C.N. - Tree of Heaven. Mar. Maharuk Guj, Hindi, Mar Maharakha, Kan - Hemaraheeramara, Mal - Mattipongilyam, Oriya - Mahala, Sans - Madala arala; Tam - Perumaroutta, Tel - Peddamaanu.

S/T - T

HA - Tree

HT - 20m

GR - Quick growing

R - By seeds. shoot, root cuttings.

E/D - Deciduous.

Flo.S. - Feb - March

CSA - 152, 481.2 m^2

CS - Round

LA - 167.47 cm^2

SI - 13.01

No. A26 <u>Alangium chinense</u> (Lour) Harms

Fam - Alangiaceae.

C.N. - Beng - Bonipodo; Assam - Bhelu; Garo - Phagrany; HP and Punjab -Budanar; Kashmir - Prot; Khasi - Dieng - Mylliatlap; Kumaun - Garh.

S/T - T

HA - Tree

HT - 10m

GR - Quick growing

R - By seeds

E/D - Deciduous.

No. A27 Albizia amara Boiv

Fam - Mimoseae

C.N. - Mar - Tugli Lalai; Sans - Krishna sirisha; Tam - Turinjil; Tel - Sigara.

S/T - T

HA - Tree

HT - 10m

GR - Quick growing

R - By seeds, Root suckers

E/D - Deciduous

Fla.S. - April - June

CS - Spreading

No. A28 Albizia chinensis (Osbeck) Merrill

Fam - Mimoseae

C.N. - Beng - Chakua, Assam - Saukarai, Hindi - Siran; Garo - Bealphiu; Kan - Kalbage; Khasi - Dieng - phyneat; Mal - Pattavaga; Mar - Laeli; Tam - Pilivagei; Telkandachigera

S/T - T

HA - Tree

HT - 10-12m

GR - Quick growing

R - By seeds

E/D - Deciduous

Fla.S. - April - June.

CS - Spreading flat topped

No. A29 Albizia lebbeck Benth

Fam - Mimoseae.

C.N. - The Siris tree. Beng - Sirish; Guj -Pilosarasio; Hindi - Siris, Kan - Bagemara; Mal - Vag. Nenmenivaka, Vaka; Mar. Sirisha; Sans - Srisah, Bhondi; Tom - Vokoi, Vogei Tel - Dirisono, Sirisho; Trade - Kokko

S/T - T

HA - Tree

HT - 20m

GR - Quick growing

R - By seeds

E/D - Deciduous

Flo.S. - April - May

CAS - 62,509.32 m^2

CS - Round / spreading.

LA - 272.51 cm^2

SI - 19.72

No. A30 Albizio moluccano Mig.

Fom - Mimoseae.

C.N. - White popinoe, Lead tree, Guj - Losobovol; Hindi - Subobul, Vilaitiborol; Mal - Takoronnimarom; Oriyo - Rajokosundori; Tom - Nattuccovundol; Tel - Koniti.

S/T - T

HA - Tree

HT - 15m

GR - Quick growing

R - By seeds

E/D - Evergreen

Flo.S. - July - Oct.

CS - Oblong

No. A31 Albizio odoratissimo Benth.

Fom - Mimoseae.

C.N. - Black siris; Beng - Kokur siris; Hin - Kola siris; Mar - Chikundo; Sons - Svetoshirisho;

Tom - Koruvogei; Tel - Chindugo.

S/T - T

HA - Tree

HT - 18m

GR - Quick growing

R - By seeds

E/D - Evergreen

Flo.S. - April - June.

CS - Oblong

No. A32 Albizio procera Benth

Fam - Mimoseae

C.N. - White siris, Beng - Koroi; Assam - Korai Cachar - Jigring - bon - phayng; Kan - Bellate; Mol - Karunth - agora; Mar - Kinhai; Tom - Kondovogei; Tel - Tellochindugo

S/T - T

HA - Tree

HT - 20m

GR - Quick growing

R - By seeds

E/D - Deciduous

Flo.S. - June - Sept.

CSA - 28471.26 m^2

CS - Round / Oblong

LA - 286.74 cm^2

SI - 20.21

No. A33 Aleurites fordii Hemsl

Fom - Euphorbiaceae.

C.N. - Tungoil tree

S/T - T

HA - Tree

HT - 8m

GR - Quick growing

R - By seeds

E/D - Deciduous

Fla.S. - April - June.

CS - Round

No. A34 Alnus nepalensis D. Don

Fam - Betulaceae.

C.N. - Indian or Nepalese Alder. Hin - Uits; Aru.P. - Udis; Chamba - Piak; Kumaun - Udish Lepcha - Kayal; Punjab - Koe.

HA - Tree

HT - 20 m

GR - Quick growing

R - By seeds

E/D - Deciduoous

Fla.S. - Sept - Nov.

No. A35 Alnus nitida Endl

Fam - Betulaceae

C.N. - The west - Himalayan Alder; Kashmir - Seril; Punjab - Sharol; U.P. Kunis.

HA - Tree

HT - 20m

GR - Quick growing after 1st year.

R - By seeds

E/D - Deciducous

Fla.S. - August - October

No. A36 Alstonia scholaris (Linn.) R. Br.

Fam - Apocynaceae.

C.N. - Eng - Devil tree, shaitan wood, Hindi - Chattiyan saittan kajat; Mal - Elilampala, Yaksippala, Pala, Daiva ppala; Mar - Satvin; Sans - Saptapamah, Saptachadah; Tam - Elilappalai, Palai

S/T	-	T
HA	-	Tree
HT	-	15m
Gr	-	Quick growing
R	-	By seeds
E/D	-	Evergreen
Flo.S.	-	Dec - Mar.
CSA	-	241,680.5 m^2
CS	-	Round
LA	-	52.31 cm^2
SI	-	15.23

No. A37 Anona squamosa Linn.

Fam	-	Anonaceae.
C.N.	-	Custard apple, Sugar apple, Sweet sop.; Assam - Atakatal; Beng, Guj, Mar and Hindi - Seetaphal, Sharifa; Kan - Seethaphala; Mal - Sitappalam, Attaccakka; Oriya - Seethaapholo; Punjab - Sharifa; Sans - Seetaaphalam; Tam - Atta, Sitappalam Tel - Seetaaphalam.
S/T	-	T
HA	-	Small tree
HT	-	10m
GR	-	Fast growing
R	-	By seeds, Grafting, Budding
E/D	-	Evergreen
Flo.S.	-	March - July extended upto sept.
CSA	-	2178.21 m^2
CS	-	Round.

LA - 53.86 cm^2
SI - 26.19

No. A38 Anona reticulata Linn.

Fam - Anonaceae.
C.N. - Bullock's Heart; Beng and Hindi - Luvuni, nona;
Goa and Kokan - Anona;
Guj and Mar - Raamaphal;
Kan - Raamaphala; Mal - Raamappazham;
Oriya - Raamaphala; Sans - Lavani, Raamaphalam;
Tam - Manilvatta, raamsita; Tel - Raamaphalamu.
S/T - T
HA - Tree
HT - 10m
GR - Fast growing
R - By seeds
E/D - Evergreen
Flo.S. - June.
CSA - 2017.44 m^2
CS - Round
LA - 50.91 cm^2
SI - 17.24

No. A39 Anogeissus latifolia Wall.

Fam - Combretaceae.
C.N. - Axlewood, Button tree; Guj - Dhavdo;
Hindi - Dhaura; Kan - Bejjalu;
Mal - Maruka- njiram; Mar - Dabria;
Oriya - Dohu; Tam. Vekaynaga; Tel - Chirumaanu,
tellamaddi, Bihar - Bhanji; U.P., N.W. Himal - Bakli
S/T - T
HA - Tree
GR - Slow growing

R - By seeds,, Root suckers
E/D - Evergreen
Flo.S. - May - July
CSA - 67542.82 m^2
CS - Round / oblong
LA - 140.23 cm^2
SI - 18.72

No. A40 Anthocephalus chinensis (Lamk.)

Fam - Rubiaceae.
C.N. - Mar, Hin, Sans - Kadamba; Beng - Kadam; Tam - Vellai - cadama; Tel - Kadambama.
S/T - T
HA - Tree
HT - 20m
GR - Quick growing
R - By seeds.
E/D - Deciduous
Flo.S. - Nov - Feb.
CSA - 52,233.5 m^2
CS - Spreading
LA - 106.72 cm^2
SI - 19.63

No. A41 Aphanamixis polystachya (Wall) Parker.

Fam - Meliaceae.
C.N. - Rohituka tree; Hin - Harin - hara; Mal - Cemmaram; Sans - Rohitakah; Tam - Malampuluvan, Semmaram; Beng - Tiktaraj, Pittaraj, Tel - Chawamanu.
S/T - T
HA - Tree
HT - 13m

GR - Slow growing

R - By seeds

E/D - Evergreen

Flo.S. - July.

CSA - 10826.95 m^2

CS - Oblong / Round

LA - 1566.4 cm^2

SI - 18.14

No. A42 Artocarpus heterophyllus Lamk.

Fam - Urticaceae.

C.N. - Jack fruit tree, Hin - Kathal, Cakki; Mar - Phannas; Mal - Palavu; Sana - Panasah; Tam - Pila, Palavu.

S/T - T

HA - Tree

HT - 10m

GR - Slow growing

R - By seeds

E/D - Evergreen

Flo.S. - Nov. - Jan.

CSA - 196,419.1 m^2

CS - Oblong

LA - 106.86 cm^2

SI - 19.05

No. A43 Artocarpus lacucha Buch

Fam - Urticaceoe.

C.N. - Monkey Jack. Hindi Beng - Ḍahua; Mar - Wotomba; Sans - Lakucha; Tam - Ilagusam; Tel - Kammaregu.

S/T - T

HA - Tree

HT - 18m

GR - Quick growing
R - By seeds.
E/D - Deciduous
Flo.S. - Mar - April
CSA - 2113.20 m^2
CS - Spreading / Round
LA - 104.32 cm^2
SI - 18.95

No. A44 Azadirachta indica A. Juss.

Fam - Meliaceae.
C.N. - Indian Lilac, Neem tree, Margosa tree;
Beng and Hin - Nim; Guj - Limbado;
Kan - Bevinamara; Mal - Veppu, Aruveppa;
Mar - Limba; Oriya - Nimba; Tam - Veppam;
Tel - Veepachettu.
S/T - T
HA - Tree
HT - 20 m
GR - Quick growth after 1st season
R - By seeds
E/D - Evergreen
Flo.S. - Jan - March, Aug. - Sept.
CSA - 300,445.3 m^2
CS - Spreading.
LA - 83.89 cm^2
SI - 29.2

No. B1 Balanites roxburghii Planch

Fam - Balanitaceae.
C.N. - Desert - Date; Beng. Hingol; Guj - Ingoriyo;
Hin and Mar - Hingon; Kan - Ingalore,
Mal - Nanjunto;

Oriya - Ingudihala, Sons - Angavruksha;
Tam - Nanjundan; Tel - Garo; Raj - Hingorni

S/T - T
HA - Tree
HT - 9m
GR - Quick growing
R - By seeds.
E/D - Evergreen
Flo.S. - April - June.
CS - Spreading

No. B2 Bambusa arundinocia (Retz) Roxb

Fom - Poaceae
C.N. - Thorny Bamboo; Beng - Bans; Guj - Wans; Hin - Kantabans; Kan - Andebidiru; Mal - Illi; Mar - Bambu; Oriya - Bendo; Sans - Bahupallava vansa; Tam - Mullumungil; Tel - Mullabongu; Assam - Banho; H.P. Kallabans; Jammu - Lambert; Kashmir - Billawar; Punjab - Magar bang.
S/T - T
HA - Shrub.
HT - 20m
GR - Quick growing
R - By cuttings.
E/D - Deciduous.
CS - Oblong.

No. B3 Bambusa vulgaris Schrad.

Fam - Poaceae
C.N. - The Golden bamboo; Beng - bans; Mar - Kolaka; Oriya - Sundragai; Tam & Mal - Ponungile.
S/T - T
HA - Shrub/tall perennial grasses.

HT - 15m

GR - Quick growing

R - Cutting.

E/D - Deciduous.

No. 84 Barringtonia acutangula (L) Goertn.

Fom - Borringtonioceae.

C.N. - Indian Oak. Assam - Konopo; Beng, Hin - Hijol; Guj-Somudrophol; Kon - Holekouvo; Mol - Attompu, Attupelu, Mar - Dattephol; Oriyo - Hinjolo; Tom - Adompo, somuttiroppolom; Tel - Kanopochettu; Sons - Somudropholoh.

S/T - T

HA - Tree

HT - 9-12 m

GR - Quick growing

R - By seeds

E/D - Evergreen

Flo.S. - March - May, Sept - Oct.

CS - Spreading

No. 85 Barringtonia racemosa Roxb

Fom - Borringtonioceoe.

C.N. - Beng - Somudrophol; Hin - Ijjut; Kon - Konoginetere; Mol - Katampu; Mar - Nivar; Tom - Arottam; Tel - Konopo.

S/T - T

HA - Tree.

HT - 6-8m

GR - Fast growing.

R - By seeds.

E/D - Evergreen

Flo.S. - Throughout the year.

No. B6 Bauhinia acuminata Linn.

Fam - Caesalpinaceae.
C.N. - Kanchan
S/T - T
HA - Shrub.
HT - 3m
GR - Quick growing
R - By seeds.
E/D - Deciduaus
Fla.S. - June
CSA - 109.8 m^2
CS - Oblang / Raund.
LA - 69.46 cm^2
SI - 22.31

No. B7 Bauhinia purpurea Linn.

Fam - Caesalpinaceae
C.N. - Butterfly tree, Mauntain ebany. Beng - Dev kanchan; Hin - Khairwal; Kan - Baswanapada; Mal - Chuvanna - Mandaram, Mar- Rakta Kaanchan; Tam - Mandari; Tel - Kaanchanamu.
S/T - T
HA - Tree
HT - 7 m
GR - Quick grawing
R - Thraugh seeds
E/D - Deciduaus
Fla.S. - Sept - Nav.
CSA - 625.2 m^2
CS - Oblang
LA - 107.3 cm^2
SI - 23.58

No. B8 <u>Bauhinia</u> <u>racemosa</u> Lamk.

Fam	-	Caesalpinaceae
C.N.	-	Beng - Banraj; Guj - Asundro; Hin - Astha; Kan - Banne; Mal - Kotapuli; Mar - Apta; Oriya - Omborodo; Sans - Swetakanchanamu; Tam - Araivattatthi; Tel - Ari; Punjab - Kosundra.
S/T	-	T
HA	-	Small tree
HT	-	5m
GR	-	Quick growing
R	-	By seeds
E/D	-	Deciduous
Flo.S.	-	Mar - June
CSA	-	136.9 m^2
CS	-	Oblong
LA	-	73.4 cm^2
SI	-	25.68.

No. B9 <u>Bauhinia</u> <u>semla</u> Wanderlin

Fam	-	Caesalpinaceae
C.N.	-	Hin - Semla; Mar - Koilar; Tel - Nirpa. H.P. - Karalla; Punjab - Kural.
ST	-	T
HA	-	Tree
HT	-	10m
GR	-	Quick growing
R	-	By seeds
E/D	-	Deciduous
Flo.S	-	Sept - Nov.
CS	-	Round.

No. B10 <u>Bauhinia</u> <u>varigata</u> Linn.

Fam	-	Caesalpinaceae

C.N.	-	Budhist bauhinia, Mountain Ebany, Beng - Raktakanchan; Guj - kavindara; Hin - Kachnar; Kan - Arisinatige; Mal - Mandaram, Kannu; Malayakatti; Mar - Kanchan, Sans - Kavidarah; Tam - Shemmandarai; Tel - Devakanchanamu.
S/T	-	T
HA	-	Tree
HT	-	5m
GR	-	Quick grawing
R	-	By seeds
E/D	-	Deciduaus
Fla.S.	-	Nav.
CSA	-	1769.52 m^2
CS	-	Oblang
LA	-	53.2 cm^2
SI	-	27.41

No. B11 Betula alnaides Buch-Ham.

Fam	-	Betulaceae
C.N.	-	Indian birch. Nagabirch. Beng - Halasunli; Guj - Bhajpatra; Hin - Bhujpatra; Sans - Bhurja patram; Tel - Bhajapatramu; Urdu - Bhurjapatra; Assam - Dieng - ling; Garhwal - Sauer; Kumaun - Banutis; Nagaland Teri-ching's; Punjab - Shagru.
S/T	-	S
HA	-	Tree
HT	-	15m
GR	-	Quick grawing after 1st yr.
R	-	By seeds, cutting.
E/D	-	Deciduaus (Winter)

Flo.S. -	Nov. - Jan.
CS -	Oblong

No. B12 Bischofia javanica Blume.

Fam -	Bischofiaceae.
C.N. -	Bishopwood; Beng - kainjal; Hin - Paniala; Kan - Gobranerale; Mal - Nira; Mar - Boke; Oriya - Dingiri; Tam - Thondi; Tel - Nalupumusti; Andaman - Ye - badauka; Assam - Urian; Megh - Deing. Soh - Tug.
ST -	T
HA -	Tree
HT -	15m
GR -	Quick growing
R -	By seeds, cuttings.
E/D -	Semi - deciduous.
Flo.S. -	April - Sept
CS -	Oblong.

No. B13 Bougainvillea spectabilis Willd.

Fam -	Nyctaginaceae.
C.N. -	Bougainvillea
S/T -	T
HA -	Shrub
HT -	8m
GR -	Quick growing
R -	By cutting
E/D -	Evergreen
Flo.S. -	Throughout the year.
CSA -	939.25 m^2
CS -	Oblong / Round.
LA -	33.15 cm^2
SI -	32.53

No. B14 Bridelia squamosa Lamk.

Fam - Eupharbiaceae

C.N. - Hin - Khaja; Beng - Geia, Kantakai; Mal - Mukkayini; Mar - Asanai; Sans - Mahavira; Tam - Mullavengai; Tel - Bantha-yepi.

S/T - T

HA - Tree

HT - 10m

GR - Quick grawing

R - By seeds, Raat suckers.

E/D - Deciduaus.

Fla.S.- May - Oct.

CSA - 58,432.1 m^2

CS - Spreading

LA - 168.09 cm^2

SI - 25.1

No. B15 Braussanetia papyrifera L. Nerit

Fam - Maraceae

C.N. - Paper mulberrys, Hin - Jangli taat; Kan - Kaagaduppunaeralae.

S/T - T

HA - Tree

HT - 12m

GR - Quick grawing

R - By seeds, cuttings, air-layering.

E/D - Deciduaus

Fla.S. - Aug - Nav.

CS - Oblang.

No. B16 Buchanania lanzan Spreng.

Fam - Anacardiaceae.

C.N. - Almondette tree. Beng - chironji; Guj and Mar - Charoli; Hin - Achar; Kan - Murkali; Mal-Mungapera; Oriya - Charu; Sans - Priyalam; Tam - Morala; Tel - Mortichettu or Saara.

S/T - T

HA - Tree

HT - 13m

GR - Quick growing

R - By seeds, root suckers.

E/D - Evergreen

Flo.S. - Jan - Mar.

CS - Round.

No. B17 Buteo monosperma Lamk.

Fam - Fabaceae

C.N. - Flame of the forest; Beng. Mal, Mar - Palas; Guj - Khakharo; Hin - Kashmir. Dhak ; Kan - Muttuga; Oriya - Porasu; Punjab -chichra; Sans - Palaasa; Tam - Taraso; Tel - Mooduga, Palaasamu.

S/T - T

HA - Tree

HT - 10m

GR - Slow growing

R - By seeds

E/D - Deciduous.

Flo.S. - Jan - April

CSA - 38,592.1 m^2

CS - Oblong / Ovoid

LA - 448.6 cm^2

SI - 29.43

No. C1 *Caesalpinia pulcherrima* (L) Swartz.

Fam - Cesalpinaceae.

C.N. - White gold mahur; Kan - Kempukenjiga; Mar - Sankasura; Tam - Vadanarayana; Tel - Sankesula, Vatanarayana.

S/T - T

HT - 4m

GR - Quick growing

R - By seeds, cuttings.

E/D - Evergreen.

Flo.S. - Throughout the year.

CSA - 639.32 m^2

CS - Spreading.

LA - 246.4 cm^2

SI - 29.09

No. C2 *Callistemon citrinus* (Curtis) stapf.

Fam - Myrtaceae

C.N. - Bottle brush, scarlet bottle brush.

S/T - T

HA - Small tree

HT - 5m

GR - Slow growing

R - By seeds, cuttings

E/D - Evergreen

Flo.S. - Throughout the year esp. April.

CSA - 45,997.2 m^2

CS - Conical

LA - 214.01 cm^2

SI - 12.7-49

No. C3 *Calophyllum inophyllum* Linn

Fam - Clusiaceae

C.N. - Alexandrian laurel,
Beng and Hin - Sultanachampa;
Guj - Udi; Kan - Hanne; Mal - Punnai;
Mar - Surangi; Oriya - Paanang,
Sans - Punnagah; Tam - Punnai, Punnagam;
Tel - Pannachettu.

S/T - T
HA - Tree
HT - 18m
GR - Slow growing
R - By seeds.
E/D - Evergreen
Fla.S. - Dec - Jan.
CSA - 21,426.3 m^2
CS - Round / spreading
LA - 130.51 cm^2
SI - 28.43

No. C4 Calotropis gigantea R.Br (Linn)

Fam - Asclepiadaceae
C.N. - Gigantic swallow wart; Beng - Akand;
Mar - Rui; Mal - Erukku; Tam - Erukkam;
Tel - Peddajilleedu

S/T - T
HA - Shrub
HT - 5m
GR - Quick growing
R - By seeds, cuttings
E/D - Evergreen
Fla.S. - Feb - July
CSA - 47.5 m^2
CS - Oblong / Round
LA - 48.58 cm^2
SI - 9.93

No. C5 Calotropis procera (R.Br) Ait.

Fam	-	Asclepiadaceae.
C.N.	-	Swallow wort; Hin - Akada, Mar - Mandare, Rui; Oriya - Orkho; Sans - Alkarka; Tam - Velleruku; Tel - Chinnajilleedu.
S/T	-	T
HA	-	Shrub
HT	-	6m
GR	-	Quick growing
R	-	By seeds, cutting
E/D	-	Evergreen
Flo.S.	-	December
CSA	-	87.7 m^2
CS	-	Oblong / Round
LA	-	50.06 cm^2
SI	-	10.32

No. C6 Carissa spinarum Linn.

Fam	-	Apocynaceae
C.N.	-	Hin - Karaunda; Mar - Karwand; Oriya - Anka; Tam - chiru; Tel - Kalivi; Kashmir - Garunda; Punjab - Janglikarunda
S/T	-	T
HA	-	Shrub
HT	-	3m
GR	-	Quick growing
R	-	By seeds, root suekers.
E/D	-	Evergreen
Flo.S.	-	Mar - May
CS	-	Round

No. C7 Cassia fistula Linn

Fam	-	Caesalpinaceae.

	C.N. -	Golden showers, Indian laburnum; Beng and Hin, Jammu - Amaltas; Guj, Mar - Garmala, Bahwa; Kan - Aragena; Mal - Svarnaviram; Oriya - Sunari;Punjab - Alash; San - Saraphala; Tam - Arakkuvadam; Tel - Reelachettu, VKaalapanna
	S/T -	T
	HA -	Tree
	HT -	12m
	GR -	Quick growing
	R -	By seeds, suckers
	E/D -	Deciduous
	Fla.S. -	March - May
	CSA -	2957.11 m^2
	CS -	Round
	LA -	130.51 cm^2
	SI -	20.4

No. C8 Cassia javanica Linn.

Fam -	Caesalpinaceae.
S/T -	T
HA -	Tree
HT -	12m
GR -	Quick growing
R -	Through seeds.
E/D -	Deciduous
Fla.S. -	May - June
CS -	Round

No. C9 Cassia pumila Lamk.

Fam -	Caesalpinaceae.
C.N. -	Yellow Cassia; Mar - Sarmal; Tel - Nallajiluga; Kan - Nelatagache.

S/T - T
HA - Tree
HT - 10-12m
GR - Quick growing
R - By seeds
E/D - Evergreen
CSA - 13,273.7 m^2
CS - Round
LA - 118.47 cm^2
SI - 19.84

No. C10 Cassia renigera Wall ex. Benth.

Fam - Caesalpinaceae
C.N. - Pink Cassia
S/T - T
HA - Tree
HT - 10m
GR - Quick growing
R - By seeds
E/D - Deciduous .
Fla.S. - May - June
CSA - 9,432 m^2
CS - Round / spreading
LA - 115.2 cm^2
SI - 17.21

No. C11 Cassia siamea Lamk.

Fam - Caesalpinaceae.
C.N. - Iron wood tree; Beng - Minjri; Guj - Kaisid; Kan - Hiretangad, Mar - Kassad, Tam - Manja-Kannai; Tel - Seematangeedu.
S/T - T
HA - Tree

HT - 10-12m

GR - Fast growing

R - By seeds.

E/D - Evergreen

Flo.S. - Aug - May.

CSA - 3927.36 m^2

CS - Oblong

LA - 138.32 cm^2

SI - 21.2

No. C12 Casuarina equisetifolia Linn.

Fam - Casuarinaceae

C.N. - Australian or Whistling pine; Beng - Jau; Guj and Hin - Jangli saru; Kan - Chabaku; Mal - Chavukku; Mar - Suru; Tam - Savukku; Tel - Saravi Sarugudu.

S/T - T

HA - Tree

HT - 10m

GR - Quick growing

R - By seeds

E/D - Evergreen

Flo.S. - Feb - April, Sept - Oct

CS - Oblong

No. C13 Ceiba pentandra (Linn) Gaertn.

Fam - Bambacaceae

C.N. - Kapok

S/T - T

HA - Tree

HT - 15m

GR - Quick growing

R - By seeds

E/D - Deciduous
Fla.S. - March - July
CSA - 3126.98 m²
CS - Oblong
LA - 135.07 cm²
SI - 18.21

No. C14 Celtis australis Linn

Fam - Ulmaceae.
C.N. - European Nettle tree; Assam - Mahita; Cachar - Banridu; Kashmir - Brimij, Khasi - Dieng - sah - thang - chi; Punjab - Batkar.
S/T - T
HA - Tree
HT - 12m
GR - Quick growing
R - By seeds, stump - planting.
E/D - Deciduous

No. C15 Citrus aurantium Linn

Fam - Rutaceae
C.N. - Beng - Nebu; H - Limu - Niba, Khatta; Mal - Karna; Tel - Mallikanarangi;Tam - Narattai
S/T - T
HA - Tree
HT - 5m
GR - Quick growing
R - By cutting, Grafting
E/D - Evergreen
Fla.S. - Sept - Nov
CSA - 494.9 m²
CS - Round / Oblong
LA - 20.23 cm²
SI - 35.81

No. C16 Citrus limon (Linn) Burm

Fam	-	Rutaceae
C.N.	-	Lime of India. (Limbu.); Beng - Bara nebu, Gora nebu; Hin - Bara nimbu. Pahari nimbu; Sans - Mala nimbu; Tam - Periya; Yelumichai; Tel - Bijopuram.
S/T	-	T
HA	-	Shrub
HT	-	3m
GR	-	Slow growing
R	-	By cutting, Grafting
E/D	-	Evergreen
Flo.S.	-	Nov - Jan
CSA	-	583.72 m^2
CS	-	Oblong
LA	-	18.55cm^2
SI	-	32.5

No. C17 Clerodendrum inerme (Linn) Gaertn.

Fam	-	Verbenaceae
C.N.	-	Beng - Banjai, Hin - Vanjai; Kan - Kundali; Mal - Cheruchinna, Mar - Vanajai; Kadumendi; Tam - Pinarichangan-guppi; Tel - Etiplshinika.
S/T	-	T
HA	-	Shrub
HT	-	5m
GR	-	Quick grawing
R	-	By seeds, cutting
E/D	-	Evergreen
Flo.S.	-	Nov - Jan.
CSA	-	723.43 m^2
CS	-	Round
LA	-	42.34 cm^2
SI	-	18.02

No. C18 Clerodendrum infortunatum Linn (auct), Wight.

Fam - Verbenaceae

C.N. - Hin and Beng - Bhant, San - Bhantaka;
Tam -Perugilai; Tel - Gurrapukattiyaku;
Mal - Peruku.

S/T - T

HA - Shrub

HT - 3-4m

GR - Quick growing

R - By seeds, cutting

E/D - Evergreen

Flo.S. - Oct - Jan

CSA - 854 m^2

CS - Round

LA - 47.9 cm^2

SI - 19.07

No. C19 Cocos nucifera Linn

Fam - Arecaceae

C.N. - Coconut tree; Beng - Dab, Narikel;
Hin -Nariyal; Mal - Narikelam; Mar - Naral;
Sans - Narikela; Tam - Tenkai; Tel - Narikelamu.

S/T - T

HA - Tree

HT - 10-15m

GR - Slow growing

R - By seeds

E/D - Evergreen

Flo.S. - Throughout the year

CSA - 109,347.4 m^2

CS - Round

LA - 1635 cm^2 per leaflet

SI - 9.31

No. C20 Cordia dichotoma Farst

Fam	-	Cardiaceae
C.N.	-	Seb estan fruit tree. Beng - Bahubara; Guj- Bargunda; Hin - Chata - lasara; Kan - Chikka challe; Mal - Cheruviri; Tam - Naruvili; Tel - Chinn - anakkeru.
S/T	-	T
HA	-	Tree
HT	-	10m
GR	-	Quick grawing after 1st yr.
R	-	By seeds, stem cutting
E/D	-	Evergreen
Fla.S.	-	March - April
CS	-	Raund / Oblang

No. C21 Cariaria nepalensis Wall

Fam	-	Cariaceae
C.N.	-	Mussarie berry tree; Hin - Masuri; Kashmir - Balel
S/T	-	S
HA	-	Shrub
HT	-	5m
GR	-	Quick grawing
R	-	By seeds.
E/D	-	Deciduaus
CS	-	Raund

No. C22 Corylus colurna Linn

Fam	-	Betulaecae
C.N.	-	Turkish Hazel, Hin- Sharali; Kashmir - Virin; Kumaun - Bhatia, badam; Punjab - Thangi
S/T	-	S
HA	-	Tree

HT - 10m

GR - Quick growing

R - By seeds

E/D - Deciduous

No. D1 Dalbergia latifolia Roxb.

Fam - Fabaceae.

C.N. - Black wood, Indian Rose wood. Beng - Sitsol; Guj, Hin and Mar - Shisham; Kan - Bite; Mal and Tam - Itti; Oriya - Sisua; Tel - Irugudu, cittegi.

S/T - T

HA - Tree

HT - 20m

GR - Quick growing

R - By seeds, stem, root cuttings.

E/D - Semideciduous

Flo.S. - August - Sept

CSA - 21,723.2 m^2

CS - Round

LA - 187.9 cm^2

SI - 10.12

No. D2 Dalbergia sisoo Roxb.

Fam - Fobaceoe.

C.N. - Sissoo; Beng, Mar. Oriya and Assam - Sissu; Guj - Sisam; Hin - Shisham; Kan - Agaru; Mal -Iruvil; Tam - Sissuitti; Tel - Errasissoo; Punjab - Tali.

S/T - T

HA - Tree

HT - 10m

GR - Moderate during 1st yr. and rapid afterwards.

R - By seeds, Root and Stem cuttings.

E/D - Evergreen

Flo.S. - March - April - June

CSA - 5,848.5 m²

CSA - Round

LA - 190.84 cm²

SI - 18.72

No. D3 Delonix regia (Bojer) Rafin.

Fam - Caesalpinaceae.

C.N. - Flameboyant, Flametree, Gulmohur;
Tam - Mayarum; Tel - Seemasantkesula.

S/T - S

HA - Tree

HT - 15m

GR - Quick growing

R - By seeds, cuttings

E/D - Deciduous

Flo.S. - Aprill - June

CSA - 44,209.23 m²

CS - Spreading / Flat topped.

LA - 358.32 cm²

SI - 14.38

No. D4 Dendrocalamus strictus Nees

Fam - Poaceae

C.N. - Solid Bamboo: Beng - Karail; Guj - Nakorvans;
Hin - Banskaban; Kan - Kiribidiru;
Mal & Tam - Kalmungil; Mar - Bhariyel;
Oriya - Saliabanso; San - Vansha;
Tel - Saadharanapuveduru.

S/T - T

HA - Shrub / tall perennial grass.

HT - 12m

GR - Quick growing

R - By seeds, stem, rhizome cutting, layering

E/D - Deciduous

No. D5 Derris indica (Lam.) Bennett.

Fam - Fabaceae.

C.N. - Pongam - Oil Tree, Karanj, Indian Beech;
Assam - Karchaw; Beng, Guj, Hin, Kumoun,
Mar & Punjab - Karanja; Kan - Honge;
Mal - Pungu. Oriya - Karanjo;
Tam - Ponga, Pongam;
Tel - Gaanugachettu, Punguchettu.

S/T - T

HA - Tree

HT - 10m

GR - Quick growing

R - By seeds.

E/D - Evergreen

Flo.S. - April - June

CSA - 6,278.1m^2

CS - Round

LA - 79.6cm^2

SI - 25.20

No. D6 Diospyros melanoxylon Roxb.

Fam - Ebenaceae.

C.N. - Ebony, Coromandel Ebony - Persimmon.
Beng - Kend; Guj - Tamrag;
Hin and Mar - Tendu; Kan - Abanasi;
Mal - Kari; Oriya - Kendu; Tam - Karai;
Tel - Tumki.

S/T - T

HA - Tree

HT - 10m

GR - Slow growing

R - By seeds, root suckers.

E/D - Deciduous

Flo.S. - Feb - April

CSA - 324,355.2m²

CS - Oblong

LA - 167.78 cm²

SI - 17.89

No. D7 Dryptes roxburghii (Wall)

Fam - Euphorbiaceae.

C.N. - Putronjiva. Sans, Hin and Beng - Putronjivo; Pun - Jiyaputra; Kan - Putrajivo; Mal - Pongalam; Tam - Karupali; Tel - Kudurujivi

S/T - T

HA - Tree

HT - 15m

GR - Slow growing

R - By seeds

E/D - Evergreen

Flo.S. - Mar - May

CSA - 3445.32 m²

CS - Round

LA - 144.37 cm²

SI - 19.81

No. D8 Duranta repens L

Fam - Verbenaceae.

S/T - T

HA - Shrub

HT - 3m

GR - Quick growing

R - By seeds

E/D - Evergreen

Flo.S. - Throughout the year

CSA - 60.47 m^2

CS - Spreading

LA - 62.7 cm^2

SI - 21.5

No. E1 Emblica officinalis Goertn.

Fam - Eupharbiaceae.

C.N. - Gooseberry, Emblic myrobalon.

Beng and Hin - Amla; Guj - Amali;

Kan - Amalaka, nelli; Mal and Tam - Nelli;

Mar - Awala; Son - Amaloka;

Tel - Amalakama, raotausirika

S/T - T

HA - Tree

HT - 5m

GR - Quick growing

R - By seeds, cutting. Budding, inarching.

E/D - Deciduous

Flo.S. - June - July also in Feb, Mar - May.

CSA - 17,381.2 m^2

CS - Oblong

LA - 140.64 cm^2

SI - 11.62

No. E2 Embryopteris peregrina Goertn.

Fam - Ebenaceae.

S/T - T

HA - Tree

HT - 10m

GR - Quick growing
R - By seeds
E/D - Deciduous
Flo.S. - Mar - May
CSA - 28,609.1 m²
CS - Spreading
LA - 84.07 cm²
SI - 12.84

No. E3 Erythrina variegata Linn

Fam - Fabaceae.

C.N. - Indian coral tree; Beng - Polito mandar;
Guj - Bangoro; Hin - Dadap; Kan - Horivana
Mal and Tam - Kalyanamurkku;
Mar - Mondor, Pangara;
San - Mandara; Tel - Baadita, Moduga.

S/T - T
HA - Tree
HT - 10m
GR - Quick growing
R - By seeds, stem cuttings
E/D - Deciduous
Flo.S. - Feb - May
CSA - 22,903.7 m²
CS - Oblong
LA - 168.94 cm²
SI - 31.76

No. E4 Eucalyptus citriodora Hook.

Fam - Myrtaceae
C.N. - Lemon scented gum
S/T - T
HA - Tree

HT - 20m

GR - Quick growing

R - By seeds

E/D - Evergreen

Flo.S. - Feb - April. Oct - Dec.

CSA - 52,447.63 m^2

CS - Conical

LA - 48.37 cm^2

SI - 12.0

No. E5 Eucalyptus hybrid

Fam - Myrtaceae

C.N. - Mysore gum

S/T - T

HA - Tree

HT - 20m

GR - Quick growing

R - By seeds

E/D - Evergreen

Flo.S. - Feb. - April., Oct. - Dec.

CSA - 50,047.33 m^2

CS - Conical

LA - 50.37 cm^2

SI - 12.91

No. E6 Exbucklandia populnea (R.Br) R.W.Br.

Fam - Hamamelidaceae

C.N. - Beng - Bipli; Khasi - Dieng - doh; Trade - Pipli.

S/T - T

HA - Tree

HT - 10m

GR - Slow growing

R - By seeds

E/D	-	Evergreen
Flo.S.	-	Nov. - Dec.
CS	-	Round

No. F1 Ficus benghalensis Linn

Fam	-	Moraceae
C.N.	-	Banyan Tree, Beng - Bar; Guj - Vad; Hin - Bargad; Kan - Ala; Mal - Ala, Vatam; Mar - Vad; Sans - Bahupada; Tam - Al; Tel - Peddamarri
S/T	-	T
HA	-	Tree
HT	-	20m
GR	-	Quick growing
R	-	By cutting, seeds
E/D	-	Evergreen
Flo.S.	-	April - June
CSA	-	2,36,493.67 m^2
CS	-	Spreading
LA	-	119.10 cm^2
SI	-	21.72

No. F2 Ficus benjamina Linn

Fam	-	Moraceae
C.N.	-	Assam - Chilubor; Beng - Pakur; Mar - Pimpri; Tam - Putrajuvi
S/T	-	T
HA	-	Tree
HT	-	12m
GR	-	Quick growing
R	-	By seeds, cutting
E/D	-	Evergreen
Flo.S.	-	Sept - Nov

CSA - $87,326.12\ m^2$
CS - Spreading
LA - $29.27\ cm^2$
SI - 18.62

No. F3 <u>Ficus elastica</u> Roxb

Fam - Moraceae
C.N. - Indian Rubber tree
S/T - T
HA - Tree (Epiphytic)
HT - 12m
GR - Quick growing
R - By cutting
E/D - Evergreen
CSA - $6028.18\ m^2$
CS - Spreading / Round
LA - $94.20\ cm^2$
SI - 19.43

No. F4 <u>Ficus gibbosa</u> Blume

Fom - Moroceae
C.N. - Mar - Datir; Garhwal - Chanchri; Sans - Udumbber; Tom - Irodgam; Tel - Tella - bariniko; Orissa - Korotosani
S/T - T
HA - Tree
HT - 10m
GR - Quick growing
R - By cuttings, seeds
E/D - Evergreen
Flo.S. - April - May
CSA - $223,45.4\ m^2$
CS - Spreading

LA - 40.1 cm^2
SI - 19.81

No. F5 Ficus glomerata Roxb

Fam - Mara eae
C.N. - Beng - Dumur; Hin - Gular; Kan, Mal,
Tam - Athi; Mar - Umbar; Oriya - Dimra;
Tel - Atti, medichettu.
S/T - T
HA - Tree
HT - 15m
GR - Quick grawing
R - By seeds. cutting
E/D - Deciduous
Fla.S. - Aug - Oct, Dec - Feb
CSA - 2,18,769.8 m^2
CS - Spreading
LA - 47.28 cm^2
SI - 13.58

No. F6 Ficus hispida (L.) F.

Fam - Maraceae
C.N. - Kala - umbar, Beng - Kakdumur;
Assam - Khaskadumar; Hin - Kanea dumbar;
Punjab - Rumbal; Sans - Kakadumbura;
Tam and Mal - Peyatti; Tel - Vettiyati.
S/T - T
HA - Tree
HT - 10m
GR - Quick growing
R - By seeds, cuttings
E/D - Evergreen
Fla.S. - April - July

CSA - 46942.02 m^2

CS - Spreading

LA - 45.23 cm^2

SI - 17.21

No. F7 Ficus religiosa Linn

Fam - Moraceae

C.N. - Peepal tree; Beng and San - Ashthwa; Guj - Pipro; Hin - Pipal; Kan - Arali Ashwatha; Mar - Pimpala; Tam - Arasu; Tel - Ashavathamu, Raavichettu

S/T - T

HA - Tree

HT - 20m

GR - Grows slow in early stages later grows fast

R - Through seeds, cutting.

E/D - Evergreen

Flo.S. - Jon. - May.

CSA - 1,44,868 7 m^2

CS - Round/Oblong.

LA - 114.15 cm^2

SI - 18.70

No. F8 Ficus semicordata Buch Ham.

Fam - Moroceae

C.N. - Beng - Jagya Dumur; Hin - Jahephali; Kan - Gargaso; Mol - Perina; Mar - Porodumer; Tom - Torodi; Tel - Bommamorri.

S/T - T

HA - Tree

HT - 10m

GR - Quick growing.

R - Through seeds.

E/D	-	Evergreen.
Flo.S.	-	Throughout the year.
CSA	-	52,809.61 m^2
CS	-	Round
LA	-	84.50 cm^2
SI	-	17.38

No. F9 — Ficus virens Ait

Fam	-	Moraceae
C.N.	-	Hin and Punjab - Pilkhan; Ben - Pakar; Mal - Pepar, Mar - Pipli; Sans - Plaksha; Tam - Kurugu; Tel- Badiju
S/T	-	T
HA	-	Tree
HT	-	10m
GR	-	Grows slowly in early stages later grows fast
R	-	By seeds, cutting
E/D	-	Evergreen
Flo.S.	-	Jan - May
CSA	-	1,97, 838.2 m^2
CS	-	Oblong
LA	-	43.3 cm^2
SI	-	15.91

No. G1 — Gorcinia indica Chosis.

Fam	-	Guttiferaceae
C.N.	-	Hin and Mar - Kokam; Mal - Punampuli; Tam - Murgal
S/T	-	T
HA	-	Tree
HT	-	8m
GR	-	Slow growing (1 st yr).
R	-	Through seeds

E/D - Evergreen
Flo.S. - Nov - Feb
CSA - 210.748 m^2
CS - Oblong
LA - 82.1 cm^2
SI - 22.03

No. G2 Garcinia talbotii Raizada.
Fam - Guttiferaceae
S/T - T
HA - Tree
HT - 7m
GR - Slow growing
R - By seeds
E/D - Evergreen
Flo.S. - Nov.
CSA - 193.02 m^2
CS - Round
LA - 78.9 cm^2
SI - 21 7

No. G3 Gardenia jasminoides Eills.
Fam - Rubiaceae
C.N. - Sans - Anant. Gandharaj. Tam - Karinga
S/T - T
HA - Tree
HT - 5m
GR - Quick growing
R - By seeds, stem cutting
E/D - Evergreen
Flo.S. - April - Aug extended upto Sept.
CSA - 265.87 m^2
CS - Oblong

LA - 57.51 cm^2

SI - 19.21

No. G4 Gardenia resinifera Roth

Fam - Rubiaceae

C.N. - Hin and Mar - Dikamali; Sans - Jantuka; Tam - Tikkamalli; Tel - Erubikki

S/T - T

HA - Tree

HT - 5m

GR - Quick growing

R - By seeds, cutting

E/D - Deciduous

Flo.S. - Mar - June

CSA - 572.36 m^2

CS - Oblong

LA - 61.17 cm^2

SI - 19.73

No. G5 Gliricidia sepium (Jacq) Kunth ex Walp.

Fam - Faboceae

C.N. - Mother - of - cocoa, Mexican lilac.

S/T - T

HA - Tree

HT - 10m

GR - Quick growing

R - By seeds and large cutting

E/D - Deciduous

Flo.S. - Jan - March

CSA - 13412.6 m^2

CS - Oblong / Round

LA - 136.46 cm^2

SI - 12.79

No. G6 Grevillea robusta A. cunn

Fam	-	Proteaceae.
C.N.	-	Silvery or silky oak, Tam - Savukkamaram
S/T	-	T
HA	-	Tree
HT	-	20m
GR	-	Quick growing
R	-	By seeds
E/D	-	Evergreen
Flo.S.	-	Feb - April
CS	-	Oblong

No. G7 Grewia elastica Royle.

Fam	-	Tiliaceae
C.N.	-	Beng - Dhamni; Hin and Punjab - Dhaman; Oriya - Mirgi chara; Mal - Satachi; Mar - Dhaman; Tam - Tarra; Tel - Charachi; Sans - Dharmana.
S/T	-	T
HA	-	Tree
HT	-	10m
GR	-	Quick growing
R	-	By seeds
E/D	-	Deciduous
Flo.S.	-	May - Aug
CS	-	Round

No. G8 Grewia subinequalis DC.

Fam	-	Tiliaceae.
C.N.	-	Beng, Guj Hin, Mar and Punjab. Phalsa; Kan - Bhuttiyadippe; Oriya - Pharasakoli; Tam- Palisa; Tel - Nollajano.
S/T	-	T

HA - Shrub.
HT - 7m
GR - Quick growing
R - By seeds
E/D - Evergreen
Flo.S. - Apr - June
CS - Round

No. G9 Guazma ulmifolio Lamk.

Fam - Sterculiaceae
C.N. - Son, Tam, Tel and Mal - Rudraksha, Hin - Rudraki, Beng - Rudrakya; Mar - Rudroksh.
S/T - T
HA - Tree
HT - 10m
GR - Quick growing
R - By seeds
E/D - Evergreen
Flo.S. - Mar - August.
CSA - 30279.8 m^2
CS - Round / Spreading
LA - 85.21 cm^2
SI - 13.31

No. H1 Hamelia patens Jocq.

Fam - Rubiaceae
C.N. - Scarlet bush
S/T - T
HA - Shrub
HT - 3m
GR - Quick growing
R - By seeds, cuttings

E/D - Evergreen
Fla.S. - Oct - Jan
CSA - 824.06 m^2
CS - Raund
LA - 47.2 cm^2
SI - 19.07

No. H2 Heterophragma roxburghii DC.

Fam - Bignaniaceae
C.N. - Mar, Guj, M.P. - Warras; Kan - Bechadi;
Tel - Barukaligattu.
S/T - T
HA - Tree
HT - 18m
GR - Quick grawing
R - By seeds
E/D - Evergreen
Fla.S. - Feb - April
CSA - 155217.7 m^2
CS - Raund / Oblang
LA - 34.7 cm^2
SI - 14.2

No. H3 Hibiscus rasa-sinensis Linn

Fam - Malvaceae
C.N. - Jasud. Chinese Hibiscus; Sans and Beng - Jaba;
Hin - Jasum; Mar - Jasavanda;
Tam - Sapattuppu; Tel - Dasanamu.
S/T - T
HA - Shrub
HT - 3m
GR - Quick grawing
R - By cutting

E/D - Evergreen
Flo.S. - Throughout the year
CSA - 61.47 m^2
CS - Round / Oblong
LA - 44.7 cm^2
SI - 23.32

No. H4 Hippophae rhamnoides Linn

Fam - Elaeagnaceae
C.N. - Common seabuckthorn;
Ladakh and H.P. - Sirma;
Punjab - Kalabisa, Serma; U.P. - Chuma.
S/T - T
HA - Tree
HT - 10m
GR - Quick growing
R - By seed, stem cuttings, suckers
E/D - Deciduous
Flo.S. - Mar - May

No. H5 Holoptelia integrifolia, (Roxb) DC.

Fam - Ulmaceae
C.N. - Indian Elm. Kanju; Guj - Khanjho; Hin and Kumaun - Kanju; Kan - Thavasai; Mal - Aval; Oriya - Dauranja; Sans - Chirabilva; Tam - Ayal; Tel - Thapass; M.P - Karanjalam; Punjab - Rajain. Mar - Papdi
S/T - T
HA - Tree
GR - Quick growing
R - By seeds, stem cutting
E/D - Deciduous
Flo.S. - Feb - April

CSA - 29443.5 m²
CS - Oblong
LA - 67.30 cm²
SI - 31.03

No. 11 <u>Ixora arborea</u> Roxb

Fam - Rubiaceae
S/T - T
HA - Tree
HT - 6m
GR - Quick growing
R - By cutting
E/D - Evergreen
Flo.S. - Throughout the year
CSA - 57.04 m^2
CS - Oblong to spreading
LA - 54.2 cm^2
SI - 17.3

No. 12 <u>Ixora chinensis</u>

Fam - Rubiaceae
S/T - T
HA - Shrub
HT - 6m
GR - Quick growing
R - By cutting
E/D - Evergreen
Flo.S. - March
CS - Oblong

No. 13 <u>Ixora coccinea</u> L

Fam - Rubiaceae
C.N. - Beng and Hin - Rangan. Mar - Pendgul;

Sans - Bandhuka; Tam - Vedji; Tel - Karanam, Tachi; Mal - Techi

S/T - T

HA - Tree

HT - 6m

GR - Quick growing

R - By cutting

E/D - Evergreen

Fla.S. - Throughout the year

CSA - 183.26 m^2

CS - Oblong

LA - 69.70 cm^2

SI - 23.30

No. 14 Ixora rosea

Fam - Rubiaceae

S/T - T

HA - Tree

HT - 6m

GR - Quick growing

R - By cutting

E/D - Evergreen

Fla.S. - More or less throughout the yr.

CSA - 296.03 m^2

CS - Oblong

LA - 62.21 cm^2

SI - 20.30

No. 15 Ixora undulata

Fam - Rubiaceae

S/T - T

HA - Tree

HT - 6m

GR - Quick growing
R - By cutting
E/D - Evergreen
Flo.S. - March - April
CS - Oblong

No. J1 <u>Jacaranda</u> <u>mimosaefolia</u> D.Don.

Fam - Caesalpinaceae
C.N. - Nil - gulmohur
S/T - S
HA - Tree
HT - 10m
GR - Quick growing
R - By seeds
E/D - Deciduous
Flo.S. - March - April
CSA - 7148.54 m^2
CS - Round
LA - 46.4 cm^2
SI - 19.0

No. J2 <u>Juniperus</u> <u>communis</u>

Fam - Pinaceae
C.N. - Common juniper; Beng - Havasha; Hin - Aaraar; Mar - Hosha; Kumaun - Chichia; Punjab and Kashmir - Betar.
S/T - S
HA - Shrub
HT - 10m
GR - Quick growing
R - By seeds
E/D - Evergreen
Flo.S. - March - April
CS - Round / Oblong

No. K1 *Kigelia africana* Lamk

Fam - Bignoniaceae
C.N. - Sausage tree
S/T - T
HA - Small tree
HT - 10m
GR - Quick growing
R - By seeds
E/D - Evergreen
Flo.S. - Mar - June
CSA - 58432.21 m^2
CS - Round / Oblong
LA - 267.6 cm^2
SI - 12.90

No. L1 *Lagerstroemia parviflora* Roxb

Fam - Lythraceae
C.N. - Beng and Hin - Phurush; Mar - Dhayti;
Tam - Tindiyam; Tel - Chinagoranta.
S/T - T
HA - Tall tree
HT - 20m
GR - Quick growing
R - By seeds
E/D - Deciduous
Flo.S. - June
CSA - 67051.42 m^2
CS - Round / Oblong
LA - 84.12 cm^2
SI - 17.01

No. L2 *Lagerstroemia speciosa* (Linn)

Fam - Lythraceae

C.N. - Queen crape Myrtle. Beng and Hin - Punjab Jaraal; Kan - Haledasavala; Mal - Manimaruthu; Mar -Taman; Oriya - Patali; Tam - Kadali; Tel - Varagaagu.

S/T - T

HA - Tree

HT - 10m

GR - Quick growing

R - By seeds

E/D - Evergreen

Fla.S. - April - June

CSA - 72569.31 m²

CS - Oblong

LA - 87.62 cm²

SI - 13.9

No. L3 Lantana camara Linn.

Fam - Verbenaceae

C.N. - Lantana, Wildsage; Kan - Natahugide; Mal - Arippu; Mar - Ghaneri, Chadurang; Tam - Unniched; Tel - Puulikampa; M.P. - Raimuniya.

S/T - T

HA - Shrub

HT - 3m

GR - Quick growing

R - By seeds, cutting

E/D - Evergreen

Fla.S. - Throughout the year

CSA - 324.58 m²

CS - Spreading

LA - 48.69 cm²

SI - 12.13

No. L4 Lawsonia inermis Linn

Fam - Lythraceae

C.N. - Henna; Beng - Mehedi; Guj - Medi; Hin, Mar and Punjab - Mehndi; Kan - Mayilanchi,goranta; Mal - Mailanchi; Oriya - Benjat, Sans - Mendika; Tam - Marithondi; Tel - Gorinta; Kashmir -Mohuz.

S/T - T

HA - Shrub

HT - 5m

GR - Quick growing

R - By seed and cutting

E/D - Evergreen

Flo.S. - April - July

CSA - 71.85 m^2

CS - Round

LA - 77.8 cm^2

SI - 17.0

No. M1 Madhuca butyracea Macb

Fam - Sopotaceae

C.N. - The Indian butter - Tree; Beng - Gophol; Hin - Phulwara, Chiuro

S/T - T

HA - Tree

HT - 15m

GR - Quick growing

R - By seeds

B/D - Deciduous

Flo.S. - June - July

CS - Spreading

No. M2 Madhuca longifolia (Koen)

Fam - Sapotaceae

C.N. - The Butter tree; Beng Hin and Mar - Mahwa, Guj - Mahudo; Kan - Hippe; Mal - Ilupu, Poonam; Oriya - Mahula; Tam - Illupei; Tel - Ippa.

S/T - T

HA - Tree

HT - 15m

GR - Quick growing

R - By seeds

E/D - Deciduous

Flo.S. - Feb - April

CSA - 30,463.7 m^2

CS - Round / Oblong

LA - 86.96 cm^2

SI - 22.18

No. M3 Mallotus philippensis (Lour) Muell, Arg.

Fam - Euphorbioceoe

C.N. - Hin and Bengal - Kamala, Kamila, Assam - Puddum; Mal - Tavitu, Mar - Kamala, Shendri; Tam - Kamala; Tel - Sinduri; Sans - Rechonaka.

S/T - T

HA - Tree

HT - 12m

GR - Slow growing

R - By seeds

E/D - Evergreen

Flo.S. - Nov - Jan

CSA - 30497.8 m^2

CS - Oblong / Round

LA	-	58.3 cm^2
SI	-	19.0

No. M4   <u>Mammea suriga</u> (Buch - Ham. ex. Roxb.)

Fam	-	Guttiferaceae
C.N.	-	Hin and Beng - Nagkesar; Kan - Surungi; Mar - Suringi; Mal - Surampunna; Tam - Surabunnai; Tel - Surampunnagamu; Sans - Punnag.
S/T	-	T
HA	-	Tree
HT	-	18m
GR	-	Quick growing
R	-	By seeds
E/D	-	Evergreen
Flo.S.	-	Feb - Mar
CSA	-	27,865.1 m^2
CS	-	Spreading
LA	-	46.83 cm^2
SI	-	20.1

No. M5   <u>Mangifera indica</u> Linn

Fam	-	Anacardiaceae
C.N.	-	The mango tree, Beng and Hin - Am; Guj - Amri; Kan - Maavu; Mal - Aamram, maavu; Mar - Amba; Tam - Maanga, Maavu; Tel - Maamidichettu, Maavi.
S/T	-	S
HA	-	Tree
HT	-	15m
GR	-	Quick growing after 1 st year
R	-	By seeds, transplanting, grafting, budding, air lalyering, root cutting and marcotting.

E/D - Evergreen

Flo.S. - South India - Jan - Mar;
North India - Feb. - Apr.

CSA - 69,004.67 m^2

CS - Round / Oblong

LA - 85.27 cm^2

SI - 30.77

No. M6 Melaleuca leucadendron Linn

Fam - Myrtaceae

C.N. - Cajaput tree; Beng, Hin Mar - Cajaputte,
Tam - Kaiyappudai

S/T - T

HA - Tree

GR - Quick growing

R - By seeds, cuttings

E/D - Evergreen

Flo.S. - Sept - Nov

CSA - 21,435.38 m^2

CS - Oblong

LA - 83.57 cm^2

SI - 18.67

No. M7 Melia azadirach Linn

Fam - Meliaceae

C.N. - The Persian lilac, Beng - Mahanim;
Guj - Bakamlimbodo; Hin - Bakain;
Kan - Arebvu, Hutchuburi; Mal - Karin, Vembu;
Mar - Pejri; Tam - Malaivembu;
Tel - Turakaveepa, Verriveepa.

S/T - T

HA - Tree

HT - 20m

GR - Quick growing
R - By seeds, stem, root, cutting, root sucker.
E/D - Evergreen
Flo.S. - March - May
CSA - 38964.16 m^2
CS - Oblong
LA - 83.79 cm^2
SI - (23.53) 23.53

No. M8 Milletio peguensis Ali
Fam - Fabaceae
S/T - T
HA - Tree
HT - 10m
GR - Quick growing
R - By seeds.
E/D - Evergreen
Flo.S. - Aug. - Oct.
CSA - 42311.52 m^2
CS - Round/oblong
LA - 167.2 cm^2
SI - 12.2

No. M9 Millingtonia hortensis L.f.
Fam - Bignoniaceae
C.N. - Indian cork - tree, Buch.
S/T - S
HA - Tree
HT - 10m
GR - Quick growing
R - By seeds, cutting
E/D - Evergreen
Flo.S. - Oct. - Dec.

CSA - 22439.17m²
CS - Oblong / Round
LA - 139.2 cm²
SI - 18.11

No. M10 <u>Mimusops</u> <u>elengi</u> Linn

Fam - Sapotaceae
C.N. - Bakuli; Hin and Beng - Bakul; Mar - Borsati; Sans - Bakula; Punjab - Maulsari; Tam - Magilam; Tel - Vakulamu.
S/T - T
HA - Tree
HT - 10m
GR - Quick growing
R - By seeds
E/D - Evergreen
Flo.S. - Jan. - Mar.
CSA - 13,385.2 m²
CS - Oblong / Round
LA - 105.11 cm²
SI - 22.31

No. M11 <u>Mimusops</u> <u>hexandra</u> Roxb.

Fam - Sapotaceae
C.N. - Beng - Khirkhejur; Hin - Khirni; Mar - Rajan; Sans - Rajadani; Mals, Tam, and Tel - Pala.
S/T - T
HA - Tree
HT - 10m
GR - Quick growing
R - By cutting
E/D - Evergreen
Flo.S. - Sept. - Nov.

CSA - 4063.1 m^2

CS - Oblong / Round

LA - 89.32 cm^2

SI - 20.4

No. M12 Moringa oleifero Lomk.

Fom - Moringoceoe

C.N. - Drumstick tree, Horse Radish tree. Beng, Hin, Oriyo, Assam and Punjob - Sojino; Guj - Midho sorogovo; Kon - Nugge; Mol - Moringo; Mar - Shevgo; Sons - Shobhonjono; Tom - Murugoi, Tel - Mulogo.

S/T - S

HA - Tree

HT - 10m

GR - Quick growing

R - By seeds, cutting

E/D - Deciduous

Flo.S. - Jon. - Apr.

CSA - 23450.1 m^2

CS - Oblong

LA - 14730 cm^2

SI - 28.2

No. M13 Morus alba Linn.

Fom - Moroceoe.

C.N. - Tuti. Mulberry - Beng, Hin, Mar - Kashmir and Punjob - Tut. Guj - Shetur; Kon - Hipnerle; Oriyo - Tuto; Tom - Mosukette; Tel - Reshmechettu, Pippoliponduchettu.

S/T - S

HA - Tree

HT - 8m

GR - Quick growing
R - By seeds, cutting, grafting, budding
E/D - Evergreen
Flo.S. - Feb. - June.
CSA - 1047.62 m^2
CS - Oblong
LA - 285.3 cm^2
SI - 17.4

No. M14 Murraya paniculata Linn
Fam - Rutaceae.
C.N. - Beng - Kamini; Hin - Marchula; M.P. and Guj - Chulajuti; Kan - Pandry, Tam - Simaikkonji; Tel - Nagagolunga.
S/T - T
HA - Shrub
HT - 5m
GR - Quick growing
R - By seeds, cutting
E/D - Evergreen
Flo.S. - June. - Oct.
CSA - 1354.61m^2
CS - Round
LA - 35.3cm^2
SI - 10.31

No. N1 Nerium indicum Mill.
Fam - Apocynaceae
C.N. - Pink oleander; Hin and Punjab - Kaner; Beng - Karabi; Mal - Karaviram; Mar - Kanhera; Tam, Tel- Karaviram
S/T - T
HA - Shrub

HT - 5m

GR - Quick growing

R - By cutting

E/D - Evergreen

Flo.S. - Throughout the year

CSA - 5747.63 m^2

CS - Oblong / Round

LA - 32.62 cm^2

SI - 15.7

No. N2 Nyctanthus arbor-tristis Linn

Fam - Oleaceae

C.N. - Hin, Beng and Punjab -Harsinghar;
Guj - Harsingara; Mar - Parijatak;
Mal - Mannapu; San - Sephalika;
Tam - Pavala - malligai; Tel - Sepali.

S/T - T

HA - Shrub

HT - 5m

GR - Quick growing

R - By seeds, cutting

E/D - Deciduous

Flo.S. - More or less throughout the year

CSA - 546.3 m^2

CS - Oblong / Round

LA - 88.1 cm^2

SI - 14.73

No. O1 Ouginia oojeinensis (Roxb). Hochr.

Fom - Fabaceae

C.N. - Beng - Tinis; Guj - Tonoch; Hin - Sandon;
Kan - Kari - Honne; Mal - Molavonno;
Mar - Kalaphulos; Oriyo - Banjan;

Tam - Narivengai; Tel - Tellamoduga;
M.P. - Tinsa; Bihar - Ruta; Trade - Sandan.

S/T - T
HA - Tree
HT - 12m
GR - Quick growing
R - By seeds, Root cutting
E/D - Deciduous
Flo.S. - Feb. - March

No. P1 Peltophorum pterocarpum (DC) Backer.

Fam - Caesalpinaceae.
C.N. - Copper pod tree.
S/T - T
HA - Tall tree
GR - Quick growing
R - By seeds.
E/D - Evergreen.
Flo.S.- May - Sept
CSA - 231045.3 m^2
CS - Oblong/Round.
LA - 370.7 cm^2
SI - 16.68

No. P2 Phoenix sylvestris (L) Roxb.

Fam - Arecaceae.
C.N. - The Wild datepalm; Beng & Hin - Khajur.
Guj - Kharak; Kan - Ichalu; Mar - Shindi;
Oriya - Khajuri; Tam - Icham; Tel - Peddaetta.
S/T - T
HA - Tree
HT - 10m
GR - Slow growing

R - By seeds.
E/D - Evergreen.
Flo.S. - Jan. - Feb.
CSA - 546.1 m^2
CS - Round.
LA - 411.32 cm^2
SI - 12.4

No. P3 Phyllanthus acidus (L)

Fam - Euphorbiaceae.
C.N. - Country gooseberry; Beng - Hariphol, Noari; Hin - Harfarauri; Guj., M.P. - Harporawari; Tam - Kadalai; Tel - Sanagalu; Sans - Chanako.
S/T - T
HA - Tree
HT - 8 m
GR - Quick growing
R - By seeds, Cutting, Budding.
E/D - Deciduous.
Flo.S. - Feb. - May.
CSA - 5647.5 m^2
CS - Oblong.
LA - 543.03 cm^2
SI - 11.78

No. P4 Pinus khasiana

Fam - Pinaceae.
C.N. - Khasipine.
S/T - S
HA - Tree
HT - 10m
GR - Slow growing
R - By seeds.

E/D	-	Evergreen.
Flo.S.	-	May - June, Sept. - Oct.
CS	-	Round.

No. P5 Pinus roxburghii

Fam	-	Pinaceae.
C.N.	-	Hin - Chilgoza; N.W.H.P. - Chiri.
S/T	-	S
HA	-	Tree
HT	-	10m
GR	-	Slow growing
R	-	By seeds.
E/D	-	Evergreen.
Flo.S.	-	May - June, Sept. - Oct.
CS	-	Round.

No. P6 Pinus wallichiana A.B.Jackson

Fam	-	Pinaceae.
C.N.	-	Chir pine.
S/T	-	S
HA	-	Tree
HT	-	12m
GR	-	Slow growing
R	-	By seeds.
E/D	-	Evergreen.
Flo.S.	-	May - June, Sept. - Oct.
CS	-	Round.

No. P7 Pithecellobium ducle (Roxb.) Benth

Fam	-	Mimosaceae.
C.N.	-	Manila tamarind, Madras thorn; Beng - Dekhani babul, Hin - Vilayatimili; Jungle jalebi; Kan - Kottampuli;

Mal - Karukkapuli; Mar - Vilayati chinat;
Tam - Kadukkaapuli; Tel - Seema chinta.

S/T - T
HA - Tree
HT - 8 m
GR - Quick growing
R - By seeds, Branch cutting.
E/D - Evergreen.
Fla.S. - Jan. - Feb.
CSA - 2564.75 m^2
CS - Oblang.
LA - 182.6 cm^2
SI - 11.78

No. P8 Poinciana pulcherrima Linn (R. Grah.)

Fam - Caesalpinaceae.
C.N. - Beng - Krishnachura; Hin - Guletura; Guj - Sandheshara; Mar. - Shankasur; Sanse & Tel - Ratnagandhi; Mal. - Settimandaram; Tam - Mayuram; Tel - Ratnagandhi.
S/T - T
HA - Shrub
HT - 3 m
GR - Quick growing
R - By cutting.
E/D - Evergreen.
Fla.S. - Oct. - Jan.
CSA - 8034.67 m^2
CS - Oblang.
LA - 214.01 cm^2
SI - 13.4

No. P9 <u>Polyalthia</u> <u>longifolia</u> (Sonn.) Th

Fam - Anonaceoe.

C.N. - Hin & Beng - Devdaru; Guj - Asupala; Mar - Ashok; Kan - Putrajivi; Mal - Ashokam; Tam - Asogam; Tel - Asokamu.

S/T - S

HA - Tree

HT - 15 or 5 m

GR - Quick growing

R - Through seeds (fresh).

E/D - Evergreen.

Flo.S. - April - June.

CSA - 10,976.62 m^2 rounded crown.

CS - Conical or Rounded

LA - 55.06 cm^2

SI - 22.27

No. P10 <u>Populus</u> <u>alba</u> Linn

Fam - Salicaceae.

C.N. - White poplar; N.W. Himal - Chitta bagnu; Jangli frost. Kashmir - Fras.

S/T - S

HA - Tree

HT - 15 m

GR - Quick growing

R - By seeds, stem, root cutting, root sucker.

E/D - Deciduous.

CS - Oblong.

No. P11 <u>Populus</u> <u>ciliata</u> Wall.

Fam - Salicaceae.

C.N. - Himalayan poplar; Beng - Bangikat; Jaunsar - biaon, piplas, kumaun; Syan;

N.W.H.P. - Bagnu chelum, tilaunja.

S/T - S

HA - Tree

HT - 20 m

GR - Quick growing

R - By seeds, stem, root cutting, root sucker.

E/D - Deciduous.

CS - Oblong.

No. P12 Populus deltoides Bartr.

Fam - Salicaceae.

C.N. - Caroline poplar, Eastern cottonwood Necklace polar.

S/T - S

HA - Tree

HT - 20 m

GR - Quick growing

R - By seeds, stem, root cutting, root sucker.

E/D - Deciduous.

CS - Oblong.

No. P13 Populus euphratica Olivier

Fam - Salicaceae.

C.N. - Indian poplar. Punjab & N.W.H.P-Bahan, bhan; Ladakh - Hotung, hondung.

S/T - S

HA - Tree

HT - 10 m

GR - Quick growing

R - By seeds, stem, root cutting, root sucker.

E/D - Deciduous.

CS - Oblong.

No. P14 Populus nigra Linn

Fam - Salicaceae.

C.N. - Lombardy - poplar; N.W.H.P. - Frost.

S/T - S

HA - Tree

HT - 20 m

GR - Quick growing

R - By seeds, stem, root cutting, root sucker.

E/D - Deciduous.

CS - Conical.

No. P15 Prosopis chilensis (Malina) stuntz.

Fam - Mimos eae.

C.N. - Mesquite; Guj - Gandaa babul, Pardesi babul; Hin - Vilayati kikkar; Vilayati babul, Kabuli kikkar.

S/T - T

HA - Tree

HT - 10 m

GR - Quick growing

R - By seeds, root suckers.

E/D - Evergreen.

Flo.S. - Dec. - April.

CSA - 7950.68 m²

CS - Spreading.

LA - 51.05 cm²

SI - 19.23

No. P16 Prosopis cineraria Linn.

Fam - Mimos eae.

C.N. - Beng & Oriya - Shami; Hin - Khejri; Guj - Sami, Khijado; Kan - Banni; Mal - Parampu, Tomba; Mar - Shami;

Tam - Perumbay, Jambu; Tel - Jammichettu.

S/T - T

HA - Tree

HT - 12 m

GR - Quick growing

R - By seeds, root suckers.

E/D - Evergreen.

Flo.S. - Dec. - April.

CSA - 13,430.6 m^2

CS - Spreading.

LA - 54.23 cm^2

SI - 18.1

No. P17 Prosopis pallida (H & B ex Willd)

Fam - Mimos eae.

S/T - T

HA - Tree

HT - 10 m

GR - Quick growing

R - By seeds, root suckers.

E/D - Evergreen.

Flo S. - Dec. - April.

CS - Spreading.

No. P18 Prosopis stephaniana Kunth.

Fam - Mimos eae.

S/T - T

HA - Shrub

HT - 5 m

GR - Quick growing

R - By seeds, root suckers.

E/D - Evergreen.

Flo.S. - Dec. - Feb.

CS - Spreading.

No. P19 Prosopis tamarugo FiPhil.

Fam - Mimos eae.

S/T - T

HA - Tree

HT - 13 m

GR - Quick growing

R - By seeds, root suckers.

E/D - Evergreen.

Flo.S. - Dec. - April.

CS - Spreading.

No. P20 Psidium guayava Linn.

Fom - Myrtaceae.

C.N. - Guava tree. Beng - Peyara;
Hin & Punjab - Amrud; Guj - Perala;
Sons - Mansola; Tam, Mal - Koyya;
Tel - Goyya; Mar - Peru

S/T - T

HA - Tree

HT - 5 m

GR - Quick growing

R - By cutting, seeds, Budding, Grafting.

E/D - Evergreen.

CSA - 9,243.1 m^2

CS - Oblong.

LA - 53.66 cm^2

SI - 28.38

No. P21 Pterygota alata vor. irregularis (W.W.Smith)

Fom - Sterculioceae

C.N. - Assam - Tula; Kan - Bekaro, Mal - Porutonti;
Tam - Kodiottondi.

S/T - T

HA	-	Tree
HT	-	15 m
GR	-	Quick growing
R	-	By seeds, cuttings.
E/D	-	Semi deciduous.
Flo.S.	-	Mar. - April.
CSA	-	179,320.8 m^2
CS	-	Rround/Oblong
LA	-	189.4 cm^2
SI	-	22.04
CS	-	Rround/Oblong
LA	-	189.4 cm^2
SI	-	22.04

No. Q1 Quercus palustris

Fam	-	Fagaceae.
C.N.	-	Oak.
S/T	-	T
HA	-	Tree
HT	-	15 m
GR	-	Quick growing
E/D	-	Deciduous.
CS	-	Round.

No. Q2 Quercus petraea

Fam	-	Fagaceae.
C.N.	-	Oak.
S/T	-	T
HA	-	Tree
HT	-	15 m
GR	-	Quick growing
E/D	-	Deciduous.
CS	-	Round.

No. Q3 Quercus rubra

Fam	-	Fagaceae.
C.N.	-	Oak.
S/T	-	T
HA	-	Tree
HT	-	15 m
GR	-	Quick growing
E/D	-	Deciduous.
CS	-	Round.

No. R1 Ricinus communis Linn.

Fam	-	Euphorbiaceae.
C.N.	-	The castor; Beng - Bheranda; Guj - Diveligo; Hin & Mar. Erandi; Kan-Haralu; Mal - Avanakku; Tam - Amanakku; Tel - Aamudamuchettu.
S/T	-	T
HA	-	Shrub
HT	-	6 m
GR	-	Quick growing
R	-	By seeds.
E/D	-	Evergreen.
Flo.S.	-	Sept. - Oct.
CSA	-	942.56 m^2
CS	-	Oblong.
LA	-	243.5 cm^2
SI	-	15.71

No. S1 Salix albo Linn.

Fam	-	Salicaceae.
C.N.	-	European willow; White willow. Kashmir - Butvir, Vivir; H.P. Punjab - Bisbhushan, Madnu, Malchang.
S/T	-	T

HA	-	Tree
HT	-	20 m
GR	-	Quick growing
R	-	By stem cutting, root cutting.
E/D	-	Deciduous.
Flo.S.	-	Mar. - May.
CS	-	Oblong/Round.

No. S2 Salix babylonica Linn.

Fam	-	Salicaceae.
C.N.	-	Weeping willow. Garhwal - Gadhbanis; Kashmir - Biasa, Guir; Punjab - Bisa; Tel - Attuppalai,
S/T	-	T
HA	-	Tree
HT	-	10 m
GR	-	Quick growing
R	-	By stem, root cutting, suckers.
E/D	-	Deciduous.
Flo.S.	-	Mar. - May.
CS	-	Round.

No. S3 Salix caprea Linn.

Fam	-	Salicaceae.
C.N.	-	The sallow, goat willow Hin & Punjab - Bedmushk.
S/T	-	T
HA	-	Shrub
HT	-	5 m
GR	-	Quick growing
R	-	By cutting.
E/D	-	Deciduous.

Flo.S. - Mar. - May.
CS - Round/Oblong.

No. S4 Salix fragilis Linn.

Fam - Salicaceae.
C.N. - Crack or Kashmir willow; H.P. Tilchang.
S/T - T
HA - Tree
HT - 18 m
GR - Quick growing
R - By seeds, cutting.
E/D - Deciduous.
Flo.S. - Mar. - May.
CS - Oblong/Round.

No. S5 Salix tetrasperma Roxb.

Fam - Salicaceae.
C.N. - Indian willow; Beng - Panijama; Hin - Bod. jalmala; Kan - Niravanji; Mal & Tam - Vanji; Mar - Wallunj; Oriya - Baisi; Tel - Eetipoala; Assam - Veh; Kashmir - Vir, bin; Khasi -Jamyneri; M.P. Dhanie; Punjab - Bis, Bain
S/T - T
HA - Tree
HT - 15 m
GR - Quick growing
R - By cutting.
E/D - Deciduous.
CS - Round.

No. S6 Samaneo samon Jacq.

Fam - Mimos eae.
C.N. - Rain Tree.

S/T - T

HA - Tree

HT - 20 m

GR - Quick growing

R - By seeds cutting.

E/D - Evergreen.

Flo.S. - Mar. - June

CSA - 99306.2 m^2

CS - Spreading/Round.

LA - 282.6 cm^2

SI - 15.64

No. S7 Sapindus emarginatus Vahl.

Fam - Sapindaceae.

C.N. - Soapnut; Assam - Haithaguti; Beng - Ritha; Mar- Ritha; Sans - Phenila.

S/T - T

HA - Tree

HT - 10 m

GR - Quick growing

R - By seeds.

E/D - Evergreen.

Flo.S. - Oct. - Dec.

CSA - 43,789.24 m^2

CS - Oblong/Round.

LA - 110.6 cm^2

SI - 23.6

No. S8 Sapium sebiferum Roxb

Fam - Euphorbiaceae

C.N. - Makhan tree. Chinese Tallow Tree.

S/T - T

HA - Tree

HT - 12 m

GR - Quick grawing

R - By seeds.

E/D - Deciduaus.

Fla.S. - June - Aug.

CSA - 24980.3 m^2

CS - Raund.

LA - 74.2 cm^2

SI - 14.2

No. S9 <u>Saraca asoka</u> Raxb. De Wilde.

Fam - Caesalpinaceae.

C.N. - Hin & Mar - Ashak, Punjab & Beng - Asak; Mar - Asaka; Sans - Ashaka; Tam - Asagam; Tel - Asakamu.

S/T - T

HA - Tree

HT - 5 m

GR - Quick grawing

R - By seeds.

E/D - Evergreen.

Fla.S. - Dec - May.

CSA - 2295.2 m^2

CS - Spreading.

LA - 68.8 cm^2

SI - 17.93

No. S10 <u>Sesbania grandiflora</u> Pers.

Fam - Fabaceae.

C.N. - Swamp - pea, Agathi; Kan - Agase; Mal- Mathi; Mar - Hadga, Agasta; Oriya - Ogasti; Tam - Agathi; Tel - Arise - chetta.

S/T - T

HA - Tree

HT - 10 m

GR - Quick growing

R - By seeds.

E/D - Evergreen.

Fla.S. - Sept. - Dec.

CSA - 4694.87 m^2

CS - Oblong.

LA - 130 cm^2

SI - 20.45

No. S11 Sesbania sesban (Linn) Merrill.

Fam - Fabaceae.

C.N. - Comman sesban; Beng & Hin - Jainti; Guj - Jayati; Kan - Arisinajeenangimera; Mal - Sempa; Mar -Jayanti, Shewarie; Oriya - Jayantei; Sans - Jayantika; Tam - Chittagathi; Tel - Samintha; Assam - Jayantri; Punjab - Jaint.

S/T - T

HA - Shrub

HT - 6 m

GR - Quick growing

R - By seeds.

E/D - Evergreen.

Fla.S. - Aug. - Dec.

CSA - 4563.7 m^2

CS - Oblang.

LA - 118.3 cm^2

SI - 19.2

No. S12 Sesbania speciosa Taub.

Fam - Fabaceae.

C.N. - Tam - Seemaiagathi.

ST - T

HA - Shrub

HT - 4 m

GR - Quick grawing

R - By seeds.

E/D - Evergreen.

Fla.S. - Sept. - Dec.

CS - Oblang.

No. S13 Soymida febrifuga A. Juss

Fam - Meliaceae.

C.N. - Indian Red waad, Beng & Hindi Mar - Rahan; Guj - Rahina; Kan - Suani; Oriya - Sahan; Tam - Shem; Tel - Sumi, Sanidamaanu.

S/T - T

HA - Tree

HT - 15 m

GR - Quick grawing

R - By seeds.

E/D - Deciduaus.

Fla.S. - Mar.

CSA - 78325.4 m^2

CS - Raund/Oblang.

LA - 49.7 cm^2

SI - 20.3

No. S14 Spathodea campanulata Beauv.

Fam - Bignaniaceae

C.N. - Indian Tulip tree

S/T - T

HA - Tree

HT - 12 m

GR - Quick growing
R - By seeds, cutting.
E/D - Evergreen.
Flo.S. - Nov. - Jan.
CSA - 73,250.17 m^2
CS - Oblong / Round
LA - 89.3 cm^2
SI - 24.84

No. S15 Spondias pinnata (L.f.)

Fam - Anacardiaceae.
C.N. - Hin - Bemg & Mar - Amra; Kan - Ambate; San - Amrataka; Tam - Mabulichi; Tel - Amratakamul; Mal - Mapuli.
S/T - T
HA - Tree
HT - 10 m
Gr - Quick growing after 1st year.
R - By seeds.
E/D - Deciduous.
Flo.S. - Feb. - Apr.
CSA - 25587.31 m^2
CS - Round.
LA - 130.64 cm^2
SI - 22.9

No. S16 Sterculia foetida Linn.

Fam - Sterculiaceae.
C.N. - Jangli badam, Hin & Mar - Jangli badam; Kan - Penari; Tam & Mal - Pinari; Tel - Manjiponaku.
S/T - T
HA - Tree

HT - 15 m

GR - Quick growing

R - By seeds.

E/D - Deciduous.

Flo.S. - Mar. - May.

CS - Oblong/Round.

No. S17 Sterculia guttata Roxb.

Fam - Sterculiaceae.

C.N. - Kukur, Golder.

S/T - T

HA - Tree

HT - 15 m

GR - Quick growing

R - By seeds.

E/D - Deciduous.

Flo.S. - Jan. - Feb.

CS - Oblong/Round.

No. S18 Strychnos nux-vomica Linn

Fam - Loganiaceae.

C.N. - Beng & Punjab - Kuchila; Hin - Kuchla; Kan-Kanjira; Mal - Kanniram; Mar - Kajra; Sans - Visha - mushti; Tam - Etti; Tel - Mushti.

S/T - T

HA - Tree

HT - 12 m

GR - Quick growing

R - By seeds.

E/D - Deciduous.

Flo.S. - Mar. - April

CSA - 1067.441 m^2

CS - Oblong/Round.

LA - 67.37 cm^2

SI - 12.87

No. S19 Syncarpia glomulifera Sm.

Fom - Myrtoceoe

C.N. - Turpentine tree.

S/T - T

HA - Tree

HT - 20 m

GR - Quick growing

R - By seeds.

E/D - Evergreen.

CS - Oblong/Round.

No. S20 Syzygium cumini Linn

Fom - Myrtoceoe.

C.N. - Block plum; Beng - Kolojom; Guj - Jombu; Hin & Punjab - Jomon; Mar - Jombhul; Kon - Nerole; Mol - Perinnorol; Oriyo - Jomo; Tom - Neredum; Tel - Neereedu.

S/T - T

HA - Tree

HT - 20 m

GR - Quick growing

R - By seeds, cuttings. Grafting. Budding.

E/D - Evergreen.

Flo.S. - Mar. - May.

CSA - 112143.2 m^2

CS - Oblong/Spreading.

LA - 77.82 cm^2

SI - 20.60

No. T1 <u>Tabernaemontana</u> <u>divaricata</u> Linn.

Fam	-	Apacynaceae.
C.N.	-	Beng, Mar, Hin & Sans - Tagar, Chandani; Tam - Nandiyavattam; Tel - Gandhitagarapu.
S/T	-	T
HA	-	Shrub
HT	-	3m
GR	-	Quick growing
R	-	By cutting.
E/D	-	Evergreen.
Fla.S.	-	Thraughaut the year.
CSA	-	128.67 m^2
CS	-	Raund.
LA	-	47.81 cm^2
SI	-	30.2

No. T2 <u>Tamarindus</u> <u>indica</u> Linn.

Fam	-	Caesapinaceae.
C.N.	-	The Tamarind tree; Beng - Anbli, Tentuli; Guj & Kan - Amli; Hin - Imli; Mal - Amlam, Puli; Mar - Chinch; Oriya - Tentuli; Tam - Amilam pul; Tel - Chintachettu; Assam - Tetuli; Punjab - Imbli.
S/T	-	T
HA	-	Tree.
HT	-	20 m
GR	-	Quick growing (Early)
R	-	By seeds.
E/D	-	Evergreen.
Fla.S.	-	April - Oct.
CSA	-	276839.5 m^2
CS	-	Spreading.

LA - 128.60 cm^2

SI - 18.4

No. T3 Tecomo stans Linn.

Fom - Bignonioceoe.

C.N. - Kon - Koreneklor; Tom - Sono - Patti; Tel - Pochogotlo

S/T - T

HA - Shrub

HT - 5 m

GR - Quick growing

R - By seeds, cutting.

E/D - Evergreen.

Flo.S. - Feb. - April

CSA - 61.23 m^2

CS - Oblong.

LA - 43.7 cm^2

SI - 23.8

No. T4 Tectono grandis Linn.

Fom - Verbenoceoe.

C.N. - Teak; Beng - Segun; Hin & Mar - Sogwon; Guj- Sago; Kon - Tego; Mol & Tom - Thekku; Oriyo - Singuru; Tel - Adoviteeku, Peddoteek; Assam - Chingjogu.

S/T - T

HA - Tree

HT - 20 m

GR - Quick growing

R - By seeds.

E/D - Deciduous.

Flo.S. - June - Sept.

CSA - 10272.14 m^2

CS	-	Oblong/Round
LA	-	790.37 m^2
SI	-	23.48

No. T5 Terminalia alata Heyne ex Roth.

Fam	-	Combretaceae.
C.N.	-	Laurel; Beng - Asan; Guj - Sadar; Hin - Asan, Sain, Saj; Kan - Sadada; Mar - Ain; Oriya - Sahaju; Tam - Karramarda, Tel - Nallamaddi.
S/T	-	T
HA	-	Tree
HT	-	20 m
GR	-	Quick growing
R	-	By seeds, cutting.
E/D	-	Deciduous.
Flo.S.	-	May - July.
CS	-	Oblong/Round.

No. T6 Terminalia arjuna (Roxb) Wight & Arn.

Fam	-	Combretaceae.
C.N.	-	Arjun, Arjhan; Beng - Guj - Sadado; Hin & Punjab - Arjuna; Kan - Maddi; Mar - Sadaru, vellamarda; Oriya - Arjuno, sahajo; Tam - Vellamatta; Tel - Yerramaddi; Assam - Orjun.
S/T	-	T
HA	-	Tree
HT	-	15 m
GR	-	Quick growing
R	-	By seeds, cutting, air layering.
E/D	-	Deciduous.
Flo.S.	-	April - July.

CSA	-	719,992.2 m^2
CS	-	Oblong/Round
LA	-	60.06 cm^2
SI	-	24.57

No. T7 Terminalia bellerica (Gaertn) Roxb

Fam	-	Combretaceae.
C.N.	-	Belleric myrobalan; Beng Bhairah; Hin - Bahera; Mal & Tam - Tani; Mar - Beheda; Oriya - Bhara, Tel - Thandrakoaya.
S/T	-	T
HA	-	Tree
HT	-	15 m
GR	-	Quick growing
R	-	By seeds, cuttings.
E/D	-	Deciduous.
Flo.S.	-	April - May.
CSA	-	82813.9 m^2
CS	-	Oblong/Round
LA	-	63.20 cm^2
SI	-	19.06

No. T8 Terminalia catappa Linn.

Fam	-	Combretaceae.
C.N.	-	The Indian Almond tree; Beng - Badam; Hin - Deshi badam; Mal - Adamarram; Tam - Natvadom; Tel - Boadamuchettu, Vedam.
S/T	-	T
HA	-	Tree
HT	-	10 m
GR	-	Quick growing
R	-	By seeds.
E/D	-	Deciduous.

Flo.S.	-	Oct.- Nov.
CSA	-	94367.4 m^2
CS	-	Conical
LA	-	62.01 cm^2
SI	-	20.9

No. T9 <u>Terminalia chebulo</u> Retz.

Fam	-	Combretaceae.
C.N.	-	Chebulic myrobalan; Beng - Horitaki; Guj - Hardo; Hin - Harra; Mar - Hirda; Oriyo - Haridra; Tam - Kadukkai; Tel - Karakkaaya; Assam - Silikha; Punjab - Har
S/T	-	T
HA	-	Tree
HT	-	15 m
GR	-	Quick growing
R	-	By seeds.
E/D	-	Deciduous.
Flo.S.	-	Mar.- Oct.
CSA	-	82,314.16 m^2
CS	-	Round/Oblong.
LA	-	60.60 cm^2
SI	-	19.06

No. T10 <u>Thespesia populneoides</u> (Roxb) Kostel.

Fam	-	Molvaceae.
C.N.	-	Umbrella tree, Indian Tulip tree, Beng - Dumbla, porespipol; Guj - Paarsapeepala; Hin & Punjab - Paraspipal; Kan - Hoovorase; Mal - Poovarasu; Mar - Bhendi; Oriya - Gunjausto; Sans - Gardhobhanda; Tom - Chelanthi; Tel - Gangaraavichettu.
S/T	-	T

HA - Tree

HT - 10 m

GR - Quick growing

R - By seeds, cuttings.

E/D - Evergreen.

Flo.S. - Throughout the year.

CSA - 34,635.32 m^2

CS - Round

LA - 184.39 cm^2

SI - 29.81

No. T11 Thevetia peruviana (Pers.) Merrill.

Fam - Apocynoceae.

C.N. - Yellow oleoner; Beng - Koklaphul, Haldi korubi; Guj & Hin - Pila kaner; Kan - Kodukasi; Mal - Monjaareli; Mar - Pivola konhera; Bitti Oriya - Konyorphul; Tom - Pachoiyalari; Tel - Pochoganneru.

S/T - T

HA - Shrub

HT - 6m

GR - Quick growing

R - By seeds, cutting.

E/D - Evergreen.

CSA - 21,775.22 m^2

CS - Round / Oblong.

LA - 11.08 cm^2

SI - 27.8

No. T12 Thuja occidentalis Linn.

Fam - Cupressaceae.

C.N. - American Arborvitae, White cedar.

S/T - T

HA - Tree
HT - 15 m
GR - Quick growing
R - By cutting.
E/D - Evergreen.
CS - Conical

No. T13 Thuja plicata D. Don.

Fam - Cupressaceaee.
C.N. - Giant arborvitae, Western red cedar.
S/T - T
HA - Tree
HT - 20 m
GR - Quick growing
R - By cutting.
E/D - Evergreen.
CS - Conical

No. T14 Trema orientalis Blume

Fam - Ulmaceae.
C.N. - Charcoal tree. Indian nettle tree. Beng - Chikan; Guj & Mar - Gol; Hin - Gio; Kan - Gorklu; Mal - Ama; Oriya - Kharkas; Tam - Ambaratthi; Tel - Bundamuru;
S/T - T
HA - Tree
HT - 6 m
GR - Quick growing
R - By seeds, stumps.
E/D - Evergreen.
Flo.S. - Throughout the year.
CSA - 42,5734.1 m^2
CS - Round/Oblong.

LA	-	65.7 cm^2
SI	-	27.30

No. V1 Ulmus wallichiana Planch.

Fam	-	Ulmaceae.
C.N.	-	Hin - Mored pabuna; Kashmir - Brari; Kumoun - Moral; Punjab - Kain.
S/T	-	T
HA	-	Tree
HT	-	15 m
GR	-	Quick growing
R	-	By seeds.
E/D	-	Evergreen.
CS	-	Round

No. Z1 Zizyphus mauritiana Var. Fruticosa

Fam	-	Rhamnaceae.
C.N.	-	Indian jujube; Beng & Hin - Ber; Guj - Bordi; Kan - Elanji; Mal & Tam - Elentha; Mar - Bera, bor; Oriya - Badori; San - Karakandhy; Tel - Reegu.
S/T	-	T
HA	-	Tree
HT	-	10 m
GR	-	Quick growing (Early)
R	-	By seeds.
E/D	-	Evergreen.
Flo.S.	-	April - Oct.
CSA	-	2638.17 m^2
CS	-	Round
LA	-	24.08 cm^2
SI	-	12.4

No. Z2 Zizyphus oenoplia Mill

Fam - Rhamnaceae.
C.N. - Jackal jujube; Beng - Siakul; Hin - Makai; Kan - Barige; Mal - Kottavalli; Oriya - Kantokalli; Tam - Ambulam; Tel - Banka paragi.
S/T - T
HA - Straggler shrub.
HT - 5 m
GR - Quick growing
R - By seeds.
E/D - Evergreen.
Flo.S. - April - June.
CS - Round

No. Z3 Zizyphus rugosa Lamk.

Fam - Rhamnaceae.
C.N. - Hin - Suran; Mar - Turan - Torni, Kan - Mahigotte; Mal - Malantutali; Tam - Kattilandai; Tel - Pinduparighamu.
S/T - T
HA - Straggler shrub.
HT - 5 m
GR - Quick growing
R - By seeds.
E/D - Evergreen.
Flo.S. - Dec. - Feb.
CS - Round

No. Z4 Zizyphus xylopyra Willd.

Fam - Rhamnaceae.
C.N. - Hin - Kat - ber; Kan - Mullukare; Mar - Koddntegoti; Oriya - Goteoboro,

Kantobohul; Tam - Kottei; Tel - Gotte.

S/T - T

HA - Straggler shrub.

HT - 4 m

GR - Quick growing

R - By seeds.

E/D - Evergreen.

Flo.S. - April - June.

CS - Round

APPENDIX-C

Zonewise recommendation of plant species for constitution of Green Belt :

Note for the use of Appendix C :

For listing plant species for cultivation in on oreo of concern, please follow the following steps.

1. Place the oreo (os per District) of your concern in subzone and zone, after referring to Appendix A.
2. Refer to Appendix C ot corresponding zone (Cz) and subzone (I.1, II.3, V.2 etc.).
3. List the alphabets and numbers under zone and subzone (e.g. Cz V.2 - A 1, 2, 3, 4, 5 etc.; B - 1, 2, 3, 4 etc.; C - 2, 3, 4, ... 12 etc.)separorotely on sheets.
4. Decipher the above numbers from Appendix B. (e.g. A - 1 - Abutilon indicum, A - 2 - Acacia ouriculiformis etc.; B - 1 - Balanites roxburghii, B - 2 - Bambusa orundinocia, etc.; C - 2 - Callistemon citrinus, C - 3 - Calophyllum inophyllum, C - 4 - Calotropis gigantea etc. ..... and so on.

   Completion of the exercise will mean that your list of plants for cultivation in the area of concern is ready. Detailed information, useful for agronomic and other aspects, is available in Appendix B.

Cz I. Western Himalayan Region

Cz I.1 - **A** - 3,4,7,9-11,13,16,17,19,22-26,28-35,41,44; **B** - 6-12,16; **C** - 14,21,22; **D** - 1; **E** - 4-6; **F** - 1-4; 7-9; **G** - 6-8; **H** - 4; **I** - 1,2; **J** - 2; **L** - 3,4; **M** - 1,8; **N** - 1,2; **O** - 1; **P** - 4-6, 10 - 14; **Q** - 1-3; **S** - 1-5,8,15; **T** - 1-3, 6, 7,9, 12,13; **U** - 1; **Z** - 1

Cz I.2 - **A** - 3,4,7,9-11,13,16,17,19,22-26,28-35,39,41, 44; **B** - 4,6-17; **C** - 2-5,14,18,21,22; **D** - 1,4; **E** - 1,4-6,8; **F** - 1-4,8; **G** - 4,6-8; **H** - 3,4; **I** - 1-3,5; **J** - 2; **L** - 3,4; **M** - 1,3,8,12,14; **N** - 1,2; **O** - 1; **P** - 4-6, 10-14,16,21; **Q** - 1-3; **S** - 1-5,7-10,14,15; **T** - 1-3,6,7,9,12,13; **U** - 1; **Z** - 1

Cz I.3 - **A** - 3,4,7,9-11,13,16,17,19,22-26,28-35,39,41, 44; **B** - 4,6-17; **C** - 2-5,9,11,14,18,21,22; **D** - 1,4,5; **E** - 1,2,4-6; **F** - 1-4,8; **G** - 3,4,6-8; **H** - 3,4; **I** - 1-3,5; **J** - 2; **L** - 1,4; **M** - 1, 3,8,12-14; **N** - 1,2; **O** - 1; **P** - 4-16; **Q** - 1 - 3; **S** - 2-5,7-10,14,15; **T** - 1-3,6,7,9,12,13; **U** - 1; **Z** - 1,3,4.

Cz I.4 - **A** - 1-4,7,10,11,13,16,17,19,22-26,28-32,34 - 36,39,41,44; **B** - 4,6-17; **C** - 2-8,9,14, 18,21, 22; **D** - 1,4,5; **E** - 1,2,4-6; **F** - 1-4,8; **G** - 3-4,6-8; **H** - 3,4; **I** - 1-5; **J** - 2;**K** -1; **L** - 1-4; **M** - 1,3,5,8,12-14; **N** - 1,2; **O** - 1; **P** - 4- 16; **Q** - 1 - 3; **S** - 1-5,7-10,14,15; **T** - 1-3,6,7,9,12-14; **U** - 1; **Z** - 1

Cz II. Eastern Himamlayan Region

Cz II.1 - **A** - 1,3,4,7,10,11,13,14,16,17,19,22-26,28-36, 39-41; **B** - 1,4,6-17; **C** - 2-5,7-11,13-16,18, 20-22; **D** - 1,2,4,5,6; **E** - 1,2, 4-6; **F** - 1-4; 8; **G** - 6-8; **H** - 3, 4; **I** - 1-3, 5; **J** - 2; **L** - 1-3; **M** - 1,3,8,9,12-14; **N** - 1-2; **O** - 1; **P** - 4-6, 10 - 14; **Q** - 1-3; **R** -1; **S** - 1-5,1-10,15; **T** - 1-3, 5-7,9,11,13,14; **U** - 1; **Z** - 1

Cz II.2 - **A** - 1,3,4,7,8,10,11,13,14,16-26,28-36, 39-44; **B** - 1-4,6-17; **C** - 2-9,11,13-16,18-22; **D** - 1-6,8; **E** - 1-6; **F** - 1-8; **G** - 3,4,6-8; **H** - 3,4; **I** - 2,3,5; **J** - 1,2; **L** - 1-4; **M** - 1-3, 5, 8, 9,12-14; **N** - 1,2; **O** - 1; **P** - 4-6, 10-14,16, 21; **Q** - 1-2; **S** - 2-5,7-10,15,20; **T** - 1-3, 5-7,11,13,14; **U** - 1; **Z** - 1

Cz II.3 - **A** - 1,3,4,7,8,10,11,13,14,16-26,28,29,32-36, 39-44; **B** - 1-4,6-17; **C** - 2-9,11,13-16,18-22; **D** - 1-8; **E** - 1-6; **F** - 1-8; **G** - 3,4,6-8; **H** - 3,4; **I** - 2,3,5; **J** - 1,2; **L** - 1-4; **M** - 1-3,5, 8,9,12-14; **N** - 1,2; **O** - 1; **P** - 4-10,12-16,21; **Q** - 1-3;**R** - 1; **S** - 2-5,7-10,15,20; **T** - 1-3, 5-7,11,13,14; **U** - 1; **Z** - 1

Cz II.4 - **A** - 1,3-5,7,8,10,11,13,14,16-26,28-44; **B** - 1-4, 6-17; **C** - 2-9,11,13-16, 18-20; **D** - 1-5,8; **E** - 1-6; **F** - 1-8; **G** - 3-4,6-8; **H** - 2-4; **I** - 1-3,5; **J** - 1,2; **K** -1; **L** - 1-4; **M** - 1-3,5,8,9, 12-14; **N** - 1,2; **O** - 1; **P** - 2,4-16,20,21; **Q** - 1 - 3; **R** -1;**S** - 1-5,7-10,15,20; **T** - 1-3,5-7,9,13,14; **U** - 1; **Z** - 1

Cz II.5 - **A** - 1,3,5,7,8,10-14,16-26,28,29,31-44; **B** - 1-4, 6-17; **C** - 1-9,11,13-16, 18-20; **D** - 1-8; **E** - 1-6; **F** - 1-8; **G** - 3,4,6-8; **H** - 2-4; **I** - 1-5; **J** - 1,2; **K** - 1; **L** - 1-4; **M** - 1-3,5,8,9, 12-14; **N** - 1,2; **O** - 1; **P** - 2,4-16,20,21; **Q** - 1 - 3; **R** -1; **S** - 1-5,7-10,15,20; **T** - 1-9,12, 14; **U** - 1; **Z** - 1

Cz III. Lower Gangetic Plains

(West Bengal)

Cz III.1 - **A** - 1,3-5,7,8,10-14,18-20,22,24-26,28-33,36-44; **B** - 1-10,12-16; **C** - 1-9,11-13,15-20, **D** - 1-4,7; **E** - 1-6; **F** - 1-8; **G** - 1,2-4,6-8; **H** - 3,4; **I** - 2-5; **J** - 1,2; **K** - 1; **L** - 1-4; **M** - 2, 3,5,6,8,9,11-14; **N** - 1,2; **O** - 1; **P** - 1,2,4-16,20,21; **Q** - 1 - 3; **R** -1; **S** - 1-13,15-20; **T** - 1-3,6,7,9,11-14; **Z** - 1,3,4.

Cz III.2 - **A** - 1,3-5,7,8,10-14,18-20,22,24-26,28-33,36-44; **B** - 1-10,12-16; **C** - 1-9,11-13,15-20, **D** - 1-5,7; **E** - 1-6; **F** - 1-8; **G** - 1,2-4,6-8; **H** - 1,3,4; **I** - 2-5; **J** - 1,2; **K** - 1; **L** - 1-4; **M** - 2,3,5,6,8,9,11-14; **N** - 1,2; **O** - 1; **P** - 1,2,4-16,20,21; **Q** -1-3; **R** -1; **S** - 1-13,15-20; **T** - 1-3,5-7,9-14; **Z** - 1,3,4.

Cz III.3 - **A** - 1,3-5,7,8,10-14,18-20,22,24-26,28-33,36-44; **B** - 1-10,12-17; **C** - 1-9,11-20, **D** - 1-5,7; **E** - 1-6; **F** - 1-8; **G** - 1-4,6-8; **H** - 1,3,4; **I** - 2-5; **J** - 1,2; **K** - 1; **L** - 1-4; **M** - 2,3,5,6,8,9,11-14; **N** - 1,2; **O** - 1; **P** - 1,2,4-16,20,21; **Q** - 1-3; **R** -1; **S** - 1-13,15-20; **T** - 1-14; **U** - 1; **Z** - 1,3,4.

Cz III.4 - **A** - 1,3-5,7,8,10-14,18-20,24-33,36-41; **B** - 1-10,12-16; **C** - 1-8,11-13,15-20; **D** - 1-5,7; **E** - 1-6; **F** - 1-6; **G** - 1,2-4,6-8; **H** - 1,3,4; **I** - 2-5; **J** - 1; **K** -1; **L** - 1-4; **M** - 2,3,5,6,8, 9,11-14; **N** - 1,2; **O** - 1; **P** - 1,2,4-16,20,21; **Q** - 1-3; **R** - 1; **S** - 1-13,15-20; **T** - 1-7,9-14; **Z** - 4.

Cz IV. Middle Gangetic plains.

Cz IV.1 - **A** - 1, 3, 4,7,10-15,18,20,22,24-26,28-33,36-42,44; **B** - 1-4,6-10,12-16; **C** - 2-13,15,16,18-20; **D** - 1-5,7; **E** -1-5; **F** - 1-3,5-7,9; **G** - 3,4,6-9; **H** - 1-4; **I** - 2,3,5; **J** - 1; **K** - 1; **L** - 1-4; **M** - 2,3,5,6,8,9,11-14; **N** - 1,2; **O** - 1; **P** - 1,2,7-9, 12-16,20,21; **R** -1; **S** - 1-15,20; **T** - 1-4,6,7,9-12,14 **Z** - 1,3,4.

Cz IV.2 - **A** - 1,3,4,7,10-15,18-20,21,24-26,28-30,32,33,36-44; **B** - 1-4,6-10,12-17; **C** - 2-13,15-20; **D** -1-8; **E** - 1-3,5; **F** - 1-7,9; **G** - 3,4,6-9; **H** - 1-4; **I** - 2-5; **J** - 1; **K** - 1; **L** - 1-4; **M** - 2,3,5,6,8,9,11-14; **N** - 1,2; **O** - 1; **P** - 1,2,5-9,12-16,20, 21; **R** - 1; **S** 1-15,20; **T** - 1-4,6,7,9-12,14; **Z** - 1,3,4.

Cz V. Upper Gangetic Plains

(Uttar Pradesh)

Cz V.1 - **A** - 1-5,7,10-15,18,20-22,24-33,36-41,44; **B** - 1-4, 6-10,12-15,17; **C** - 2-16,18-20; **D** - 1-4,6-7; **E** - 2-5; **F** - 1-3,5-7,9; **G** - 3,4,6-9; **H** - 2-4; **I** - 1-5; **J** - 1,2; **K** - 1; **L** - 1-4; **M** - 2,3,5,8-14; **N** - 1,2; **O** - 1; **P** - 1-3, 5,7-9, 12-16, 19-21; **R** - 1; **S** - 1-17, 20; **T** -1-3,6, 7,9-12,14; **Z** - 1,3,4.

Cz V.2 - **A** - 1-5,7,10-15,18,20-22,24-33,36-44; **B** - 1-4, 6-10,12-15.17; **C** - 2-12,15,16,18-20; **D** - 1-5,7,8; **E** - 2-5; **F** - 1-3,5,7,9; **G** -3,4,6-9; **H** - 1-4; **I** - 1-5; **J** - 1,2; **K** - 1; **L** - 1-4; **M** - 2,3,5,8-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7-9,12-16,19-21; **R** - 1; **S** - 1-17,20; **T** - 1-3,6,7,9-12,14; **Z** - 1,3,4.

Cz V.3 - **A** - 1-5,7,10-15,18,20-22,24-26,28-33,36-44; **B** - 1,3,4,6-10,12-15,17; **C** - 2-12,15,16,18-20; **D** - 1-5,7,8; **E** - 2-5; **F** - 1-3, 5-7,9; **G** - 3,4,6-9; **H** - 1-4; **I** - 1-5; **J** - 1,2; **L** - 1-4; **M** - 2,3,5,8-14; **N** - 1,2; **O** -1; **P** - 1-3,5,7,9,12-16,19-21; **R** - 1; **S** - 1-15,20; **T** - 1-4,6,9-12,14; **Z** - 1,3,4.

Cz VI. Trans Gangetic Plains

Cz VI.1 - **A** - 1-5,7,8,10-15,18,20,22,24-27,29-32,36-42, 44; **B** - 1-4,6-10,12-15,17; **C** - 2-13,15,16,18, 20; **D** - 1-8; **E** - 1-5; **F** - 1-3, 5-7,9; **G** - 3-4,6-9; **H** - 1-4; **I** - 1,3,4; **J** - 2; **K** - 1; **L** - 1-4, **M** - 2,5,8-14; **N** - 1,2; **O** - 1; **P** - 1-16,18-21; **R** - 1; **S** - 1-13,15,20; **T** - 1-3,6,7,9,11,14; **U** - 1; **Z** - 1,3,4.

Cz VI.2 - **A** - 1-5,7,8,10-15,18,20,22,24-26,29-32,36-42, 44; **B** - 1-4,6-10,12-15,17; **C** -2-13,15,16,18, 20; **D** - 1-6,8; **E** - 1-5; **F** - 1-3,5-9; **G** - 3-4,6-9; **H** - 1-4; **I** - 1-3,5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,3,5,8-14; **N** - 1,2; **O** - 1; **P** - 1-3,7,9,12,15-17,19; **R** - 1; **S** - 1-13, 15,20; **T** - 1-3,6,7,9-12, 14; **U** - 1; **Z** -1-4.

Cz VI.3 - **A** - 1-5,7,8,10-15,18,20,22,24,26,29-32,36-42, 44; **B** - 1,3,4,6-10,13-14,17; **C** - 2-13,15,16,18,20; **D** - 2-8; **E** - 3,5; **F** - 1-3,5-7,9; **G** - 3,4,6-9; **H** - 1-4; **I** - 1-5; **J** -2; **K** - 1; **L** -1-4; **M** - 2,5,8-14; **N** - 1,2; **O** - 1; **P** - 1-3,7-9,12,15-17, 19-21; **R** - 1; **S** - 1-13,20; **T** - 1-4,6,9-11,14; **U** - 1; **Z** - 1-4.

Cz VII. Eastern Plateau and Hills.

Cz **VII.1** - **A** - 1,3,4,6,7,10-15,18-22,25,27,29-32,36-44; **B** - 1,3,4,6-10, 12-16; **C** - 2-11,13,15,16,18-20; **D** - 2-8; **E** - 2-5; **F** -1-7,9; **G** - 3,4,6,8,9; **H** - 1-3,5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1-4; **M** -2-5,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7-9;12,13, 15,16,19-21; **R** - 1; **S** - 5-18,20; **T** - 1-7,9-12; 14; **Z** - 1-4.

Cz **VII.2** - **A** - 1,3,4,7,10,11,13-15,18-22,25,27,29-32,36-44; **B** - 1-4,6-10,12-16; **C** - 2-11,13,15,16,18-20; **D** - 2-8; **E** - 1-5; **F** - 1-7,9; **G** - 3,4,6,8, 9; **H** - 1-3,5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,3,5,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7, 9;12,13,15,16,20,21; **R** - 1; **S** - 5-18,20; **T** - 1-7,9,11,14; **Z** - 1-4.

Cz **VII.3** - **A** - 1,3,5,7,10-15,18-20,22,25,27, 29-32, 36-44; **B** - 1-4,6-10,12-16; **C** - 2-11,13,15,16, 18-20; **D** - 2-8; **E** - 1-5; **F** - 1-7,9; **G** - 3,4,6,8,9; **H** - 1-3,5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,3,5,9-14; **N** - 1,2; **O** - 1; **P** - 1,2,5,7-9;12- 15,16,20,21; **R** - 1; **S** - 5,6,9, 13-16, 18, 20; **T** -1-7,9-12,14; **Z** - 1-4.

Cz VII.4 - **A** - 1,3-5,7,10-15,18-20,22,25,27, 29-32, 36-44; **B** - 1-4,6-10,12-16; **C** - 2-11,13,15,16, 18-20; **D** - 2-8; **E** - 1-5; **F** - 1-7,9; **G** - 3,4,6,8,9; **H** - 1-3,5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,3,5,9,11-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7-9; 12,15,16,20,21; **R** -1; **S** - 5,6,9-16,18-20; **T** - 1-7,9-12,14; **Z** - 1-4.

Cz VII.5 - **A** - 1,3-5,7,10-15,18-20,22,25-27, 29-32, 36-44; **B** - 1-4,6-10,12-16; **C** - 2-11,13,15,16, 18-20; **D** - 2-8; **E** - 1-5; **F** - 1-7,9; **G** - 3,4,6,8,9; **H** - 2-5; **I** - 1-3,5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,3,5,9,10-14; **N** - 1,2; **O** - 1; **P** - 1,3,7,9;12,15,16,20,21; **R** -1; **S** - 5,6,13-15,18-20; **T** - 1-7,9-12,14; **Z** - 1-4.

Cz VIII. Central Plateau and Hills.

Cz VIII.1 - **A** -1-4,7,10-15,18,20,22,24-27, 29-32, 36-44; **B** - 1-4,6-10,13-17; **C** - 2-9,11,13,15,16,18-20; **D** - 2-8; **E** - 2-5; **F** - 1-7,9; **G** -3,5,9; **H** - 1-3,5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,3,5,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7-9,14-16,19-21; **R** -1; **S** - 5,6,8-13,20; **T** - 1-3,6,9,10,12,14; **Z** - 1-4.

Cz VIII.2 - **A** -1-4,7,10,11,13,14,18,20,22,24,25,27,29-44; **B** - 1-4,6-10,12-17; **C** - 2-9,11,13,15,16,18-20; **D** - 2-8; **E** -2-5; **F** -1-7,9; **G** - 3-9; **H** - 1-3,5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,3,5,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7-9,14-16,19-21; **R** -1; **S** - 5,6,8-13,20; **T** - 1-3,6,9,10,12,14; **Z** - 1,3,4.

Cz VIII.3 - **A** - 1,3,4,8,10,11,13,14,18,20,22,25,27,29-32,36-44; **B** - 2-4,6-10,12-16; **C** - 2-11,13, 15, 16,18-20; **D** -2-8; **E** -1,3-5; **F** -1,7,9; **G** - 3-6,8,9; **H** - 1-3,5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,3,5,9-11; **N** - 1,2; **O** - 1; **P** - 1-3,5,7,9,14-16,19-21;**R** -1; **S** - 5-15,20; **T** - 1-4,6,7,9,11,14; **Z** - 1,3,4.

Cz VIII.4 - **A** -1,3,4,8,10,11,13,14,18,20,22,25,27,29-32,36-44; **B** - 1-4,6-10,12,14-17; **C** - 2-11,13,15,16,18-20; **D** - 2-8; **E** - 1,3-5; **F** - 1,7,9; **G** - 3-6,8,9; **H** - 1-3,5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,3,5,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7,9,14, 16,19-21; **R** - 1; **S** - 5-13,20; **T** - 1-4,6,7,9,11, 14; **Z** - 1,3,4.

Cz VIII. 5 - **A** - 1,3,4,8,10,11,13,14,18,20,22,25,27,29-32,36- 44; **B** - 1-4,6-10,12,14-17; **C** - 2-11,13,15,16,18-20; **D** -2-8; **E** -1-5; **F** -1-7,9; **G** - 3-6,8,9; **H** - 1-3,5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2-5,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7,9,16,19-21;**R** -1; **S** - 5,6,8-13,20; **T** - 1-3,6,9,10,12,14; **Z** - 1,3,4.

Cz VIII.6 - **A** - 1,3,4,8,10,11,13,14,18,20,22,25,27,29-32,36-44; **B** - 1,3,4,6-10,12-17; **C** - 2-11,13,15,16,18 -20; **D** -2-8; **E** -1-5; **F** -1-7,9; **G** - 3-6,8,9; **H** - 1-3,5; **I** - 1-3,5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2, 3,5,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,7,9,14-16,19-21; **R** - 1; **S** - 5,6,8-13,20; **T** - 1 - 3,6,9, 10,12,14; **Z** - 1,3,4.

Cz VIII.7 - **A** - 1,3,4,8,10,11,13,14,18,20,22,25,27,29,32,36-44; **B** - 1,3,4,6-10,12-17; **C** - 2-11,13,15, 16,18-20; **D** -2-8; **E** -1-5; **F** -1-7,9; **G** - 3-6, 8; **H** - 1-5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1,4; **M** - 2,3,5, 9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7-9,14-16,19,20; **R** - 1; **S** - 5,6,8-13,20; **T** - 1 - 3,6,9, 10,12,14; **Z** - 1,3,4.

Cz VIII.8 - **A** - 1-4,7,8,10,11,13-15,18,20,22,25,29,32,36-44; **B** - 1,3,4,6-10,12-17; **C** - 2-11,13,15,16, 18 -20; **D** -2-8; **E** -1-5; **F** -1-7,9; **G** - 3-6,8; **H** - 1-3,5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1,4; **M** - 2,5, 9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7-9,14-16,19-21; **R** - 1; **S** - 5,6,8-13,18,20; **T** - 1-4,6,7,9,12,14; **Z** - 1-4.

Cz VIII.9 - **A** - 1-5,8,10,11,13-15,20,22,25,29,30,32, 36-44; **B** - 1,3,6-10,12-14,16,17; **C** - 1-11, 13,15, 16,18-20; **D** - 2-7; **E** - 1-5; **F** - 1-7,9; **G** - 3-6,8; **H** - 1-3,5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,5, 9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7,9,15, 16,19-21; **R** - 1; **S** - 5,6,8-13,18,20; **T** - 1-4,6,7,9,10-12,14; **Z** - 2,3,4.

Cz VIII.10 - **A** - 1-5,8,10,11,13-15,20,22,25,29,30,32,36-44; **B** - 2,3,6-10,12-14,16,17; **C** - 2-10,13,15, 16,18-20; **D** - 2-7; **E** - 1-5; **F** - 1-7,9; **G** - 3-

6,8; **H** - 1-3.5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,5. 9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7,9,15, 16,19-21; **R** - 1; **S** - 5,6,8-13,20; **T** - 1-4,6,7,9 -12,14; **Z** - 1,3,4.

Cz VIII.11 - **A** - 1-5,7,8,10,11,13-15,18,20,22,25,29,30,32, 36 -38,40-44; **B** - 1,3,6-10.12-14,16,17; **C** - 2,4, 6-10,15,18-20; **D** - 2-7; **E** - 1-5; **F** - 1-7,9; **G** - 3-6,8; **H** - 1-3,5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,5,9,11-14; **N** - 1,2; **O** - 1; **P** - 1,2,5,7,9, 14-16,19-21; **R** - 1; **S** - 5,6,8-13,20; **T** - 1-4,6, 9-12,14; **Z** - 2,3,4.

Cz VIII.12 - **A** - 1-5,8,10,11,13-15,18,20,22,25,27,29,30, 32, 36-44; **B** - 1-3,6-10,13,14,16,17; **C** - 2,4,6-8, 13-15,18,20; **D** - 2,3,5-7; **E** - 1-5; **F** - 1-7,9; **G** - 3-6,8; **H** - 1-3,5; **I** - 3,5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,3,5,9-12,14; **N** - 1,2; **O** - 1; **P** - 1-3, 5,7,9,14-16,19-20; **R** - 1; **S** - 5-13,20; **T** - 1-4, 6,9,11,14; **Z** - 1-4.

Cz VIII.13 - **A** - 1-5,7,10,11,13-15,18,20,22,25,29,30, 32,36-44; **B** - 1-3,6-10,13,14,16,17; **C** - 2,4,6-8,13, 18,20; **D** - 2,3,5-7; **E** - 1-5; **F** - 1-7; **G** - 3-6, 8; **H** - 1-3,5; **I** - 3,5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,9,11,12,14; **N** - 1,2; **O** -

1; **P** - 1-3,7,9,14, 15,19-21; **R** -1; **S** - 5,6,8-13,20; **T** - 1-4,6,9, 11,14; **Z** - 1-4.

Cz VIII.14 - **A** - 1-5,7,10,11,13-15,20,22,25,29,30,32,36-38, 41,44; **B** - 1,3,6-10,13,14,16; **C** - 2,4,6-8,13, 18,20; **D** - 2,3,5,7; **E** - 1-5; **F** - 1-7; **G** - 3-6, 8; **H** - 1-3,5; **I** - 3,5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,5,8,10-12,14; **N** - 1,2; **O** - 1; **P** - 1-3,7,9, 14-16,19-21; **R** - 1; **S** - 5,6,8-13,20; **T** - 1-4,6, 9, 11,14; **Z** - 1-4.

Cz IX Western Plateau and Hills.

Cz IX. 1 - **A** -1-3,7,10,11,13-15,18-20,22,25,27,29-32, 36-44, **B** - 1-4,6-10,12-17; **C** - 1-13,15,16,18-20; **D** - 2- 8; **E** - 1-5; **F** - 1-7,9; **G** - 1,3-9; **H** - 1-3,5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2-6,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7-9, 14-16,19-21; **R** - 1; **S** - 5-15,18,20; **T** - 1-4,6,7,9,11,12,14; **Z** - 1-4.

Cz IX. 2 - A - 1-3,7,10-15,18-22,25,27,29-44, **B** - 1-4,6-10, 12-17; **C** - 1-13,15,16,18-20; **D** - 2-8; **E** - 1-5; **F** - 1-7,9; **G** - 3-8; **H** - 1-3,5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2-5,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7,9,14-16,19-21; **R** - 1; **S** - 5-20; **T** - 1-4,6,7,9-12,14; **Z** - 1-4.

Cz IX. 3 - **A** - 1-5,7,10-15, 18-20,22,25,27, 29-32,36-44, **B** - 1-4,6-10,12-17; **C** - 1-13,15,16,18-20; **D** - 2-8; **E** - 1-5; **F** - 1-7,9; **G** - 3-9; **H** - 1-3,5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2-6,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7-9,14-16,19-21; **R** - 1; **S** - 5-17, 20; **T** - 1-4,6,7,9,11,12,14; **Z** - 1-4.

Cz IX. 4 - A -1-3,7,10-15,18-22,25,27,29-32,36-44, **B** - 2-4,6-10,12-17; **C** - 1-13,15,16,18-20; **D** - 2-8; **E** - 1-5; **F** - 1-7,9; **G** - 3-9; **H** - 2-5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,5,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7,9,14,16,19-21; **R** - 1; **S** - 5,6,8-17, 20; **T** - 1-4,6,7,9-11,12,14; **Z** - 1-4.

Cz X. Southern Plateau and Hills Region.

Cz X. 1 - **A** - 1-3,6-8,10-15,19-22,25,27-33,36-44, **B** - 1-4,6-10,12-17; **C** - 1-11,13,15-20; **D** - 2- 8; **E** - 1-5; **F** - 1-7,9; **G** - 3-9; **H** - 1-3,5; **I** - 1,3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2-5,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7-9,14-16,19-21; **R** - 1; **S** - 5,6,9-20; **T** - 1-7,9,11,12,14; **Z** - 1-4.

Cz X. 2 - A - 1-3,6-8,10-15,19-22,25-44, **B** - 1-4,6-10,12-17; **C** - 1-11,13,15,16,18-20; **D** - 2-8; **E** - 1-5; **F** - 1-7,9; **G** - 3-9; **H** - 1-3,5; **I** - 3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2-5,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7-9,14-16,19-21; **R** - 1; **S** - 5,6,9-20; **T** - 1-7,9,11,12,14; **Z** - 1-4.

Cz X. 3 - **A** - 1-3,6,8,10-15,18-22,25-32,36-44, **B** - 1-4,6-10,12-17; **C** - 1-11,13,15,16,18-20; **D** - 2-8; **E** - 1-5; **F** - 1-7,9; **G** - 3-6,8,9; **H** - 1-3,5; **I** - 3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2-5,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7-9,14-16,19-21; **R** - 1; **S** - 5, 6,9-20; **T** - 1-6,9,11,12,14; **Z** - 1-4.

Cz X. 4 - A - 1-3,6-15,18-22,25,27-33,36-44, **B** - 1-4,6-10, 12-17; **C** - 1-11,13,15,16,18-20; **D** - 2-8; **E** -

1-5; **F** - 1-7,9; **G** - 3-6,8,9; **H** - 2,3,5; **I** - 1,3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2-5,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7-9,14-16,19-21; **R** - 1; **S** - 5, 6,9-20; **T** - 1-6,9,11,14; **Z** - 1-4.

Cz X. 5 - **A** - 1-3,6-15,18-22,25,27,28,30-32,36-40, **B** - 1-4,6-10,12-16; **C** - 1-11,13,15,16,18-20; **D** - 2-8; **E** - 1-5; **F** - 1-7,9; **G** - 3-6,8,9; **H** - 2,3,5; **I** - 3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2-5,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7,9,14-16,19-21; **R** - 1; **S** - 5-20; **T** - 1-6,9,11,14; **Z** - 1-4.

Cz X. 6 - **A** - 1-3,6-8,10-15,19-22,25,27-33,36-44, **B** - 1-4,6-10,12-17; **C** - 1-11,13,15,16,18-20; **D** - 2-8; **E** - 1-5; **F** - 1-7,9; **G** - 3-6,8,9; **H** - 1-3,5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2-5,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7,9,14-16,19-21; **R** - 1; **S** - 5-20; **T** - 1-7,9,11,14; **Z** - 1-4.

Cz XI. East Coast Plains and Hills Region.

Cz XI. 1 - **A** - 1-3,6-8,10,11,13,14,18,19-22,25-32,36-44, **B** - 1-10,12-16; **C** - 1-20; **D** - 1-8; **E** - 1-5; **F** - 1-7,9; **G** - 1-6,8,9; **H** - 1-3,5; **I** - 3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2-6,9-14; **N** - 1; **O** - 1; **P** - 1-3,5,7-9,14,16,19-21; **R** - 1; **S** - 5,6,8-20; **T** - 1-3,5-12,14; **Z** - 1-4.

Cz XI. 2 - **A** - 1,3,6-8,10-15,18-22,25-32,36-44, **B** - 1-10, 12-17; **C** - 2-20; **D** - 1-8; **E** - 1-5; **F** .-1-7,9; **G** - 1-6,8,9; **H** - 1-3,5; **I** - 1,3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2-6,9-14; **N** - 1; **O** - 1; **P** - 1-3,5,7-9,14,16,19-21; **R** - 1; **S** - 5,6,8-20; **T** - 1-3,5-12,14; **Z** - 1-4.

Cz XI. 3 - **A** - 1-3,6-8,10-15,18-22,25-32,36-44, **B** - 1-10,12-17; **C** - 1-20; **D** - 1-8; **E** - 1-5; **F** -1-7,9; **G** - 1-6,8,9; **H** - 1-3,5; **I** - 1,3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2-6,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,7-9,14-16,19-21; **R** - 1; **S** - 5,6,8-20; **T** - 1-3, 5-12,14; **Z** - 1-4.

Cz XI. 4 - **A** - 1-3,6-15,18-22,25,27-32,36-44, **B** -1-10, 12-17; **C** - 1-20; **D** - 1-8; **E** - 1,3-5; **F** - 1-7,9; **G** - 1-6,8,9; **H** - 1-3,5; **I** - 3-5; **J** - 2;

K - 1; **L** - 1-4; **M** - 2-6,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,7-9,14-16,19-21; **R** - 1; **S** - 5,6,8-20; **T** - 1-3,5-12,14; **Z** - 1-4.

Cz XI. 5 - **A** - 1-3,6-15,18-22,25,27,32,36-44, **B** -1-10, 12, 14-17; **C** - 1-20; **D** - 1-8; **E** - 1-5; **F** - 1-7,9; **G** - 1-6,8,9; **H** - 1-3,5; **I** - 1,3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2-6,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,7-9, 14-16,19-21; **R** - 1; **S** - 5-20; **T** -1-3,5-9,11,14; **Z** - 1-4.

Cz XI. 6 - **A** - 1-3,6-15,18-22,25,27-32,36-44, **B** -1-10, 12-14,16,17; **C** - 1-20; **D** - 1-8; **E** - 1-5; **F** - 1-7,9; **G** - 1-6,8,9; **H** - 1-3,5; **I** - 3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2-6,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,7-9,14-16,19-21; **R** - 1; **S** - 5-20; **T** - 1-3,5-12,14; **Z** - 1-4.

Cz XII. West Coast Plains and Ghat Region.

Cz XII. 1 - **A** - 1,3,4,6-8,10-15,18-22,25,27-33,36-44, **B** - 1-10,12-17; **C** - 1-20; **D** - 1-8; **E** - 1-5; **F** - 1-7,9; **G** - 1-6,8; **H** - 2,3,5; **I** - 1,3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2-6,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5, 7-9,14-21; **R** - 1; **S** - 5-15,17-20; **T** -1-4,11,12, 14; **Z** - 1-4.

Cz XII. 2 - **A** - 1,3,4,6-15,18-22,25,27-33,36-44, **B** - 1-10, 12-17; **C** - 1-20; **D** - 1-8; **E** - 1-3,5; **F** - 1-7,9; **G** - 1-6,8; **H** - 2,3,5; **I** - 1,3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2-6,9-14; **N** - 1; **O** - 1; **P** - 1-3,5,7-9,14-21; **R** - 1; **S** - 5,6,8-13,15-20; **T** - 1-11,14; **Z** - 1-4.

Cz XII. 3 - **A** - 1,3,4,6-8,10-15,18-22,25,27-33,36-44, **B** - 1-10,12-17; **C** - 1-20; **D** - 1-8; **E** - 1-5; **F** - 1-7,9; **G** - 1-6,8; **H** - 1-3,5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2-6,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5, 7-9,14-21; **R** - 1; **S** - 5,8-20; **T** - 1-11,14; **Z** - 1-4.

Cz XII. 4 - **A** - 1,3,4,6-15,18-22,25,27-33,36-44, **B** - 1-10, 12-17; **C** - 1-20; **D** - 1-8; **E** - 1-5; **F** - 1-7,9; **G** - 1-6,8; **H** - 2,3,5; **I** - 1-5; **J** - 2; **K**

- 1; **L** - 1-4; **M** - 2-6,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7-9,14-21; **R** - 1; **S** - 5-20; **T** - 1-9, 11,12,14; **Z** - 1-4.

Cz XIII. Gujarat Plains and Hill Region.

Cz XIII.1 - **A** - 1-6,10,11,13-15,18,20,22,25,27,29-32,36-44, **B** - 1-4,6-10,12-14,17; **C** - 2-20; **D** - 2-8; **E** - 1-5; **F** - 1-7,9; **G** - 3-9; **H** - 1-3,5; **I** - 1,3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,3,5,6,9-14; **N** - 1; **O** - 1; **P** - 1-3,5,7-9,14-21; **R** - 1; **S** - 5,6.8-14,17-20; **T** -1-4,6-12,14; **Z** - 1-4.

Cz XIII.2 - **A** - 1-6,10,11,13-15,18,20,22,25,27,29-32,36-44, **B** - 1-4,6-10,12-14,17; **C** - 2-18; **D** - 2-8; **E** - 1-5; **F** - 1-7,9; **G** - 3-5,9; **H** - 1-3,5; **I** - 1,3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,3,5,6,9-14; **N** - 1; **O** - 1; **P** - 1-3,5,7-9,14-21; **R** - 1; **S** - 5,6.8-14,16,17,20; **T** - 1-4,6-12,14; **Z** - 1-4.

Cz XIII.3 - **A** - 1-6,10,11,13-15,18,20,22,25,27,29-32,36-44, **B** - 2-4,6-10,12-14,17; **C** - 2-20; **D** - 2-8; **E** - 1, 3-6,8,9; **F** - 1-7,9; **G** - 3-9; **H** - 2,3,5; **I** - 3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,3,5,6,9-14; **N** - 1; **O** - 1; **P** - 1-3,5,7-9,14-21; **R** - 1; **S** - 5,6.8-14,16,17,20; **T** - 1-4,6-12,14; **Z** - 1-4.

Cz XIII.4 - **A** - 1-6,10,11,13-15,20,22,25,27,29-32,36-44, **B** - 1,6-10,12-14,17; **C** - 2-20; **D** - 2-8; **E** - 1-5; **F** - 1-7,9; **G** - 3-9; **H** - 1-3,5; **I** - 1,3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,3,5,6,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7-9,14-21; **R** - 1; **S** - 5,6,9-13,15-17,20; **T** - 1-4,6,8,12,14; **Z** - 1-4.

Cz XIII.5 - **A** - 1-6,10,11,13-15,18,20,22,25,27,29-32,36-44, **B** - 1,6-10,12-14,17; **C** - 2-20; **D** - 2-8; **E** - 1-5, **F** - 1-7,9; **G** - 3-9; **H** - 1,3,5; **I** - 1,3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,3,5,6,9-14; **N** - 1; **O** - 1; **P** -1-3,5,7-9,14-21; **R** - 1; **S** - 5,6,9-13,15-17, 20; **T** - 1-4,6,8-12,14; **Z** - 1-4.

Cz XIII.6 - **A** - 1-6,10,11,13-15,18,20,22,25,27-32,36-44, **B** - 1-3,6-10,12-14,17; **C** - 2-20; **D** - 2-8; **E** - 1-5; **F** - 1-7,9; **G** - 3-5,9; **H** - 1-3,5; **I** - 1,3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,3,5,6,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7-9,14-21; **R** - 1; **S** - 5,6,9-13,15-20; **T** - 1-4,6-12,14; **Z** - 1-4.

Cz XIII.7 - **A** - 1,3-7,10,11,13-15,18,20,22,25,27-32,36-44, **B** - 1,2,6-10,12-14,16,17; **C** - 2-20; **D** -

2-8; **E** - 1-5; **F** - 1-7,9; **G** - 3-9; **H** - 1-3; **I** - 3-5; **J** - 2; **K** - 1; **L** - 1-4; **M** - 2,3,5,6,9-14; **N** - 1,2; **O** - 1; **P** - 1-3,5,7-9,14-21; **R** - 1; **S** - 5,6,9-13, 15-17,20; **T** - 1-4,6-12,14; **Z** - 1-4.

Cz XIV. Western Dry Region

Cz XIV. - **A** - 1-7,10,11,13-15,20,22,27,29-32,37,38, 41,44; **B** - 1-3,6-10,12-14,17; **C** - 2-5,13,18; **D** - 2,5,8; **E** - 2-5; **F** - 1-7,9; **G** - 3,4,9; **H** - 2-5; **I** - 3,5; **L** - 3,4; **M** - 2,5,14; **N** - 1; **O** - 1; **P** - 2,,7,9,15-21; **R** - 1; **S** - 6,8,10-12,15,20; **T** - 1-4,6,9,14; **Z** - 1-4.

Cz XV. The island Region.

(Andaman, Nicobar And Lakshadweep)

Cz XV. - **A** - 1-3,5-7,9-13,18-20,22,24,25,27,30-32,37-44, **B** - 1-10,12-17; **C** - 1-20; **D** - 1-8; **E** - 1-6; **F** - 1-7,9; **G** - 1-9; **H** - 1-3,5; **I** - 1-5; **J** - 2; **K** - 1; **L** - 1,4; **M** - 1-3,5,6,8-14; **N** - 1,2; **O** - 1; **P** - 1-3,5-9,12,15-21; **R** - 1; **S** - 1,5,6,8,15-18,20; **T** -1-14 **Z** - 1-4.

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