

A MANUAL FOR URBAN GREENING IN MMR

Survey of biological resources in forest areas in MMR to develop strategic manual for rejuvenation of native plant species, in and around urban Mumbai.

MMR

ENVIRONMENT IMPROVEMENT SOCIETY

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MANUAL FOR URBAN GREENING IN MMR REGION

Mumbai Metropolitan Region Environment Improvement Society

GRASSROOTS RESEARCH AND CONSULTANCY

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01
INTRODUCTION

PREPARING A CLUSTER

for space of minimum 3m. x 3m.



Cluster Plantation : Intermediate Stage



Cluster Plantation : Final Stage

ANNEXURE

Sr.No	Common Name	Scientific Name	Sexual Method	Plant Propagation	Vegetative Method	Time duration for formation of root	Sapling to maturity care (Remark)
Shrubs							
1	Kadu Mendi	Clerodendrum innere			Stem	15 days	shade require till root not come out because of evaporation
2	Sagargota	Caesalpinia bonduc	+	2-3 weeks			shade require till root not come out because of evaporation
3	Pilu/Meswak	Salvadora persica	+	3-4 weeks			shade require till root not come out because of evaporation
3	Waghati	Capparis zeylanica	+	2-3 weeks			shade require till root not come out because of evaporation
4	Rui	Calotropis gigantia	+	2-3 weeks			water regulation, sunlight, humid climate, pest & disease
Creek							
Trees							
1	Grey Mangrove	Avicennia marina	+	3-4 weeks			first 3 months maintenance require
2	Indian Mangrove	Avicennia officinalis	+	3-4 weeks			first 3 months maintenance require
3	Sudarigan	Sonneratia caseolaris	+	4-5 weeks			first 3 months maintenance require
4	Mangrove apple	Sonneratia apetala	+	4-5 weeks			first 3 months maintenance require
5	Orange mangrove	Bruguiera cylindrica	+	4-5 weeks			first 3 months maintenance require
6	Kandel	Bruguiera gymnorliza	+	3-4 weeks			first 3 months maintenance require
7	Red mangroves	Rhizophora mucronata	+	3-4 weeks			first 3 months maintenance require
8	Geva	Excoecaria agallocha	+	3-4 weeks			first 3 months maintenance require
Herbs							
1	Spiny Barleria	Avicennia marina			Stem	15 days	water regulation, sunlight, humid climate, pest & disease
2		Sesuvium portulacastrum	+	2-3 weeks	Stem	15-20 days	first 3 months maintenance require
3	Herbaceous seepweed	Suaeda maritima	+	2-3 days			
Shrubs							
1	Sea Holly	Acanthus ilicifolius	+	3-4 days	Stem	15 days	water regulation, sunlight, humid climate, pest & disease

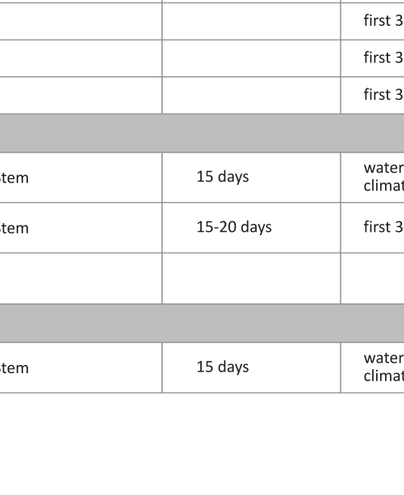
1.1 PROBLEMS WITH CURRENT PRACTICES

Biodiversity conservation is becoming a large concern with the rapid pace of urbanization in developing countries. Currently biodiversity conservation is limited to conservation of existing natural green areas, like National Parks and Sanctuaries. At the same time developmental tools and strategies are needed to make urban greens more richer in biodiversity.

The existing plantation practices tend to be superficial beautification exercises. Current tree planting practices involve monocultures of particular trees or fast growing exotic species which have limited biodiversity. Monoculture plantation may look green but does not enhance healthier ecological processes. In fact, such plantations are more vulnerable to plant diseases and insect pests in comparision to multi species plantations and harbour lower diversity. Moreover introduction of non native and exotic species are less adaptable than indigenous species.

This manual is potentially relevant to many urban contexts; 'public' and 'semi-public' landscape. It is inclusive of "difficult to categorise" mix of spaces around public housing, commercial development and institutions, car parks, left-over spaces from development, mass plantation of trees and shrubs and strips along paths, roads and other corridors. Taken as a whole, these often very ordinary places are the landscapes we are most familiar with and which inform and perhaps even shape our attitude to the world around us. In combination with private gardens, these urban spaces are also the landscapes where we have most of our first hand experiences of 'nature'.

It is interesting to establish that even after almost two centuries of experimentation, ecological planting can still be described as new, which suggests that it had never been part of mainstream practice. This needs to be changed by promoting this type of plantation in mainstream. Hence, this manual describes the way of using natural clusters in parks and gardens based on ecological rather than the purely aesthetic principles.







1.2 CONCEPTS OF CLUSTER PLANTATION

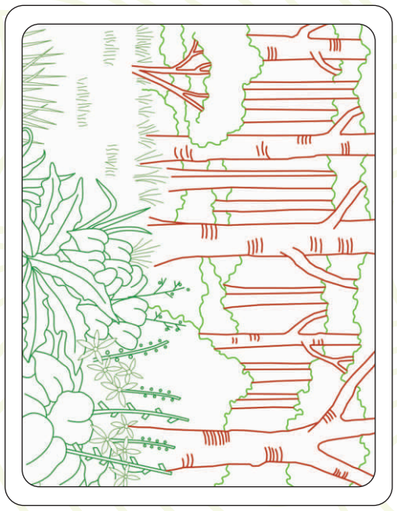
With the reduction of natural ground cover, mammals have very few habitats left in urban areas. This is the reason why at least half of the garden should remain "un-manicured". For instance, an owl feeds its young on small rodents like mice and voles. But the further it has to travel to find them; its young has far less chance of survival. Hence, the emphasis is on a more natural "un-manicured" garden with indigenous species wherever possible.

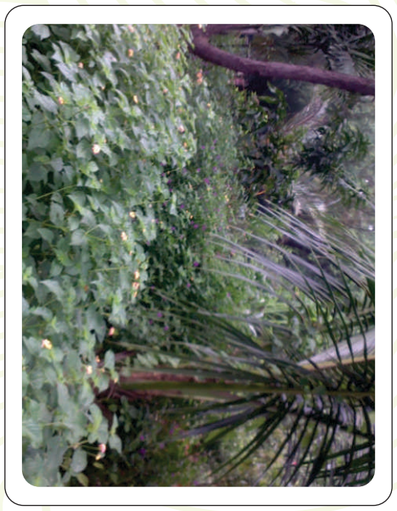
If some wild flower seeds around these designated areas are scattered around and the grass is left to grow, it will attract small mammals. Some berry trees, nut trees and hedgerow can be planted around the borders of the garden. The indigenous flora always tends to attract the animals through various ways.

Plants use color to great advantage, some brightly colored flowers attract insects that are essential for pollination. Bright red or yellow berries that attract birds, offer a meal for the bird and ensure that the enclosed seed will later be deposited in another area. The insects that are attracted towards these plants are often diet for birds which preys on them; this is also one of the ways for plants to attract the fauna. Compact vegetation should be allowed to grow in harmony. This brings up the concept of cluster plantations as they are known to exist in the wild.

Nature comprises of many plant clusters which live together in harmony under particular environmental conditions. These plant clusters can be defined as a group of heterogeneous plant species with homogeneous characters that promote their existence in a beneficial manner.

Heterogeneous plants are a varied group of plants different in plant habits i.e. herb, shrub, tree and comprising of different kind of species. Species which are different from each other in their genetic make-up may group together due to favourable environmental conditions forming plant clusters. These different species cluster together due to the availability of homogenous characters i.e. soil type, climate, nativity, other ecological factors and association with existing fauna. The homogenous characters thus act like a platform to promote homogeneity depending on heterogeneous plant growth. In this manner clusters are formed.







Sr.No	Common Name	Scientific Name	Sexual Method	Plant Propagation	Vegetative Method	Time duration for formation of root	Sapling to maturity care (Remark)
4	Palmyra palm	Borassus flabellifer	+	6 week			water regulation, sunlight, humid climate, pest & disease
5	Alexandra Laurel/ Sultan Champa	Calophyllum inophyllum	+	4-5 week			
6	Jackfruit tree	Artocarpus heterophyllus	+	4-5 week	Grafting	3 week	first 3-4 months maintenance require
7	Bhenda	Thespesia populnea	+	3 week			water regulation, sunlight, humid climate, pest & disease
8	Samudraphal	Barrigtonia asiatica	+	3-4 week	Stem cutting & Grafting	15 days	Use rooting harmone for earely rooting
9	Belpata	Hibiscus tiliaeceous	+	2-4 weeks	cutting	10-20days	shade require till root not come out because of evaporation
10	Sukanu	Cerbera manghas					
11	Kevada	Pandanus odoratus	+	2-4 weeks	Stem cutting & Grafting		shade require till root not come out because of evaporation
Herbs							
1	Spiniohex	Spiniphex sp	+				
2	Motha Gokharu	Pidalium murex	+				
3	Grass	Panicum pudum	+	10 days			shade require till root not come out because of evaporation
4	Grass	Zyosia matrella	+	1 week			shade require till root not come out because of evaporation
5	Grass	Aleuropus lagopoides	+	10 days			shade require till root not come out because of evaporation
6	Ardhaful	Scaevola taccada		2 -3 weeks	Stem	10-15 days	shade require till root not come out because of evaporation
7	Dhapa	Sesuvium portulacastrum		2 -3 weeks	Stem	10-15 days	shade require till root not come out because of evaporation
8		Uregina indica					
9		Glinus oppositifoliu	+	10 days			shade require till root not come out because of evaporation
Climbers							
1	Maryadvel	Ipomoea pes-caprae			Stem	15 days	shade require till root not come out because of evaporation
2	Karanjvel	Derris trifoliata	+	10 days			water regulation, sunlight, humid climate, pest & disease
3	Vel-ghani	Passiflora foetida	+	15 days			water regulation, sunlight, humid climate, pest & disease
4	Ran abai	Canavalia ensiformis	+	2-3 wekk			water regulation, sunlight, humid climate, pest & disease
5		Aristolochia indica	+	2 weeks			water regulation, sunlight, humid climate, pest & disease

1.3 ADVANTAGES OVER CURRENT PRACTICES

Promoting the culture of cluster plantation with associated species being indigenous in nature may prove beneficial in maintaining the ecological balance of the environment in urban areas. This type of cluster plantation will aid in conservation of native biodiversity-both flora and fauna.

The successful combination of different plant species is one of the main functions of planting design and landscape management. In traditional horticulture-based plantation design, aesthetic and functional considerations predominate: how do the different component species work together visually and how do they perform the tasks (such as dividing or filling the spaces) for which they have been designed. Biological questions relating to how plants interact with each other and their surrounding environment as a community or unit of vegetation, receive little or no consideration. This is mainly because the planting environment is generally modified to suit the requirements of standard landscape plants, whether this is through modification and importation of soils, fertilisation or irrigation, or through pruning and other maintenance operations, all of which entail an energy, labour and financial cost.

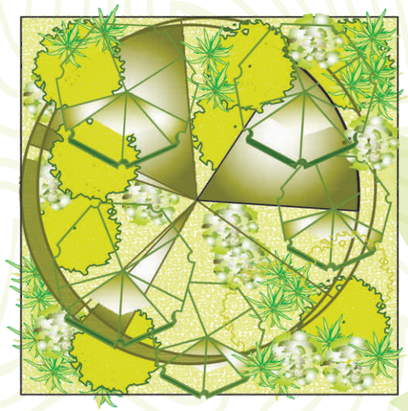
An ecological approach to landscape vegetation like cluster plantation can be radically different. Aesthetic and functional considerations can be equally applicable, but questions of ecological compatibility and long term dynamics are also a central concern.

The study of existing physiography at various urban locations can underline the current shortcomings in maintaining the required green areas. Studying the plantations of buffer areas, the areas on forest boundaries and green belts in the urban areas with human interference, can give us an idea about more tolerant plant species. These species might play a vital role in the initial period of plantation by supporting the cluster growth.

The outcome of this type of planting practice could define certain endemic species growing in forests that are suitable for urban planting and would slowly replace the exotic species. The native species being more adaptive, would be expected to promote a better environmental balance in terms of ecological associations between the floral and faunal species. Introducing adaptable species from forests would also break the monotony of monoculture at the urban sites.

Study of forest areas throws some light on the type of soil and other ecological conditions required for existence of a particular association and strategies could be developed to replicate similar conditions in the urban areas to foster cluster plantations beneficial for greening the proposed sites. The results of this study have been useful in formation of this "Plantation Manual" enlisting various useful species for urban greening and strategies for their cultivation and sustenance. This would help government agencies or private companies to implement the greening projects with ease.

The area under this study was one urban city i.e. Mumbai and the same model can be proposed for similar urban greening projects across the state and other urban cities in India.



PLAN OF CLUSTER PLANTATION / CLUSTER PALETTE

BIG TREE | MEDIUM TREE | SHRUBS | HERBS | PLANTS | CLIMBERS | GREEN COVER/GROUND COVER

Sr.No	Common Name	Scientific Name	Sexual Method	Plant Propagation	Vegetative Method	Time duration for formation of root	Sapling to maturity care (Remark)
Climbers							
1	Mayalu	Basela alba	+	3 week	Cutting	10-15 days	shade require till root not come out because of evaporation
2	Madhumalti	Quisqualis indicum	+	2 week	Stem	15 days	shade require till root not come out because of evaporation
3	Watermelon	Citrullus lanatus	+	15-20 days			proper sunlight, weatering, humid & cold climate
4	Ghosali	Luffa aegiptica	+	10 days			proper sunlight, weatering, humid & cold climate
5	Shirali	Luffa acutangula	+	2 weeks			water, moderate sun light& cold climate
6	Karli	Mymordica carentea	+	1-2 week			proper sunlight, weatering, humid & cold climate
7	Kartoli	Momordia dioica	+	2 weeks			proper sunlight, weatering, humid & cold climate
Shrubs							
1	Karda	Canna indica	+		Rhizome		water regulation, low sunlight, humid climate, pest & disease
2	Lobster claw	Heliconia rostrata	+		Rhizome		water regulation, low sunlight, humid climate, pest & disease
3	Lavasat	Mussaenda frondosa	+		Stem		shade require till root not come out because of evaporation
4	Jaswanda,China rose	Hibiscus rosa sinensus	+		Stem		shade require till root not come out because of evaporation
5	Curry patta,Curry leaves	Murraya koenigi	+		Stem		shade require till root not come out because of evaporation
6	Chandni	Tabernaemontana citrifolia	+		Stem		shade require till root not come out because of evaporation
7	Ananta	Gardenia jasminordis	+		Stem		shade require till root not come out because of evaporation
Tidal Water Buffer Zone (Coastal Vegetation)							
Trees							
1	Casurina/ Suru	Casuarina equisetifolia	+	4-5 week			watering, full sunlight for seed propagation and for stem propagation
2	Karanj	Pongamia pinnata	+	3 week	Stem	15 days	shade require till root not come out because of evaporation
3	Coconut palm	Cocos nucifera	+	5-6 week			water regulation, sunlight, humid climate, pest & disease

1.4 BENEFITS OF CLUSTER PLANTATION

Some of the benefits of Cluster Plantations include:

1) Aesthetics and visual pleasure: Cluster plantations have a rich assemblage of textures, forms and colours.

2) Cluster plantations are more stable: Introducing greater diversity into landscape plantings could be seen as an insurance policy against the failure of one or more component species caused by environmental disturbances such as climatic extremes or disease.

3) Supporting other types of organisms: In general, the greater the diversity of plant species in a unit of vegetation, the greater the diversity of other types of organism (e.g. birds and insects) that it supports, through the provision of a wider range of food sources or habitat opportunities (Knops et all 999).

4) Filling up available niches: It is a cliche that 'nature abhors a vaccum'. Bare ground rarely remains in that state for long. Most weed control in landscape plantings involves the removal of undesired plants from gaps between desired plants. These undesired plants, or weeds, are simply filling space that is not being exploited by the intended species. For example, bare ground beneath shrubs quickly colonises with aggressive species tolerant of light shade. By filling niches at the outset through the inclusion of additional species, for example by ensuring full groundcover throughout the year, and promoting a multi-layered vegetation structure, the need for weed control in this situation is reduced.

5) Valuing Ecological Services: Ecosystem services offer a variety of benefits. Economics normally classifies these benefits into three different categories: 'goods' (e.g. products obtained from ecosystems, such as resource harvests, water and genetic material), 'services' (e.g. recreational and tourism benefits or certain ecological regulatory functions, such as water purification, climate regulation, erosion control etc.) and 'cultural benefits' (e.g. spiritual and religious, heritage etc.).









PLAN OF CLUSTER PLANTATION / CLUSTER PALETTE

Sr.No	Common Name	Scientific Name	Sexual Method	Plant Propagation	Vegetative Method	Time duration for formation of root	Sapling to maturity care (Remark)
5	Ashok	Saraca asoka	+	3-4 weeks	Grafting	15 days for root formation	shade require till root not come out because of evaporation
6	Jamun, jabul	Syzyguim cumini	+	3-4 weeks			water regulation, sunlight, humid climate, pest & disease
7	Jarul	Euphorbia hereta	+	3-4 weeks			water regulation, sunlight, humid climate, pest & disease
Herb							
1	Bui awala	Phyllanthus niruri	+				water regulation, sunlight, humid climate, pest & disease
2	Maka	Eclipta erecta	+				water regulation, sunlight, humid climate, pest & disease
3	Bala	Sida acuta					water regulation, sunlight, humid climate, pest & disease
4	Fern	Nephrolepis exaltata	Spores	1 week	Rhizome	5 days	proper sunlight, weatering, humid & cold climate
5	Fern	Asplenium phelipenes	Spores	1 week	Rhizome	5 days	water regulation, sunlight, humid climate, pest & disease
6	Fern	Pteris longefolia	Spores	1 week	Rhizome	5 days	water regulation, sunlight, humid climate, pest & disease
Aquatic / Riperian Vegetation (Herbs)							
1	Ramban	Typha angustifolia	+		Rhizome	2 week	water, moderate sun light& cold climate
2	Shingada	Trapa bispinosa	+		Rhizome	1-2 week	water, moderate sun light& cold climate
3	Water lilies	Nymphia (all sps.)	+		Rhizome	2 week	water, moderate sun light& cold climate
4	Kamal	Nelumbium	+		Rhizome	1 week	water, moderate sun light& cold climate
5		Nymphiodis cristata	+		Rhizome	2 week	water, moderate sun light& cold climate
6		Marselia	Spores	8-10 days	Rhizome	1 week	water, moderate sun light& cold climate
7	Nirbrahmi	Bacopa moniari			Rhizome, Corm division	2 week	water, moderate sun light& cold climate
8	Nagar motha	Cyperus rotandus			Rhizome	2 week	water, moderate sun light& cold climate
9	Vekhanda	Acorus calamus			Rhizome	1-2 week	water, moderate sun light& cold climate

ANNEXURE

Sr.No	Common Name	Scientific Name	Sexual Method	Plant Propagation	Vegetative Method	Time duration for formation of root	Sapling to maturity care (Remark)
16	Margosa tree	Azadirachta indica	+	4-5 week	Stem cutting & Grafting	3 week	open space water regulation, low sunlight, humid climate, pest & disease
17	Pride of india	Lagestroemia speciosa	+	4-5 week			water regulation, sunlight, humid climate, pest & disease
18	Kamini	Murraya paniculata	+	4-5 week	Stem cutting & Grafting	10-20 days	water regulation, sunlight, humid climate, pest & disease
19	Putranjiva	Drypetes roxburghil	+	4-5 week	Stem cutting & Grafting	15 days	water regulation, sunlight, humid climate, pest & disease
Herbs							
1	Umbelled Bitter Cress	Cardamine subumbellata	+	15 days			open space water regulation, low sunlight, humid climate, pest & disease
2	Stinking Cassia, takala	Senna tora	+	10-15 days			open space water regulation, low sunlight, humid climate, pest & disease
Climbers							
1	Candy Corn Plant	Moullava spicata	+	10 days	Layering	10 days	open space water regulation, low sunlight, humid climate, pest & disease
2	Puncture Vine	Tribulus terrestris	+	7-8 days	Layering	5-8 days	open space water regulation, low sunlight, humid climate, pest & disease
3	kartol	Momordica cochinchinensis	+	10 days	Layering	15 days	open space water regulation, low sunlight, humid climate, pest & disease
Shrubs							
1	Malabar Hill Borage	Paracaryposis malabarica	+	2-4 week			water regulation, sunlight, humid climate, pest & disease
2	Wild Caper Bush	Capparis sepiaria	+	2-3 week			water regulation, sunlight, humid climate, pest & disease
3	Crossandra	Crossandra infundibuliformis			Cutting	15 Days	water regulation, sunlight, humid climate, pest & disease
Freshwater Buffer zone							
Tree							
1	Dhatriphal	Terminalia acutangula	+	3-4 week			water regulation, sunlight, humid climate, pest & disease
2	Taman	Lagerstroemia speciosa	+	3-4 week	Stem cutting & Grafting		water regulation, sunlight, humid climate, pest & disease
3	Arjun	Terminalia arjuna	+	4-5 week			water regulation, sunlight, humid climate, pest & disease
4	Coconut	Cocos nuciphera	+	5-6 weeks			full sunlight & watering

1.5 SCOPE AND LIMITATIONS

The strength of the manual is not only its emphasis on mixed species plantation but also outlines the process for such plantation. It promotes a fresh approach to urban planning with respect to urban plantation.

The manual shall be of use to all the stake holders of the city, from the Planning authorities to the individual resident of the city. That includes the local authorities, administrative departments, institutions as well as private developers, contractors, horticulturist, developers, planning architects, landscape designers etc.

This manual will help them make an informed decision about ecologically healthy greening practices.

The list of plant species mentioned is not exhaustive. It is inclusive of those plant species observed during the study period and is only confined to those studied plants. More detailed studies could definitely bring out more possible plant cluster suggestions. Plantation patterns for physiological conditions prevalent in MMR have been considered at the same time, suggesting species and associated species of fauna.

These are based on limited field observations and not exhaustive. The manual does not give specific detailed information about individual plants. For information about plant forms, sizes, colours, etc. other resources should be consulted.

The plant clusters mentioned in the manual are important in execution of such plantations but should only be used with a full understanding of their potential impacts.



CURRENT PLANTATION PRACTICE



CURRENT PLANTATION PRACTICE



ANNEXURE

Sr.No	Common Name	Scientific Name	Sexual Method	Plant Propagation	Vegetative Method	Time duration for formation of root	Sapling to maturity care (Remark)
7	Lobed Leaved Mysore Mallow	Decaschistia trilobata	+	16 days			shade require till root not come out because of evaporation
8	Snow Creeper	Dinetus racemosus	+	3-4 week			shade require till root not come out because of evaporation
9	Jambhli koranti	Barleria involucrata	+	3-4 week			shade require till root not come out because of evaporation
10	Dekamali	Gardenia gummifera			Stem cutting & Grafting	15 days	shade require till root not come out because of evaporation
11	Arni (plain & low hills)	Clerodendrum phlomidis			Stem cutting & Grafting	2 weeks	shade require till root not come out because of evaporation
12	Cape jasmine	Gardenia jasminoides			Stem cutting & Grafting	15 days	shade require till root not come out because of evaporation
Plains							
1	Devils tree	Alstonia scholaris	+	3-4 week	Stem cutting & Grafting	20 days	water regulation, sunlight, humid climate, pest & disease
2	Sita Ashok	Saraca indica	+	3-4 week	Stem cutting & Grafting	16 days	shade require till root not come out because of evaporation
3	Indian laburnam	Cassia fistula	+	3-4 week	Stem cutting & Grafting	12 days	water regulation, sunlight, humid climate, pest & disease
4	Palas	Butea monosperma	+	4-5 week			water regulation, sunlight, humid climate, pest & disease
5	Anjan	Hardwickia binata	+	4-5 week			water regulation, sunlight, humid climate, pest & disease
6	Bael	Aegle marmelos	+	3-4 week			water regulation, sunlight, humid climate, pest & disease
7	Bahunia	Bahunia purpurea	+	3-4 week			water regulation, sunlight, humid climate, pest & disease
8	Bartondi	Morinda pubescens	+	4-5 week			water regulation, sunlight, humid climate, pest & disease
9	Indian cork tree	Millingtonia hortensis	+	3-4 week	Stem cutting & Grafting	15 days	water regulation, sunlight, humid climate, pest & disease
10	Blue Pussyleaf	Nelsonia canescens	+	3-4 week			water regulation, sunlight, humid climate, pest & disease
11	Burmese pink cassia	Cassia renigera	+	3-4 week			water regulation, sunlight, humid climate, pest & disease
12	Indian medlar tree	Mimusops elengi	+	4-5 week			water regulation, sunlight, humid climate, pest & disease
13	Charcoal Tree	Charcoal Tree	+	3-4 week	Stem cutting & Grafting	15 days	water regulation, sunlight, humid climate, pest & disease
14	Jackfruit tree	Artocarpus heterophyllus	+	4-5 week	Grafting	3 week	first 3-4 months maintenance require
15	Shirish	Albizia lebbeck	+	4-5 week	Stem cutting & Grafting	3 week	water regulation, sunlight, humid climate, pest & disease

ANNEXURE

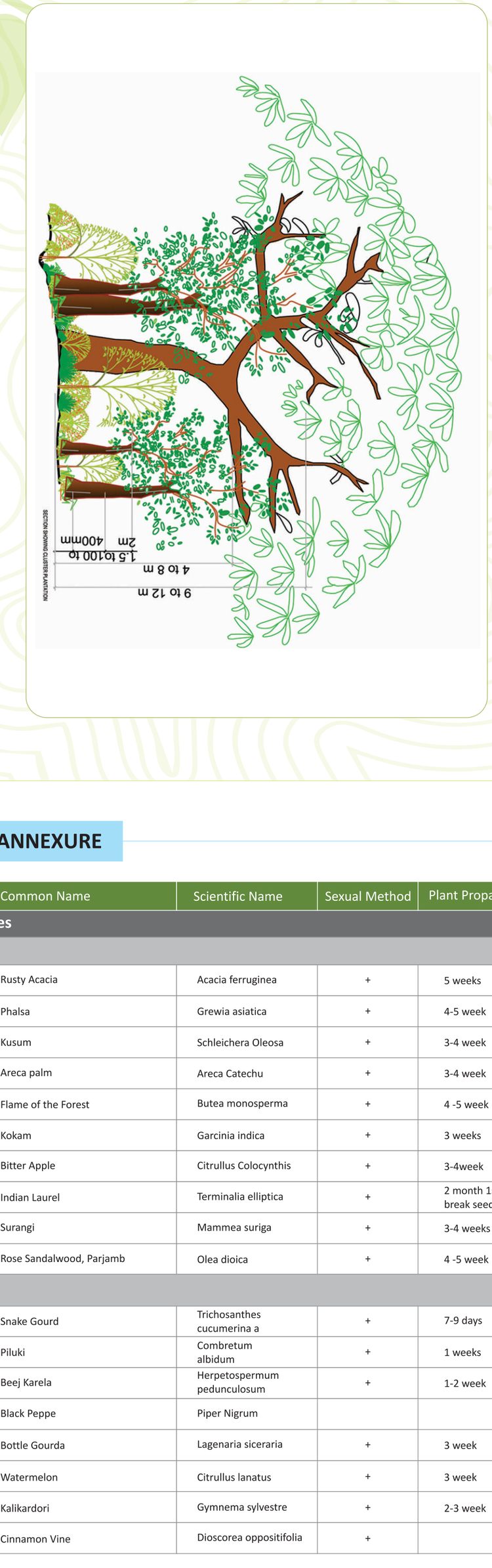
Sr.No	Common Name	Scientific Name	Sexual Method	Plant Propagation	Vegetative Method	Time duration for formation of root	Sapling to maturity care (Remark)
Herbs							
1	Job's Tears	Coix lacryma-jobi	+	1-2 week			
2	Plantain Peristylus (orchid)	Peristylus plantagineus	+	3 week	Corms division	10 days	water regulation, low sunlight, humid climate, pest & disease
3	Bee Orchid	Cottonia peduncularis					water regulation, low sunlight, humid climate, pest & disease
4	Congrace Grass	Parthenium hysterophorus	+	3-4 week			open space water regulation, low sunlight, humid climate, pest & disease
5	Dragon Stalk	Amorphophallus commutatus			Corms division	10 days	water regulation, low sunlight, humid climate, pest & disease
6	Pin Cushion Plant	Neuracanthus sphaerostachyus	+	2-3 week			water regulation, low sunlight, humid climate, pest & disease
7	Undir kani	Centranthera indica	+	3-4 week			water regulation, low sunlight, humid climate, pest & disease
8	nila jakara	Haplanthodes tentaculatus	+	3-4 week			shade require till root not come out because of evaporation
9	Slender Anthogonium	Anthogonium gracile	+	3-4 week			shade require till root not come out because of evaporation
10	Nilwanti	Cyanotis fasciculata	+	2-3 week			shade require till root not come out because of evaporation
11	Oriental Fountain Grass	Pennisetum orientale	+	3 week			shade require till root not come out because of evaporation
12	Stinking Foldwing	Dicliptera foetida					open space water regulation, low sunlight, humid climate, pest & disease
13	Sharma's Pipewort	Eriocaulon sharmae	+	3 week			shade require till root not come out because of evaporation
Shrubs							
1	Osbeckia	Osbeckia stellata	+	3-4 week			shade require till root not come out because of evaporation
2	Rubber bush	Calotropis procera	+	4-5 week			shade require till root not come out because of evaporation
3	Rose	Rosa			Corms division	10 days	water regulation, low sunlight, humid climate, pest & disease
4	Red Barleria (introduced)	Barleria repens	+	3-4 week	Corms division	15 days	water regulation, low sunlight, humid climate, pest & disease
5	Sky Blue Karvy	Strobilanthes ixiocephalus	+	3-4 week			shade require till root not come out because of evaporation
6	Malabar Embelia	Embelia basaal	+	2-3 week			open space water regulation, low sunlight, humid climate, pest & disease



02 CHOICE OF PLANTATION

2.1 DIFFERENT TIERS OF PLANTATION

From observation in fields and understanding the importance of mixed plantation, following spatial model for cluster plantation in urban areas evolves. Cluster will always have four or more tiers of big tree, medium tree, shrubs, herbs, climbers, grass or ground cover. Considering average spread of a big or a leader tree, area of 7m X 7m is considered. This area will contain the following number of individuals in each tier.



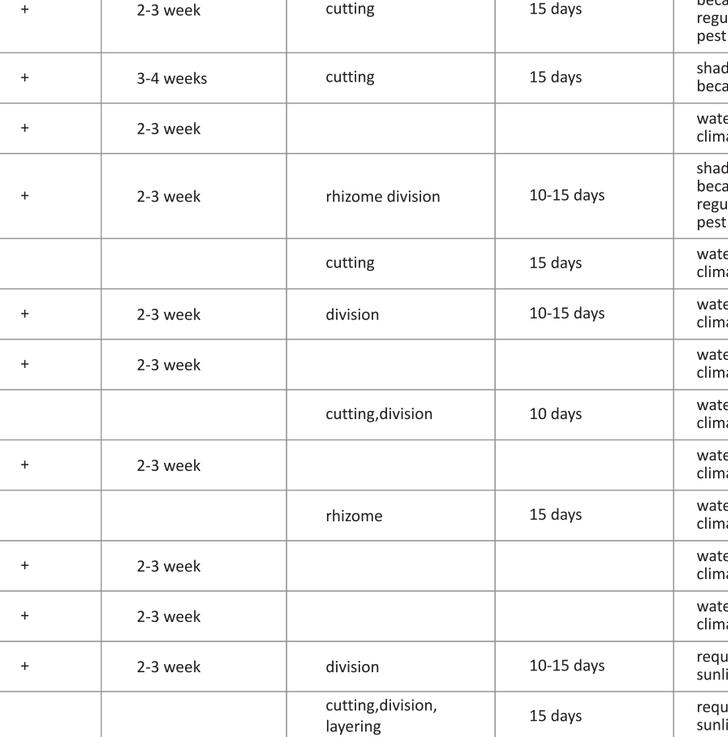
Sr.No	Common Name	Scientific Name	Sexual Method	Plant Propagation	Vegetative Method	Time duration for formation of root	Sapling to maturity care (Remark)
Hilly Slopes							
Tree							
1	Rusty Acacia	Acacia ferruginea	+	5 weeks			water regulation, sunlight, humid climate, pest & disease
2	Phalsa	Grewia asiatica	+	4-5 week	Stem	15 days for root formation	water regulation, sunlight, humid climate, pest & disease
3	Kusum	Schleichera Oleosa	+	3-4 week	Stem cutting & Grafting		water regulation, sunlight, humid climate, pest & disease
4	Areca palm	Areca Catechu	+	3-4 week			open space water regulation, low sunlight, humid climate, pest & disease
5	Flame of the Forest	Butea monosperma	+	4 -5 week	Stem cutting & Grafting	2-3week	water regulation, sunlight, humid climate, pest & disease
6	Kokam	Garcinia indica	+	3 weeks	Stem cutting & Grafting	15 days for root formation	water regulation, sunlight, humid climate, pest & disease
7	Bitter Apple	Citrullus Colocynthis	+	3-4week			water regulation, sunlight, humid climate, pest & disease
8	Indian Laurel	Terminalia elliptica	+	2 month 1st break seed coat			use rooting harmone for early rooting
9	Surangi	Mammea suriga	+	3-4 weeks			water regulation, sunlight, humid climate, pest & disease
10	Rose Sandalwood, Parjamb	Olea dioica	+	4 -5 week	Stem cutting & Grafting	15 days	water regulation, sunlight, humid climate, pest & disease
Climber							
1	Snake Gourd	Trichosanthes cucumerina a	+	7-9 days			water regulation, sunlight, humid climate, pest & disease
2	Piluki	Combretum albidum	+	1 weeks			water regulation, sunlight, humid climate, pest & disease
3	Beej Karela	Herpetospermum pedunculosum	+	1-2 week			water regulation, sunlight, humid climate, pest & disease
4	Black Peppe	Piper Nigrum			Stem Cutting	15-20 days	shade require till root not come out because of evaporation
5	Bottle Gourda	Lagenaria siceraria	+	3 week	Stem Cutting	15-20 days	water regulation, sunlight, humid climate, pest & disease
6	Watermelon	Citrullus lanatus	+	3 week			open space water regulation, low sunlight, humid climate, pest & disease
7	Kalikardori	Gymnema sylvestre	+	2-3 week	Stem cutting & Grafting	15 days	shade require till root not come out because of evaporation
8	Cinnamon Vine	Dioscorea oppositifolia	+		Rhizome	10 days	water regulation, low sunlight, humid climate, pest & disease

ANNEXURE

Sr.No	Common Name	Scientific Name	Sexual Method	Plant Propagation	Vegetative Method	Time duration for formation of root	Sapling to maturity care (Remark)
23	Koranta	Blepharis maderapatensis	+	2-3 week	cutting	15 days	shade require till root not come out because of evaporation, water regulation, sunlight, humid climate, pest & disease
24	Burr Brush	Triumfetta rhomboidea	+	3-4 weeks	cutting	15 days	shade require till root not come out because of evaporation
25	Chinchini	Acacia	+	2-3 week			water regulation, sunlight, humid climate, pest & disease
26	Jungli Haldi	Curcuma pseudomontana	+	2-3 week	rhizome division	10-15 days	shade require till root not come out because of evaporation, water regulation, sunlight, humid climate, pest & disease
27	Dashmooli	Eranthemum rosean			cutting	15 days	water regulation, sunlight, humid climate, pest & disease
28	Raan - Modi	Eupatorium repandum	+	2-3 week	division	10-15 days	water regulation, sunlight, humid climate, pest & disease
29	Goujivha	Elephantopus scaber	+	2-3 week			water regulation, sunlight, humid climate, pest & disease
30	Grass	Oplismenus burmani			cutting,division	10 days	water regulation, sunlight, humid climate, pest & disease
31	Raan - Kaapus	Urena lobata	+	2-3 week			water regulation, sunlight, humid climate, pest & disease
32		Begonia crenata			rhizome	15 days	water regulation, sunlight, humid climate, pest & disease
33	Taakla	Cassia tora	+	2-3 week			water regulation, sunlight, humid climate, pest & disease
34	Kavlaa	Smithia sensitiva	+	2-3 week			water regulation, sunlight, humid climate, pest & disease
35	Grass	Digitaria species	+	2-3 week	division	10-15 days	require open space, water regulation, sunlight, humid climate, pest & disease
36	Grass	Ischaemum species			cutting,division, layering	15 days	require open space, water regulation, sunlight, humid climate, pest & disease
37	Tear Grass / Raan - Maka	Coix - lacryma - jobi	+	15-20 days	division	15 days	require open space, water regulation, sunlight, humid climate, pest & disease
38	Aleppo Grass / Raan - Jondhala	Sorghum halepense	+	2-3 week	division, cutting	10-15 days	require open space, water regulation, sunlight, humid climate, pest & disease
39	Atibalaa	Sida rhombifolia	+	2-3 week	division	15 days	require open space, water regulation, sunlight, humid climate, pest & disease
40	Chimniche pohe / Chinese Lovegrass	Eragrostis unioloides	+	3-4 weeks			require open space, water regulation, sunlight, humid climate, pest & disease

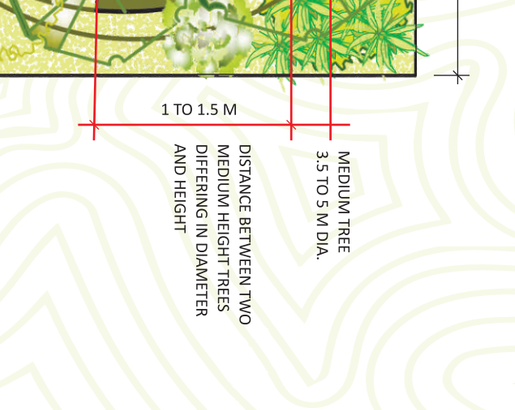
CHOICE OF PLANTATION

Different Tiers of Plantation | Different Categories of Spaces | Physiographic Conditions | Sample Clusters



PLAN OF CLUSTER PLANTATION / CLUSTER PALETTE





SKETCH VIEW FOR SAMPLE CLUSTER

2.2 DIFFERENT CATEGORIES OF SPACES

Spatial Arrangements of Clusters

The spatial arrangements given in the following pages is only a suggestive layout for achieving the derived mixed species plantation. Many more alternatives of spatial plans can be possible using this guideline.

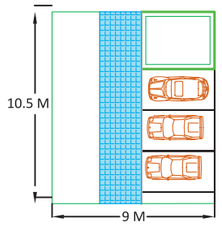
Several open spaces are available for plantation, as per the Development Plan of Mumbai. Varying scales of open spaces offer possibilities of plantations of different sizes and compositions like the Large scale open spaces include Regional parks, Catchment areas of dams, Quarry sites etc. Medium scale open spaces are maximum in numbers in urban areas. These are parks of different sizes such as recreational grounds, playgrounds, gardens etc., which though segregated offer potentials for green connectivity or green corridors through urban areas. They (open spaces) give better opportunity for interface between urban population and biodiversity in terms of appreciation of flora and fauna (native), awareness, sensitizing people.

Linear scale open spaces are a reality of urbanization. They are supporting urban functions such as transport / other infrastructure and are hence indispensable. At the same time they can play an important role in serving as green corridors for fauna and as buffers to minimize the air and sound pollution effect on surrounding area.

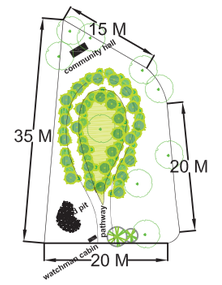
Most of the open areas beyond municipal limits along the forest, rivers, streams etc serve as an essential corridor. These corridors give the opportunity to create ecological and biological enhancement of ecosystem. It is essential to connect these fragmented open spaces to each other through green belts. This will promote mixed indigenous species cluster plantations in the buffer zones to promote movement and migration of faunal components and diversify the urban ecosystem. An important aspect of promoting such green belts and corridors is the vegetation. For example, a certain tree that is usually found in and around creeks may not grow as well in grassland and hence, may not be able to support as many life-forms as it may in a creek. Hence, while selecting plants, such factors should be kept in mind, for a successful plantation.

Proposed and existing open spaces in municipal areas appear to be fragmented and sporadic due to uncontrolled urban development. However one can see potential in connecting these open spaces by means of greening along roads or creek etc. This can lead to formation of green corridors within the city limits also.

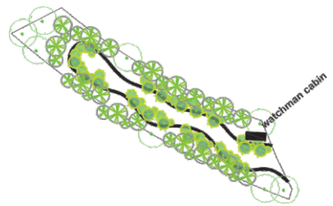
The following are some examples of different shapes and sizes of open spaces available in the urban context. Possible spatial arrangements of cluster plantation for these spaces is given in this chapter.



PARKING LOTS



MEDIUM SIZE OPEN SPACES



LINEAR STRIPS ALONG BUILDING OR HIGHWAY



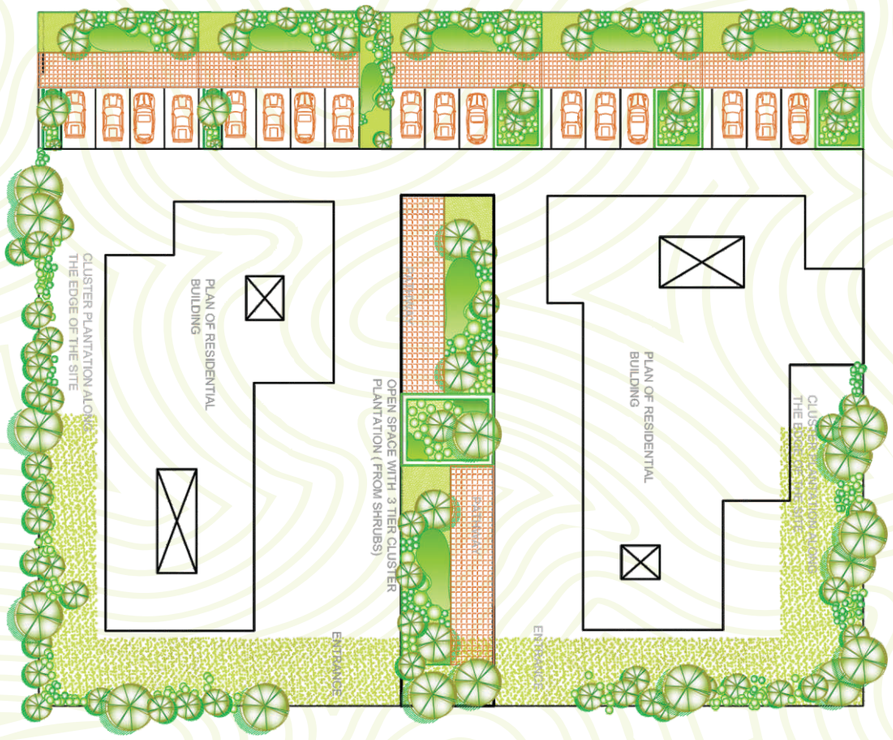
LARGE OPEN SPACES

ANNEXURE

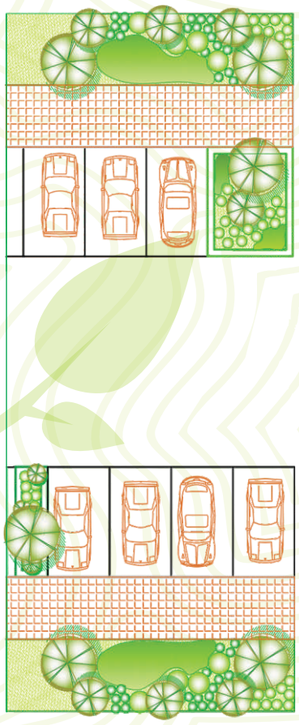
Sr.No	Common Name	Scientific Name	Sexual Method	Plant Propagation	Vegetative Method	Time duration for formation of root	Sapling to maturity care (Remark)
5	Guraa	Barleria gibsoni	+	15 days	cutting	15 days	shade require till root not come out because of evaporation
6		Clitoria annua	+	3-4 weeks	cutting	15 days	shade require till root not come out because of evaporation
7	Ken	Commelina bengalensis	+	2-3 week	cutting	15 days	shade require till root not come out because of evaporation
8	Pev or Penva	Costus speciosus			rhizome	10-15 days	shade require till root not come out because of evaporation, water regulation, sunlight, humid climate, pest & disease
9	Danti	Baliospermum solanifolium			cutting, stem	15 days	require open space, water regulation, sunlight, humid climate, pest & disease
10		Conscora diffusa	+	3-4 weeks			water regulation, sunlight, humid climate, pest & disease
11	Kali - Musali	Curculago orchioides	+	3-4 weeks	bulbils	10 days	water regulation, sunlight, humid climate, pest & disease
12	Pivla Dhotra/ Mexican poppy	Argemone mexicana	+	3-4 weeks			water regulation, sunlight, humid climate, pest & disease
13	Pathari	Launaea fallax			layering,cutting	10-15 days	require open space, water regulation, sunlight, humid climate, pest & disease
14	Burando	Blumea lacera	+		3-4 weeks	10-15 days	water regulation, sunlight, humid climate, pest & disease
15		Orthosiphon thymiflorus					
16	Pin cushion	Neuracanthus sphaerostachys					
17		Sida cordifolia	+		cutting	15 days	shade require till root not come out because of evaporation
18	Akalandi	Tridex procumbens	Spores	3-4 weeks	cutting	15 days	shade require till root not come out because of evaporation, water regulation, sunlight, humid climate, pest & disease
19	Jungli suran / Wild yam	Amorphophallus canipanulatus	Spores	3-4 weeks	cutting	15 days	shade require till root not come out because of evaporation, water regulation, sunlight, humid climate, pest & disease
20	Raan Aboli	Echolium viride	+	2-3 week	cutting	15 days	shade require till root not come out because of evaporation
21	Mudra	Abutilon indicum	Spores	3-4 weeks	cutting	15 days	shade require till root not come out because of evaporation
22	Jungli Terda / Balsam plant	Impatiens balsamina	+	2-3 week	cutting	15 days	shade require till root not come out because of evaporation, water regulation, sunlight, humid climate, pest & disease

ANNEXURE

Sr.No	Common Name	Scientific Name	Sexual Method	Plant Propagation	Vegetative Method	Time duration for formation of root	Sapling to maturity care (Remark)
3		Discoria pentaphyla	+				water regulation, sunlight, humid climate, pest & disease
4	Swet - Kawali	Cryptolepis dubia	+	2-3 week	cutting	15 days	shade require till root not come out because of evaporation
5	Wild grapes	Ampelocissus latifolia	+	15 days	cutting	15 days	shade require till root not come out because of evaporation
6	Kaartoli	Momordica dioica	+	2-3 week	layering	10 days	require open space, water regulation, sunlight, humid climate, pest & disease
7	Lamtaani	Anodendron paniculatum	+	15 days	layering	10 days	shade require till root not come out because of evaporation, water regulation, sunlight, humid climate, pest & disease
8	Pahad Vel	Cissampelos pareira			cutting	10-15 days	shade require till root not come out because of evaporation, water regulation, sunlight, humid climate, pest & disease
9	Chop - Chini	Smilax zeylanica			cutting	10-15 days	water regulation, sunlight, humid climate, pest & disease
10	Wild Shivaali	Combretum albidum	spores	10 days			water regulation, sunlight, humid climate, pest & disease
11	Tondali	Coccinea grandis	+	2-3 week			water regulation, sunlight, humid climate, pest & disease
12	Bendrichi Vel	Clematis hedysanifolia			cutting	15 days	shade require till root not come out because of evaporation
13	Bendrichi Vel	Ipomoea purpurea			cutting	10 days	shade require till root not come out because of evaporation
14	Anantmool	Hemidesmus indicus	+	2-3 week			water regulation, sunlight, humid climate, pest & disease
15	Anantmool	Hemidesmus indicus	+	2-3 week			water regulation, sunlight, humid climate, pest & disease
Herb							
1	Adiantum	Adiantum capillus - veneris	spores	15 -20 days	division	10 days	water regulation, sunlight, humid climate, pest & disease
2	Adiantum	Adiantum philippensis	spores	15 day			water regulation, sunlight, humid climate, pest & disease
3	Aghada	Achyranthes aspera	+	2-3 week			water regulation, sunlight, humid climate, pest & disease
4		Ageratum conyzoides	+	2-3 week	cutting	15 days	shade require till root not come out because of evaporation, water regulation, sunlight, humid climate, pest & disease



CLUSTER PLANTATION OPPORTUNITY IN RESIDENTIAL COMPLEX AT SITE LAYOUT LEVEL



CLUSTER PLANTATION OPPORTUNITY IN TYPICAL PARKING LOT

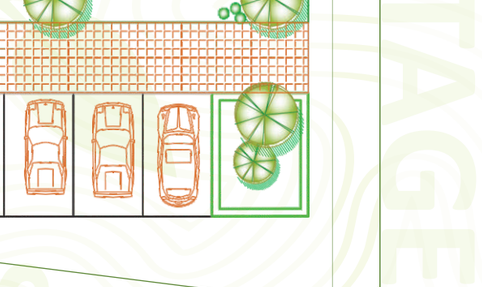
CHOICE OF PLANTATION

Different Tiers of Plantation

Different Categories of Spaces

Physiographic Conditions

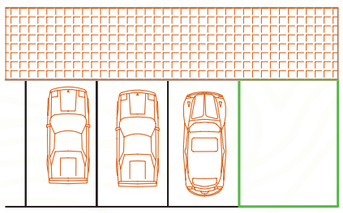
Sample Clusters



STAGE 1

Peripheral open spaces in urban areas such as green pockets in parking lots road edge conditions in commercial districts do provide opportunities for cluster plantation.

Available side open spaces used for parking. Delineate soft edges along parking lots for planting.Min width 4'-5'.



STAGE 2

Provide for car park, pathways as per requirement . select species for small clusters.

STAGE 3

Combination of small clusters and some large trees at suitable location.

CLUSTER PLANTATION OPPORTUNITY IN TYPICAL PARKING LOT

ANNEXURE

Sr.No	Common Name	Scientific Name	Sexual Method	Plant Propagation	Vegetative Method	Time duration for formation of root	Sapling to maturity care (Remark)
41	Kaala - Kuda	Wrightia tinctoria	+	3-4 weeks	cutting	2-3 weeks	water regulation, full sunlight, humid climate, pest & disease
Shrub							
1	Karvat	Ficus ampelos	+	2-3 week			
2	Wild Banana	Ensete species	+	3-4 weeks	cutting	2-3 weeks	shade require till root not come out because of evaporation
3	Ansoli	Microcos paniculata	+	2-3 week	layering	5-7 days	
4	Murud sheng / Screw pod	Helicteris isora	+	2-3 week	cutting	10 days	cutting success in less than day if air layering don e
5	Vavding	Embelia basal		2-3 week	cutting	10 days	cutting success in less than day if air layering don e
6	Karvand	Carissa carandas	+	3-4 weeks			water regulation, sunlight, humid climate, pest & disease
7	Karvy	Carvia callosa	+	2-3 week	cutting	10 days	cutting success in less than day if air layering done for fast propagation
8	Pandhara kuda / Kutaja	Holarrhena antidysentrica	+	15 days			water regulation, sunlight, humid climate, pest & disease
9	Ghaaneri	Lantana camara	+	2-3 week	layering	7-10 days	shade require till root not come out because of evaporation
10	Bandicoot berry / kukur / Dinda	Leea indica	+	3-4 weeks			water regulation, sunlight, humid climate, pest & disease
11	Lokhandi	Ixora pavetta	+	2 week	Stem cutting	10 days	water regulation, sunlight, humid climate, pest & disease
12	Bandgool	Dendrophthoe falcata	+	3-4 weeks			water regulation, sunlight, humid climate, pest & disease
13		Eupatorium repandum	+				shade require till root not come out because of evaporation
14	Dikamali	Gardenia resinifera	+	3-4 weeks	Stem cutting	10-15 days	water regulation, sunlight, humid climate, pest & disease
15		Callicarpa tomentosa					shade require till root not come out of evaporation
16	Ukshi	Calycopteris floribunda		10-15 days	Root sucker /cutting		water regulation, sunlight, humid climate, pest & disease
17	Chiknee	Bridelia hamiltoniana	+	3-4 weeks		10 days	cutting success in less than day if air layering done for fast propagation
Climber							
1	Gul - Vel	Tinospora cordifolia	+	2-3 week	layering	10 days	water regulation, sunlight, humid climate, pest & disease
2	Wakeri	Moullava spicata	+	15 daya	cutting, layering		water regulation, sunlight, humid climate, pest & disease

ANNEXURE

Sr.No	Common Name	Scientific Name	Sexual Method	Plant Propagation	Vegetative Method	Time duration for formation of root	Sapling to maturity care (Remark)
21	Kalam	Mitragyna parviflora		4-5 weeks			shade require till root not come out because of evaporation, water regulation, sunlight, humid climate, pest & disease
22	Baartondi	Morinda pubescens	+	4-5 weeks	cutting	15 days	shade require till root not come out because of evaporation
23	Singapore cherry	Muntingia calabura	+	3-4 weeks	cutting	15 days	water regulation, full sunlight, humid climate, pest & disease
24	Wad	Ficus bengalensis	+	3-4 weeks			water regulation, full sunlight, humid climate, pest & disease
25	Bokeda	Ficus hispida	+	4-5 weeks			water regulation, full sunlight, humid climate, pest & disease
26	Mast Tree	Polyalthia longifolia			cutting	15 days	shade require till root not come out because of evaporation
27	Karanj	Pongamia pinnata	+	3-4 weeks			water regulation, full sunlight, humid climate, pest & disease
28	Gelaa	Catunaregam spinosa	+	4-5 weeks	cutting, garafting	15-20 days	water regulation, full sunlight, humid climate, pest & disease
29	Rain Tree	Samanea saman	+	3-4 weeks			water regulation, full sunlight, humid climate, pest & disease
30	Reetha	Sapindus laurifolius	+	3-4 weeks			water regulation, full sunlight, humid climate, pest & disease
31	Kusum	Schleichera oleosa	+	4-5 weeks	root, sucker	2-3 weeks	water regulation, sunlight, humid climate, pest & disease
32	Jungli Badam	Sterculia foetida	+	3-4 weeks	cutting	15 days	water regulation, full sunlight, humid climate, pest & disease
33	Ghost Tree	Sterculia urens	+	4-5 weeks			water regulation, full sunlight, humid climate, pest & disease
34	Jamun	Lannea coromandelica	+	4-5 weeks			water regulation, full sunlight, humid climate, pest & disease
35	Chincha / Imli	Tamarindus indica	+	3-4 weeks	cutting, budding	15 days	water regulation, full sunlight, humid climate, pest & disease
36	Teak Wood tree	Tectona grandis	+	1 year (difficut propagation)	cutting	6-7 months	propagated by stump method, require much care and time for propagation, water regulation, sunlight, humid climate, pest & disease
37	Ain	Terminalia crenulata	+	4-5 weeks			water regulation, full sunlight, humid climate, pest & disease
38	Behada	Terminalia bellirica	+	4-5 weeks			water regulation, full sunlight, humid climate, pest & disease
39	Jungli Bhend	Thespecia populnea	+	3-4 weeks	cutting	2-3 weeks	cutting success in less than day if air layering don e
40	Deshi - Badam	Terminalia catappa	+	4-5 weeks			water regulation, full sunlight, humid climate, pest & disease

CLUSTER PLANTATION OPPORTUNITY IN TYPICAL PARKING LOT



2.3 PHYSIOGRAPHIC CONDITIONS

Cluster Plantations in various Physiographical Conditions Prevalent in MMR

Importance of mixed species plantation and creation of vegetation clusters using plant species of various habits is established. Now one has to make informed choice about the selection of species for cluster composition. Selection of species will vary depending upon prevalent physiographic conditions at site of plantation.

Although every site will have certain site specific conditions which will affect choice of the species, there are certain general physiographic conditions such as hill slopes, river buffer zones etc. for which cluster composition is suggested as follows. It is to be noted that following cluster plant lists are not exhaustive but they are indicative of the nature and habits of the plants suitable for said physiographic conditions in MMR.

CREEK

Although vegetation suitable for coastal area can thrive near creek as climatic conditions are similar but vegetation that grows in tidal waters eg mangroves is unique to cluster near creek area.

	TREES	
1	Grey Mangrove	Avicennia marina
2	Indian Mangrove	Avicennia officinalis
3	Sudarigan	Sonneratia caseolaris
4	Mangrove apple	Sonneratia apetala
5	Orange Mangrove	Bruguiera cylindrica
6	Kandel	Bruguiera gymnorliza
7	Red Mangroves	Rhizophora mucronata Excoecaria agallocha

	HERBS	
1	Spiny Barleria	Barleria cuspidata
2		Sesuvium portulacastrum
3		Suaeda fruticosa
	SHRUBS	
1	Sea Holly	Acanthus ilicifolius



SECTION SHOWING TIDAL WATER CLUSTER PLANTATION

NOTE: Refer the original research document titled Survey of biological resources in forest areas in MMR to develop strategic manual for rejuvenation of native plant species, in and around urban mumbai for details.

7.2 PLANT LIST

Sr.No	Common Name	Scientific Name	Sexual Method	Plant Propagation	Vegetative Method	Time duration for formation of root	Sapling to maturity care (Remark)
General							
Tree							
1	Atrun	Flacourtia ramontchii	+	4-5 weeks			water regulation, sunlight, humid climate, pest & disease
2	Aloo	Meyna laxiflora	+	3-4 weeks			water regulation, sunlight, humid climate, pest & disease
3	Aesar	Callicarpa tomentosa	+	4-5 weeks			require open space, water regulation, sunlight, humid climate, pest & disease
4	Kaate saavar / Red silk cotton tree	Bombax ceiba	+	4-5 weeks	grafting, budding	2-3 weeks	water regulation, sunlight, humid climate, pest & disease
5	Taad / Palmyra palm	Borassus flabellifer	+	5-6 weeks			water regulation, sunlight, humid climate, pest & disease
6	Asana	Bridelia retusa	+	4-5 weeks	grafting, budding, leaf	2-3 weeks	water regulation, sunlight, humid climate, pest & disease
7	Palas / Flame of the forest	Butea monosperma	+	3-4 weeks	grafting	2-3 weeks	water regulation, sunlight, humid climate, pest & disease
8	Kumbh	Careya arborea	+	4-5 weeks	Budding	15 days	water regulation, sunlight, humid climate, pest & disease
9	Shisham	Dalbergia latifolia	+	4-5 weeks	grafting	2-3 weeks	water regulation, sunlight, humid climate, pest & disease
10	Putranjeeva	Drypetes roxburghii	+	3-4 weeks			water regulation, sunlight, humid climate, pest & disease
11	Amla	Emblica officinalis	+	4-5 weeks	grafting	2-3 weeks	water regulation, sunlight, humid climate, pest & disease
12	Umbar / Wild Fig	Ficus racemosa	+	3-4 weeks	grafting, budding	2-3 weeks	water regulation, full sunlight, humid climate, pest & disease
13	Peepal	Ficus religiosa	+	4-5 weeks	grafting, budding, leaf	15-20 days	water regulation, sunlight, humid climate, pest & disease
14	Kaakad	Garuga pinnata	+	4-5 weeks	grafting, budding	2-3 weeks	water regulation, sunlight, humid climate, pest & disease
15	Dhaaman	Grewia tilifolia	+	4-5 weeks	grafting, budding	15-20days	water regulation, sunlight, humid climate, pest & disease
16	Vavlaa	Holoptelea integrifolia	Spores	4-5 weeks	grafting	2-3 weeks	water regulation, sunlight, humid climate, pest & disease
17	Shemaat	Lannea coromandelica	+	4-5 weeks			water regulation, full sunlight, humid climate, pest & disease
18	Chaanda	Macaranga peltata	+	4-5 weeks			water regulation, full sunlight, humid climate, pest & disease
19	Sitechi - Kumkum	Mallotus philippinesis	+	3-4 weeks			water regulation, full sunlight, humid climate, pest & disease
20	Mango	Mangifera indica	+	4-5 weeks	grafting	2-3 weeks	water regulation, sunlight, humid climate, pest & disease

7.1 LIST OF NURSERIES TO FACILITATE PROCUREMENT OF INDIGENOUS PLANT SPECIES

Go Green Nursery Pvt. Ltd.

Home Town, HCC 247 Park,
L.B.S Road, Vikhroli (West)
Mumbai-400079
Tel.: +91 - 22 - 6596 9978

Tara(Karnala) Post: Barapada, Mumbai - Goa Highway,
Near Yusuf Meherally Centre, Taluka: Panvel;
District: Raigad - 410 206, Maharashtra - India.

Yusuf Meherally Centre

D-15, Ganesh Prasad, Naushir Bharucha Marg, Tardeo,
Grant Road (West), Mumbai-400007
Tel.: 2387 0097 | Fax.:2388 9738

Sanjay Gandhi National Parka

Western Express Highway, Borivali (East)
Mumbai-400066
Tel.:28860362

Mahim Nature Park, Mahim

Opp.Dharavi Bus Depot
Mumbai-400016
Tel.:24077641, 24079939

Veer Jijamata Udyan (Victoria and Albert Zoo Gardens)

Dr. B Ambedkar Road, Byculla
Mumbai-400027
Tel.: 3725799

Sadabahar Nursery

Rose Villa, College Road,
Karanjade, Panvel, Navi Mumbai - 410206
Contact: Yakub M.Asgarali 98201 42503

Bandal Nursery

At Takwe Village, Post Kadav,
Taluka Karjat, District Raigad Karjat - 410201
Tel.:9921216666

HILLY SLOPES

There are number of hill slopes in MMR eg. Kankeshwar near Alibaug, Hills near Kalyan etc. Also in MCGM boundaries there are hill slopes where urban greening potential exists.

Following list indicates kind of mixed species palette that can be employed for cluster plantation there.

TREES		
1	Rusty Acacia	*Acacia ferruginea*
2	Phalsa	*Grewia asiatica*
3	Kusum	*Schleichera oleosa*
4	Indian Laurel	*Terminalia elliptica*
5	Surangi	*Mammea suriga*
6	Areca palm	*Areca catechu*
7	Flame of the Forest	*Butea monosperma*
8	Hairy Xantolis	*Xantolis tomentosa*
9	Wax Apple, mountain apple	*Syzygium samarangense*
10	Rose Sandalwood	*Olea dioica*
11	Kokam	*Garcinia indica*

HERBS		
1	Plantain Peristylus (orchid)	*Peristylus plantagineus*
2	Job's Tears	*Coix lacryma-jobi*
3	Crested Lepidagathis	*Lepidagathis cristata*
4	Sharma's Pipewort	*Eriocaulon sharmae*
5	Nilwanti	*Cyanotis fasciculata*
6	Pin Cushion Plant	*Neuracanthus sphaerostachyus*
7	Bee Orchid	*Cottonia peduncularis*
8	Undir kani	*Centranthera indica*
9	Dragon Stalk	*Amorphophallus commutatus*
10	Slender Anthogonium	*Anthogonium gracile*
11	Stinking Foldwing	*Diclipterafoetida*
12	Nila jakara	*Haplanthodes tentaculatus*
13	Oriental Fountain Grass	*Pennisetum orientate*

SHRUBS		
1	Arni (plain & low hills)	*Clerodendrum phlomidis*
2	Dekamal	*Gardenia gummifera*
3	Osbeckia	*Osbeckia stellata*
4	Sky Blue Karvy	*Strobilanthes ixiocephalus*
5	Cotton	*Gossypium arboreuma*
6	Rubber bush	*Calotropis procera*
7	Cape jasmine	*Gardenia jasminoides*
8	Lobed Leaved Mysore Mallow	*Decaschistia trilobata*
9	Rose	*Rosa*
10	Red Barleria (introduced)	*Barleria repens*
11	Malabar Embelia	*Embelia basaal*
12	Striped Philippine Violet	*Barleria cristata*
13	Mayurpankh	*Barleria involucrata*

CLIMBERS		
1	Piluki	*Combretum albidum*
2	Bottle Gourd	*Lagenaria siceraria*
3	Watermelon	*Citrullus lanatus*
4	Yam	*Dioscorea oppositifolia*
5	Beej Karela	*Herpetospermum pedunculosum*
6	Snake Gourd	*Trichosanthes cucumerina*
7	Black Peppe	*Piper nigrum*
8	Snow Creeper	*Porana volubilis*
9	Gudmar	*Gymnema sylvestre*



CHOICE OF PLANTATION

PLAINS

Cluster plantation in plain inland area will have extensive species list. To demonstrate mix of species with various habits and also good ecological services, following cluster composition is suggested.

TREES		
1	Anjan	*Hardwickia binata*
2	Sita Ashok	*Saraca indica*
3	Charcoal Tree	*Trema orientalis*
4	Bael	*Aegle marmelos*
5	Bartondi	*Morinda pubescens*
6	Bahunia	*Bahunia purpurea*
7	Burmese pink cassia	*Cassia renigera*
8	Indian laburnam	*Cassiafistula*
9	Devils tree	*Alstonia scholaris*
10	Palas	*Butea monosperma*
11	Indian cork tree	*Millingtonia hortensis*
12	Indian medlar tree	*Mimusops elengi*
13	Jackfruit tree	*Artocarpus heterophyllus*
14	Kamini	*Murray a paniculata*
15	shirish	*Albizia lebbeck*
16	Margosa tree	*Azadirachta indica*
17	Pride of india	*Lagestroemia speciosa*
18	Putranjiva	*Drypetes roxburghil*

HERBS		
1.	Blue Pussyleaf	*Nelsonia canescens*
2.	Umbelled Bitter Cress	*Cardamine subumbellata*
3.	Stinking Cassia	*Senna tora*
4.	Redhogweed	*Boerhavia diffusa*

SHRUBS		
1.	Crossandra	*Crossandra infundibuliformis*
2.	Malabar Hill Borage	*Paracaryposis malabarica*
3.	Wild Caper Bush	*Capparis sepiaria*

CLIMBERS		
1.	Candy Corn Plant	*Moullava spicata*
2.	Bitter Apple	*Citrullus colocynthis*
3.	Chinese Cucumbe	*Momordica cochinchinensis*
4.	Puncture Vine	*Tribulus terrestris*



SECTION SHOWING PLANTATIONS IN PLAIN REGION



07
ANNEXURE

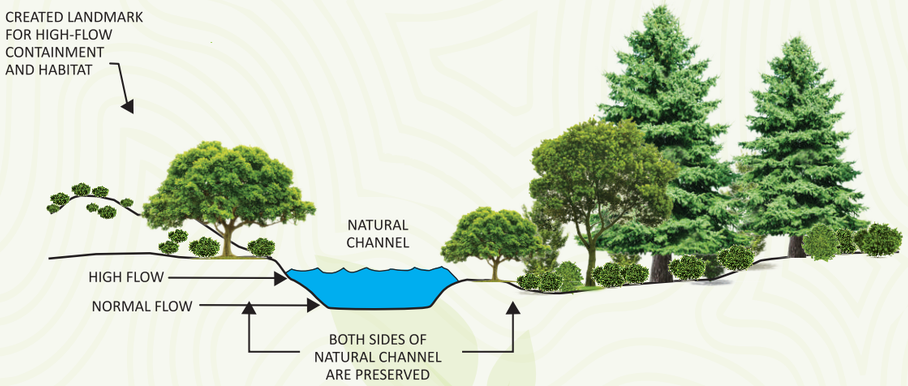
FRESHWATER BUFFER ZONE

Plantation along river buffer zones and along lakes has to be sensitive to the unique hydro geological feature. Health of any natural water body depends largely on the vegetation it supports. Considering this, one needs to work out a section through the water body which allows different habits of plants such as aquatic herbs, riparian vegetation and grasses along edge of water body. Also slopes leading to the water body have to be vegetated to control erosion and to enhance recharge. One such example is indicated in the following cluster composition:

TREES		
1	Dhatriphal	*Terminalia acutangula*
2	Jarul	*Lagerstroemia speciosa*
3	Arjun	*Terminalia arjuna*
4	Coconut	*Cocos nuciphera*
5	Ashoka	*Saraca asoka*
6	Jamun	*Syzyguim cumini*

HERBS		
1	Bhui-awla	*Phyllanthus niruri*
2	Dudhali	*Euphorbia hereto*
3	Maka	*Eclipta erecta*
4	Bala	*Sida acuta*
5	Neche	*Nephrolepis exaltata*
6	Neche	*Asplenium phelipenes*
7	Neche	*Pteris longefolia*

AQUATIC / RIPERIAN VEGETATION (Herbs)		
1	Ramban	*Typha angustifolia*
2	Shingada	*Trapa bispinosa*
3	Water lilies	*Nymphia (all sps.)*
4	Kamal	*Nelumbium nucifera*
5	Kumudini	*Nymphiodis cristata*
6	Pan-neche	*Marselia quadrifolia*
7	Nirbrahmi	*Bacopa moniari*
8	Nagar motha	*Cyperus rotandus*
9	Vekhanda	*Acorus calamus*



CLUSTER PLANTATION ALONG NATURAL CHANNEL

TIDAL WATER BUFFER ZONE

COASTAL VEGETATION

Coasts have typically sandy, muddy or rocky character. Also it has salty winds and sea spray. Vegetation suggested in these areas has to be tolerant to all such conditions. Also this vegetation acts as barrier against erosion (sand binder) & buffers strong wind. Following is indicative example of such coastal cluster:

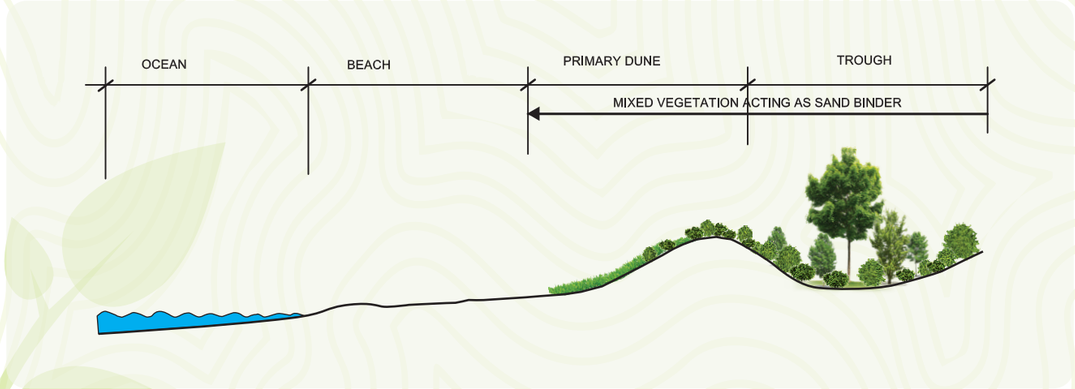
TREES		
1	Suru	*Casuarina equisetifolia*
2	Karanj	*Pongamia pinnata*
3	Coconut palm	*Cocos nucifera*
4	Palmyra palm	*Borassus flabellifer*
5	Alexandra Laurel/Sultan Champa	*Calophyllum inophyllum*
6	Jackfruit	*Artocarpus heterophyllus*
7	Bhenda	*Thespesia populnea*
8	Samudraphal	*Barrigtonia asiatica*
9	Belpata	*Hibiscus tiliaeceous*
10	Sukanu	*Cerbera manghas*
11	Kevada	*Pandanus odoratus*

HERBS		
1		*Spiniphex sp*
2	Motha Gokharu	*Pidalium murex*
3	Grass	*Panicum pudum*
4	Manila Grass	*Zyosia matrella*
5	Dloa Grass	*Aleuropus lagopoides*
6	Ardhaful	*Scaevola taccada*
7	Samudraghol	*Sesuvium portulacastrum*
8	Ran kanda	*Uregina indica*
9	Zarsi	*Glinus oppositifoliu*

CLIMBERS		
1	Maryadvel	*Ipomoea pes-caprae*
2	Karanjvel	*Denis trifoliata*
3		*Passiflorafoetida*
4	Sagar abai	*Canavalia maritima*
5	Sampsun	*Aristolochia indica*
6	Khari amarvel	*Cassytha filiformis*

SHRUBS		
1	Kadu Mendi	*Clerodendrum innere*
2	Sagargota	*Caesalpinia bonduc*
3	Pilu/Meswak	*Salvadora persica*
4	Waghati	*Capparis zeylanica*
5	Rui	*Calotropis gigantia*

NOTE : To prepare elements with the above plant types. Several combinations can be made keeping in mind the four tier structure.



SECTION SHOWING TIDAL WATER CLUSTER PLANTATION

ENVIRONMENTAL IMPACT

Roof gardens are most often found in urban environments. Plants have the ability to reduce the overall heat absorption of the building which then reduces energy consumption. The primary cause of heat build-up in cities is the absorption of solar radiation by roads and buildings in the city and the storage of this heat in the building material and its subsequent re-radiation. Plant surfaces however, as a result of transpiration, do not rise more than 4-5 °C above the ambient temperature and are sometimes cooler. Roof gardens are obviously very beneficial in reducing the effects of temperature against roofs without gardens.

Also rooftop gardens are also beneficial in reducing rain runoff. A roof garden can delay run off; reduce the rate and volume of runoff.

A key solution is to reduce peak flow by delaying (e.g., control flow drain on roofs) or retaining run-off (e.g., rain detention basins). Rooftop gardens can delay peak flow and retain the run-off for later use.

Available gardening areas in cities are often seriously lacking, which is likely the key impetus for many roof gardens. The garden may be on the roof of an autonomous building which takes care of its own water and waste. Hydroponics and other alternative methods can expand the possibilities of roof top gardening by reducing, for example, the need for soil or its tremendous weight. Plantings in containers are used extensively in rooftop gardens. Planting in containers prevents added stress to the roofs waterproofing.

VERTICAL GARDEN

A vertical garden or green wall is a wall partially or completely covered with vegetation that includes a growing medium, such as soil. Most green walls also feature an integrated water delivery system. Green walls are also known as living walls or biowalls. Such walls may be indoors or outside, freestanding or attached to an existing wall, and come in a great variety of sizes.

Vertical gardens are particularly suitable for cities, as they allow good use of available vertical surface areas. They are also suitable in arid areas, as the circulating water on a vertical wall is less likely to evaporate than in horizontal gardens.

The following is a list of plants which can be used for roof gardens and vertical gardens in MMR.

ROOF GARDEN : Dogwood, Asters, Euphorbia, Sedum, Reedgrass, Doobgrass, Plumeria

VERTICAL GARDEN : Portulaca, Pansy, climbers, succulents, mosses





Another aspect of urban greening which is not discussed in this manual is Roof gardens / Terrace gardens and vertical gardens.

ROOF GARDEN

A roof garden is any garden on the roof of a building. Besides the decorative benefit, roof plantings may provide food, temperature control, hydrological benefits, architectural enhancement, habitats or corridors for wildlife, and recreational opportunities.



ROOF GARDEN VS. GREEN ROOF





A roof garden is actually very different from a green roof, although the two terms are often and incorrectly used interchangeably. A roof garden is an area that is generally used for recreation, entertaining, and as an additional outdoor living space for the building's residents. It may include planters, plants, dining and lounging furniture, outdoor structures such as pergolas and sheds, and automated irrigation and lighting systems. A roof garden re-establishes the relationship between humans and nature that can be lost in urban environments. It is different from a green roof as in that the considerations are primarily of an aesthetic or recreational nature, whereas a green roof is usually constructed to cover a large area in the most economical and efficient means possible with an emphasis towards improving the insulation or the overall energy efficiency of cooling and heating costs within a building.

The panels that comprise a green roof are generally no more than a few inches to a foot in depth, since weight is an important factor when covering an entire roof surface. The plants that go into a green roof are usually sedum or other shallow-rooted plants that will tolerate the hot, dry, windy conditions that prevail on most rooftop gardens. With a green roof, "the plants layer can shield off as much as 87% of solar radiation while a bare roof receives 100% direct exposure".

The planters on a roof garden, on the other hand, can generally range anywhere from 6 inches up to 3 feet (0.15 to 0.9 m) in depth, depending on the weight-bearing capacity of the roof, and would be placed more for aesthetic purposes. These planters can hold a range of ornamental plants, anything from trees, shrubs, vines, or an assortment of flowers. Since the planters on a roof garden are placed in random fashion, it would be much less likely to provide the high environmental and energy benefits of a green roof.

Ref: http://en.wikipedia.org

2.4 SAMPLE CLUSTERS

It is clear that the physiographic conditions and the available space influence the choice of plant species. Following is an example showing how different clusters can be formed for one of the physiographic condition i.e. 'Plains'.

BIG TREES	
Common Name	**Scientific Name**
Kadam	*Neolamarkia cadamba*
Phanas	*Artocarpus heterophyllus*
Neem	*Azadirachta indica*
Samudraphul	*Barringtonia asiatica*
Apta	*Bauhiniara racemosa*
Shirish	*Albizia lebbeck*

SMALL TREES	
Common Name	**Scientific Name**
Parijatak	*Nyctanthes arbor-tristis*
Lokhandi	*Ixora parviflora*
Taman	*Lagerstromea speciosa*
Son Chafa	*Michelia champaca*
Bauhinia	*Bauhinia sp.*
Anant	*Gardenia jasminoides*

SHRUBS	
Common Name	**Scientific Name**
Sankasur	*Ceasalpinea pulcherrima*
Gauriphul	*Clerodendrum caudatum*
Kanher	*Nerium oleander*
Aboli	*Crossandra undulaefolia*
Jaswand	*Hibiscus rosa-sinensis*
Rat-rani	*Cestrum nocternum*

HERBS	
Common Name	**Scientific Name**
Sadaphuli	*Catharanthus roseus*
Tulsi	*Ocimun tenuiflorum*
	Syngoniu podophyllum
Marva	*Origanum majorana*
Gajar	*Daucus carota*
Gule makhmal	*Gomphrena globosa*

CLIMBERS	
Common Name	**Scientific Name**
Kunda	*Jasminum multiflorum*
Ran-jai	*Clematis gauriana*
Gokarna	*Clitoria ternatea*
Passion flower	*Passiflora caerulea*
Madhu malati	*Quisqualis indica*

GRASS	
Common Name	**Scientific Name**
Lemon grass	*Cymbopogon citratus*
Jungle rice	*Echinocloa colona*
Pink mist	*Muhlenbergia capillaris*
Fountain grass	*pennisetum hohenaekeri*
Tall reed	*Phragmates karka*

Now from the above plant list various permutations and combinations are possible. Keeping in mind that each cluster shall have atleast one species from each tier to achieve the desired effect.

For example:

CLUSTER 1		
Samudraphul	*Barringtonia asiatica*	- 1 no.
Sonchafa	*Machelia champca*	- 2 no.s
Sankasur	*Caesalpinia pulcherrima*	- 5 no.s
Sadaphuli	*Catharanthus roseus*	- 8 no.s
Madhumalati	*Quisqualis indica*	- 3 no.s
Lemon grass	*Cymbopogon citratus*	

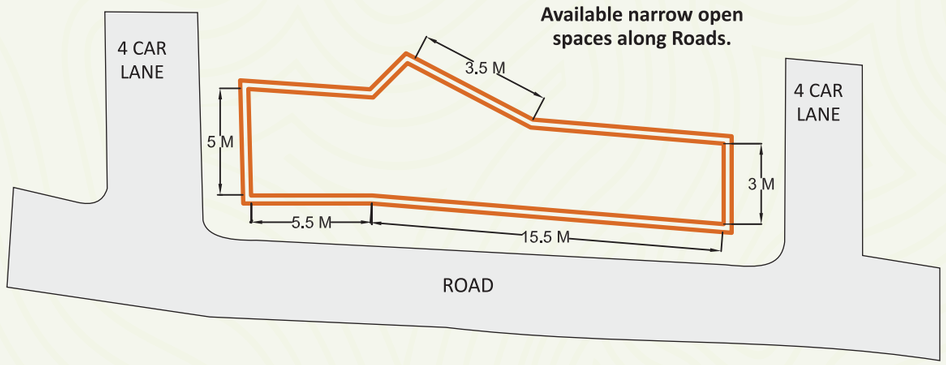
Similarly with the help of the above cluster another cluster can be made by differing the number of the species.

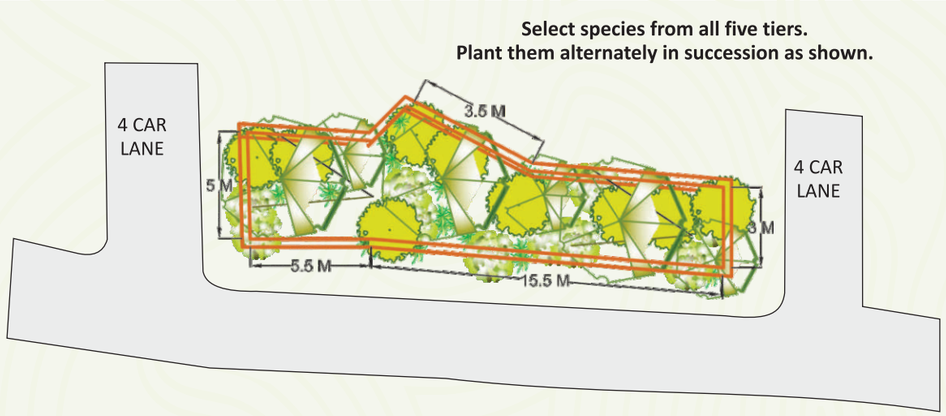
CLUSTER 2		
Samudraphul	*Barringtonia asiatica*	- 1 no.
Sonchafa	*Machelia champca*	- 1 no.s
Sankasur	*Caesalpinia pulcherrima*	- 8 no.s
Sadaphuli	*Catharanthus roseus*	- 6 no.s
Madhumalati	*Quisqualis indica*	- 4 no.s
Lemon grass	*Cymbopogon citratus*	

Similarly with the help of the above cluster another cluster can be made by differing the number of species and the type of species.

CLUSTER 3		
Samudraphul	*Barringtonia asiatica*	- 1 no.
Sonchafa	*Machelia champca*	- 1 no.s
Ananta	*Gardenia jasminoid*	- 1 no.s
Jaswandi	*Hibiscus rosa-sinensi*	- 5 no.s
Tulsi	*Ocimum tenuiflorum*	- 6 no.s
Madhumalati	*Quisqualis indica*	- 4 no.s
Jungle rice	*Echinochloa colona*	

Note: *The above mentioned clusters are just examples illustrating the methodology of the selecting plant species. The list is not an exhaustive list but only indicative*







SECTION OF CLUSTER PLANTATION ALONG 4 CAR LANE





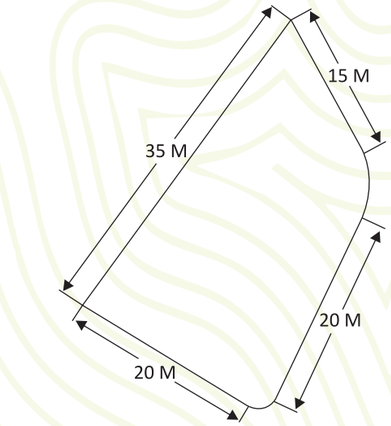
06
ROOF GARDENS

STAKE HOLDERS AND THEIR ROLES WITH RESPECT TO PLANTATION

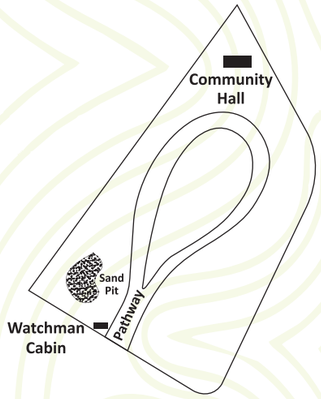
Urban greening manual based on plant associations is not a just a technical manual but a different perspective to urban greening. There is a need to generate awareness and shift in the way we look at our city, at all levels of our society, from decision making authorities to the end user. Also from scientific faculty to gardeners in green areas need to be exposed to this eco-sensitive ways of greening. To achieve the ultimate goal of more Bio-diverse urban greening, future action plan is charted out as follows.

FUTURE ACTION PLAN

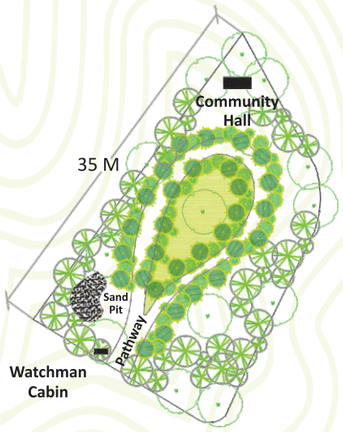
- Demonstration on a sample plot.
- Development for training module for HR enhancement.
- Outreach - Training , seminars, multi-media, publications.
- Translation in various other languages.
- Further research for tall buildings and associated greens.
- Amendments to DC rules.
- Further research on flora and fauna associations.













PLAN OF MEDIUM SIZE OPEN SPACE

CLUSTER PLANTATION OPPORTUNITY IN RECREATIONAL GROUND



LINEAR OPEN SPACE / LINEAR GARDEN



NEAR CYCLING OR JOGGING TRACK



CLUSTER PLANTATION HELPS TO CREATE A BARRIER FOR CENTRAL PLAYING AREA





CLUSTER PLANTATION NEAR PATHWAYS IN PARKS

Institutional Mechanism

Various players and agencies have a role to play in planning and execution of urban greening as suggested in this manual. Following matrix shows various tasks and players responsible for the plantation program.

PLAYERS \ TASK	Success Indicators	Monitoring and maintenance.	Resources for cluster plantation technique.	Implementing Agencies	Preparation of development plan for potential greening sites by owners.	Notification of green Corridors.	Identify open spaces for green corridors.
MMRDA			✓			✓	✓
MCGM Planning Department						✓	✓
MCGM Garden Department		✓		✓	✓		
CCF	✓	✓	✓	✓	✓	✓	✓
State Environment Department		✓	✓	✓		✓	✓
NGO Environment	✓	✓	✓	✓			✓
Institutes	✓	✓	✓	✓	✓		
PWD		✓		✓	✓		
MSRDA		✓		✓	✓		
SEZ Authority		✓		✓	✓		
SPA Developers		✓		✓	✓		
Nurseries			✓				
Contractors		✓	✓	✓			
Consultants	✓				✓		
Housing Societies		✓		✓	✓		
Private Owners		✓		✓	✓		
Gram Panchayat						✓	
Collectors						✓	

STAKE HOLDERS AND THEIR ROLES WITH RESPECT TO PLANTATION

The following chart indicates the current implemention process, as outlined by the MCGM in the document "adoption and development of Garden/ playground/ Traffic islands (locations and procedures)" (refer link *"www.Karmayog.com gardens/gardensindex.htm")* and proposed implementation processes.

Department Planning

List of available open spaces for adoption and

Identify green corridors other potential greening sites.

Advertising by MCGM for development of garden, floating of tender for contractors/ agency.

Advertising by MCGM for adoption.

Eligibility Norm should include ecologist in the team.

Tender document should include.

- Plant list of indigenous species.
- Area allotment for spaces for cluster plantation.
- Specification for green area around trees.
- Specification for ground covers.
- Conservation of old existing trees.
- Possibility of green corridor.
- Formation of a Committee that confirms to the idea of cluster plantation.

Application received in S.G. office.

Scrutiny AMC- MC- allotment

Along with allotment, M.C.G.M. to give guidelines for garden development as per cluster plantation technique.

Sponsorers to give detail development plan (based on guidelines to S.G.)

S.G. to receive proposal ensuring its confirmity to the urban greening manual and research document.

Progress of development/ maintenance reviewed after one year by S.G.

Bimonthly review/ supervision required for
- soil preparation
- procurement of saplings.
-plantation sequence. } As per manual

Continuation of contract (term 5 yrs.)
Review by S.G. at end of term.

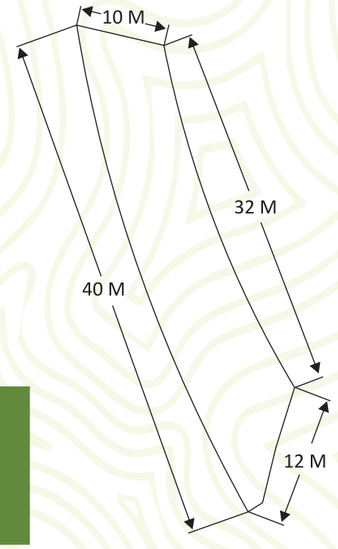
Agency to monitor flora/ fauna diversity of garden, seasonally.
Analysis of success indicators vis-a-vis bio-diversity.

NOTE

Stages of current garden development processes for gardens under MCGM are illustrated in green boxes.

Suggested stages/ additions/ reforms for effective implementation of cluster plantation technique are illustrated in red boxes.

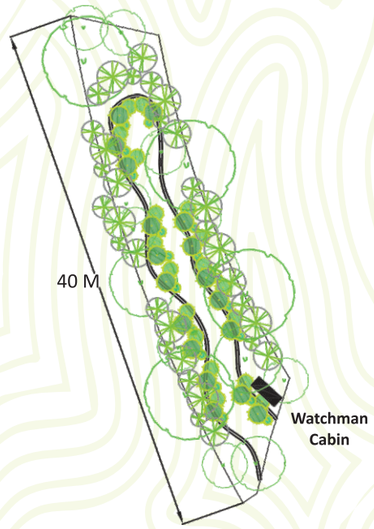
Available garden plots in typical residential neighbourhood



Plan for activities like jogging, walking, seating, entry, exits, lights etc.



Alternatively small clusters with bottom 4 tiers arranged in narrow linear spaces available.

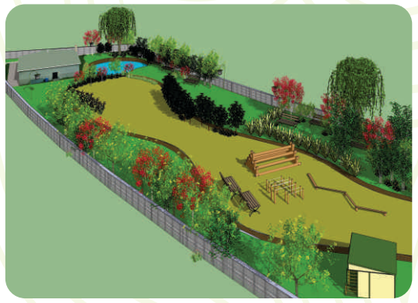


The designated open spaces have to provide for the functional requirement of the space such as walking areas, sitting areas, children play area and open playground etc. While providing for these requirements there is always a possibility to implement cluster plantation to some extent.

LINERAR OPEN SPACE/ LINEAR GARDEN

NOTE: *Refer the original research document titled Survey of biological resources in forest areas in mm to develop strategic manual for rejuvenation of native plant species, in and around urban mumbai for details.*

CLUSTER PLANTATION OPPORTUNITY IN RECREATIONAL GROUND



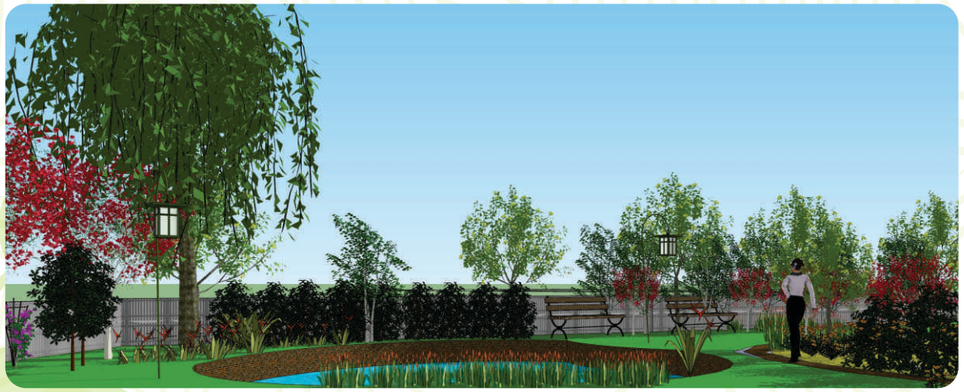
3D VIEW OF PLANTATION PLAN



MIXED PLANTATION IN A LINEAR AREA



CLUSTER PLANTATION HELPS TO CREATE A BARRIER FOR CENTRAL PLAYING AREA



PLANTATION ALONG SMALL WATER BODY WITH SOME SEATING ARRANGEMENT



05

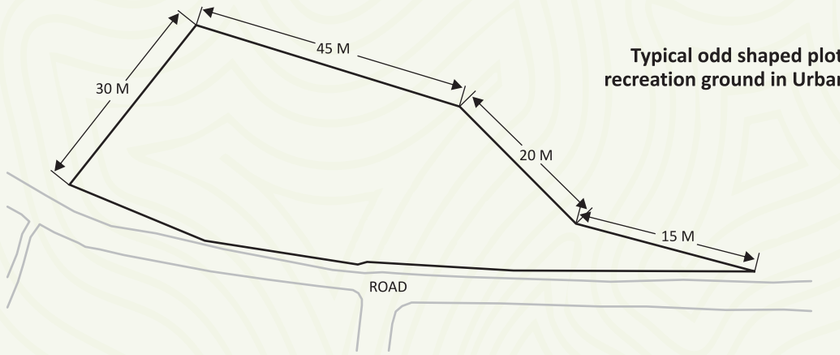
STAKE HOLDERS & THEIR ROLES WITH RESPECT TO PLANTATION

DO'S

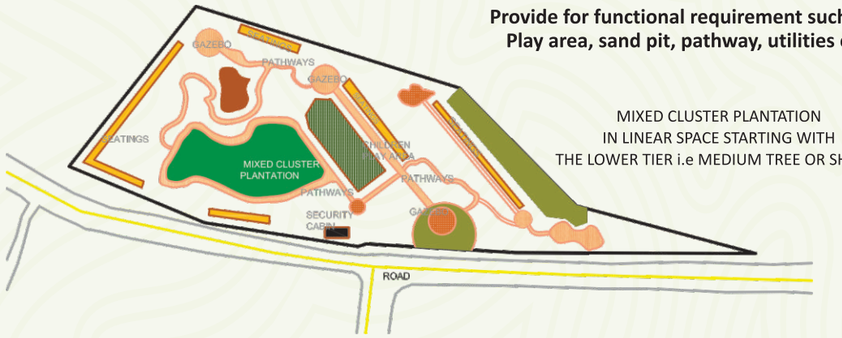
1. Monitor the growth of foliage, flowers, fruits, soil quality and use of fertilizers.
2. Check for any exotic species.
3. Monitor the birds, insects, butterflies etc. visiting the green area.
4. Since the garden is in the urban area check the moisture content required.
5. Pruning activity to be co-ordinated with vegetative propagation activity.
6. First pruning should be done post monsoon and care should be taken to avoid water logging. Second pruning should be done in spring season. (March/April).
7. Seed and sapling collection activities to be encouraged by stake holders.
8. Adequate water supply in summer.
9. Check list of the already planted species to be updated regularly.
10. Effective management of wet garbage and leaf litter to maintain moisture level in the top soil.
11. Vermi-composting to be encouraged in all garden.
12. Organic fertilizers to be used whenever required.

DON'TS

1. Human interference such as live-stock grazing, unnecessary cutting should be strictly restricted.
2. Other offences such as littering, garbage accumulation and sticking posters etc. should be avoided.
3. Do not sweep away leaf litter under the clusters.
4. Do not trim foliage excessively.
5. Plantation of Exotic species to be avoided.

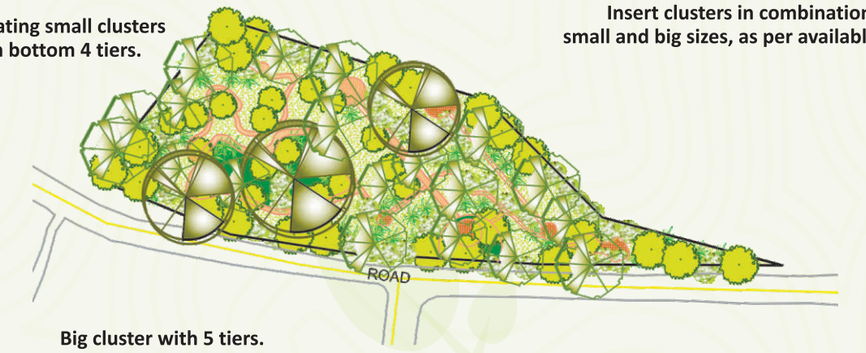


Typical odd shaped plot for recreation ground in Urban Area.



Provide for functional requirement such as Play area, sand pit, pathway, utilities etc.

MIXED CLUSTER PLANTATION
IN LINEAR SPACE STARTING WITH
THE LOWER TIER i.e MEDIUM TREE OR SHRUB.



Alternating small clusters with bottom 4 tiers.

Insert clusters in combination of small and big sizes, as per available space.

Big cluster with 5 tiers.

PLAN OF LARGE SCALE OPEN SPACE

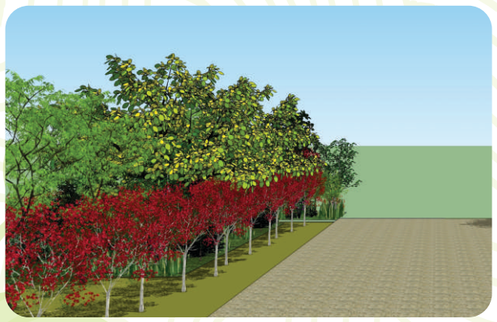
CLUSTER PLANTATION OPPORTUNITY IN RECREATIONAL GROUND



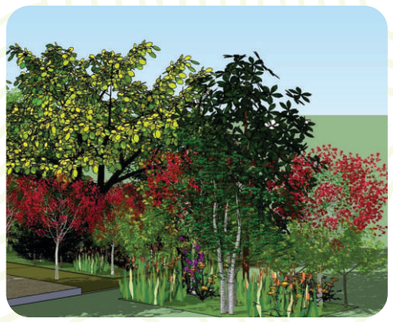
PLANTATION WITH SEATING ARRANGEMENT



PLANTATION IN LINEAR MANNER



PLANTATION ALONG ROAD



PLANTATION ALONG ROAD



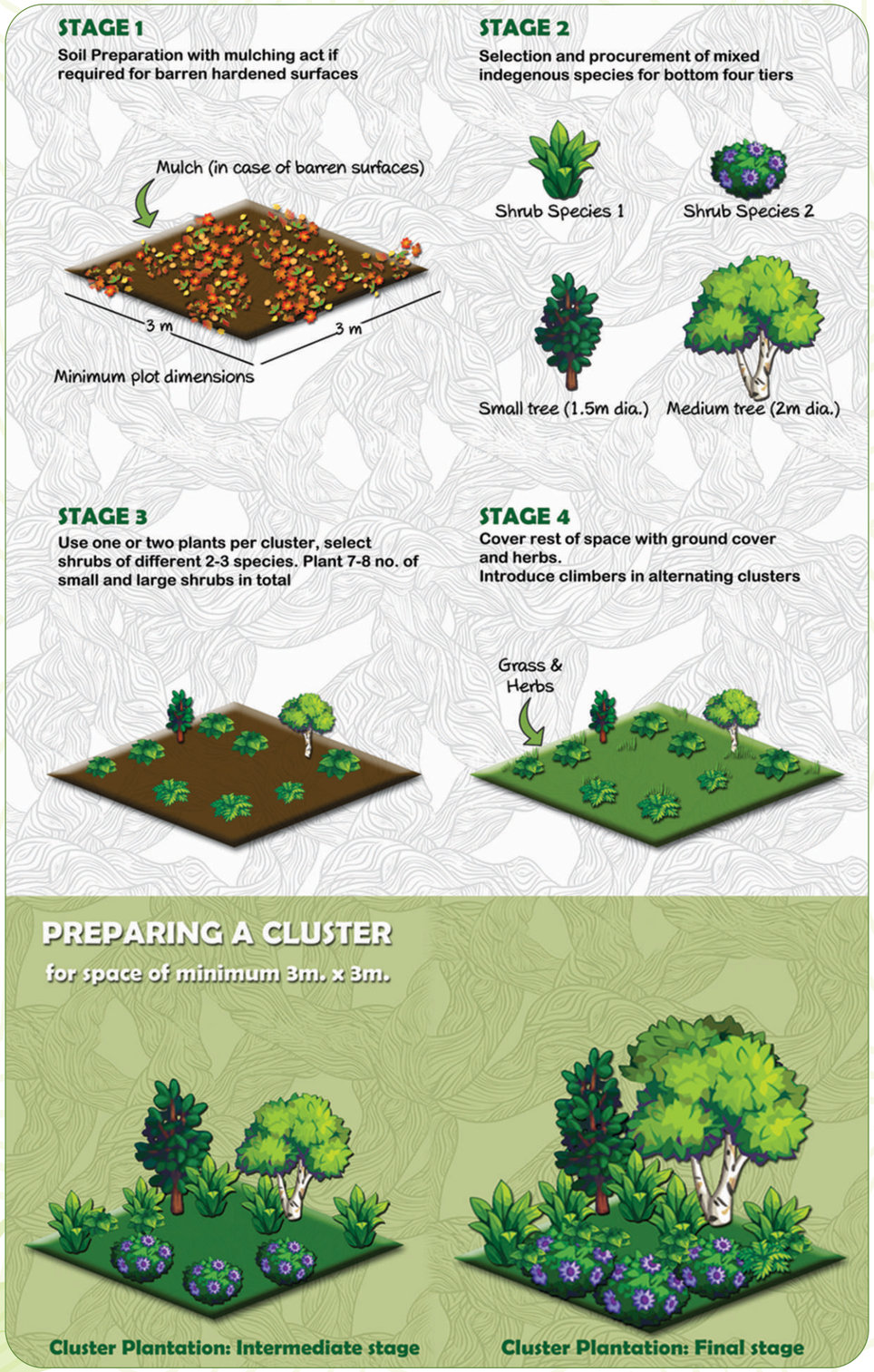
04
MAINTENANCE





03

PROCESS OF PLANTATION



Protection of tree saplings: Providing tree guards immediately after planting is necessary to protect the saplings from grazing animals. The tree guards are generally made of bamboos, old tar drums, brick jail and iron rods with welded mesh. The tree guard should be 50 cm. in diameter and 1.2 M in height.

9. **Maintenance :** Maintenance of plantation is very important and is to be done carefully. It includes watering, weeding, manuaring, mowing, pruning, mulching, pest and diseases control, etc.

   Watering : Water is required more frequently in early stages i.e. twice or thrice a week, but when the plants grows to a height of 1.2 M to 1.5 M the watering can be done once a week, taking care that the watering is required more frequently in dry and hot months and less frequently in monsoon. In fact depending on the intensity of rain, it may not require watering at all from June 15th til Sep 15th.

   Weeding & Pruning : Going by the principle of minimum manicuring, weeding is to be done only to remove the big unruly growths. Minor herbaceous growth can be ignored. The removed weeds can be used either for mulching or for making compost. Similarly pruning should be done either to remove the dried branches or to comply with the point 1 above i.e to remove branches that intrude into the children's play area or walkway or parking space etc. The trees should be pruned in such a manner that the natural shape is retained.

10. **Choice of plants :** Main points to keep in mind while choosing plants is that A) trees in a cluster plantation near parking or walk ways should have deep root system and should not lodge easily during monsoon. Palas and some of the Cassia species lodge easily and should be avoided. Similarly plants whose branch breaks easily e.g. Jamun, Sisoo (Delbargia siso) should be avoided under similar situation. B) At the edge of the water bodies avoid deciduous plants to avoid fouling of water. For example Pipal (Ficus religiosa), Terminalia catappa are semi deciduous and sheds lots of leaves in Mumbai winter. Therefore these should be avoided at the edge of the water bodies.

GUIDELINES FOR EFFECTIVE CLUSTER PLANTATION

1. **Manicuring :** Avoid over manicuring. Minimum trimming and lopping. Only trimming to and lopping a) to maintain children's play area, b) protruding branches to the walkway, footpath and parking and c) branches that disturb electric cables etc.

2. **Plant Variety :** Use of only one type of plant to be completely avoided. Equal proportion of vines/creepers, herb, shrub and trees to be used along with grass and ground covers.

3. **Structural Hindrances :** If overhead electric cables or any similar hindrances exists, plant small trees. Else big trees should be opted for.

4. **Attract Bees and Birds :** As far as possible there should be at least a few plants that give bright and attractive flowers and berries to attract bees, insects and birds. That will initiate a good ecosystem of fauna.

5. **Clearance of Site :** The site selected for plantation is to be cleared by removing wild vegetation, dried plants, plant roots, stones & debris and other unwanted materials.

6. **Preparation of Ground :** A ground is to be prepared for plantation of ground covers, lawn grasses & herbs by digging to a depth of 0.30 M, removing debris, spreading of 0.15 M fertile soil over the surface if the existing soil is not fertile, rough dressing the area, spreading of 0.05 M well decomposed manure over the surface, mixing of soil and manure to a depth of 0.20 M, rough dressing, consolidating with water, light mixing and fine dressing.

7. **Plantation of Lawn Grass or Ground Covers :** Lawn grass and ground covers are available in the nurseries or can be taken from the existing gardens in the form of cuttings. Lawn grass and ground covers are to be planted at 0.05 M distance by dibbling with the fingers. Watering is to be done every day for 30 days after grassing. There after watering can be done at every alternate day. Weeding is to be done as and when required and the weeded material can be used for making compost. Initial grass cutting is to be done with hedge shear followed by rolling with light roller to make a compact and leveled surface.

8. **Plantation of Shrubs and Tree Saplings :** The shrubs and tree saplings are available in the nurseries or can be prepared by using cuttings or seeds. It is planted by digging pits of any shape either circular or square and of suitable size. If the original soil is not very rich, it is advisable to replace it with fertile soil (at least 50% of original soil can be replaced) to help the growth of tree sapling. A pit is to be filled with a mixture of excavated/fertile soil and well decomposed manure at 3:1 proportion. A shrub or tree sapling is planted at the center of pit in such a way that the ball of earth covering roots of sapling should remain below the surface. Only one shrub or tree sapling should be planted in each pit and the polythene bag of sapling is to be removed before planting. The refilling of the pit should be slightly overfilled and the top of the filling should be firmed by pressing with hands. On firming the soil tie the trunk of tree sapling to the wooden stake to give it support if it is more than 3 feet high. Lastly place a mulch of 50 mm thick over the top refilled portion of the pit to reduce water losses. In low lying areas the tree should be planted on a minimum 300 mm high and 900 mm diameter mound with all sides sloping.

The pit size for shrubs and trees and distance between two plants are as below.

Sr. No.	Type of Plant	Size of Pit	Distance Between Two Plants
1	Small & medium shrubs	0.45 M X 0.45 M X 0.45 M	0.45 M to 0.60 M
2	Tall shrubs	0.60 M X 0.60 M X 0.60 M	1.0 M to 1.5 M
3	Small & medium trees	0.60 M X 0.60 M X 0.60 M	3.5 M to 5.0 M
4	Big trees	1.00 M X 1.00 M X 1.00 M	7.0 M to 10.0 M

CLUSTER PLANTATION TECHNIQUE:

Clusters of plants are generally defined as a group of heterogeneous plant species with homogenous habitats and requirements to grow. A cluster may compose of plant species of different habit which grow and develop in a single habitat.

Cluster plantation is very popular and widely accepted novel method of plantation in several tropical countries, as the clusters or mix species plantations have several benefits like, rapid growth, low mortality ratio and less maintenance after the plantation. Further, cluster plantation or Mix Species plantation always encourage the native species to grow and support the associated flora and fauna in the region. The other benefit of mix species plantation is the competition within the cluster for growth, resources and sunlight; According to Prof. Akira Miyawaki of Japan, such conditions occur if the cluster plantations are created in urban areas, where the resources for plant growth is a major limiting factor.

Mix species plantation has shown more than 40% of survival ratio and increase in growth rate by around 1.5 times in Japan, Malaysia and Brazil.

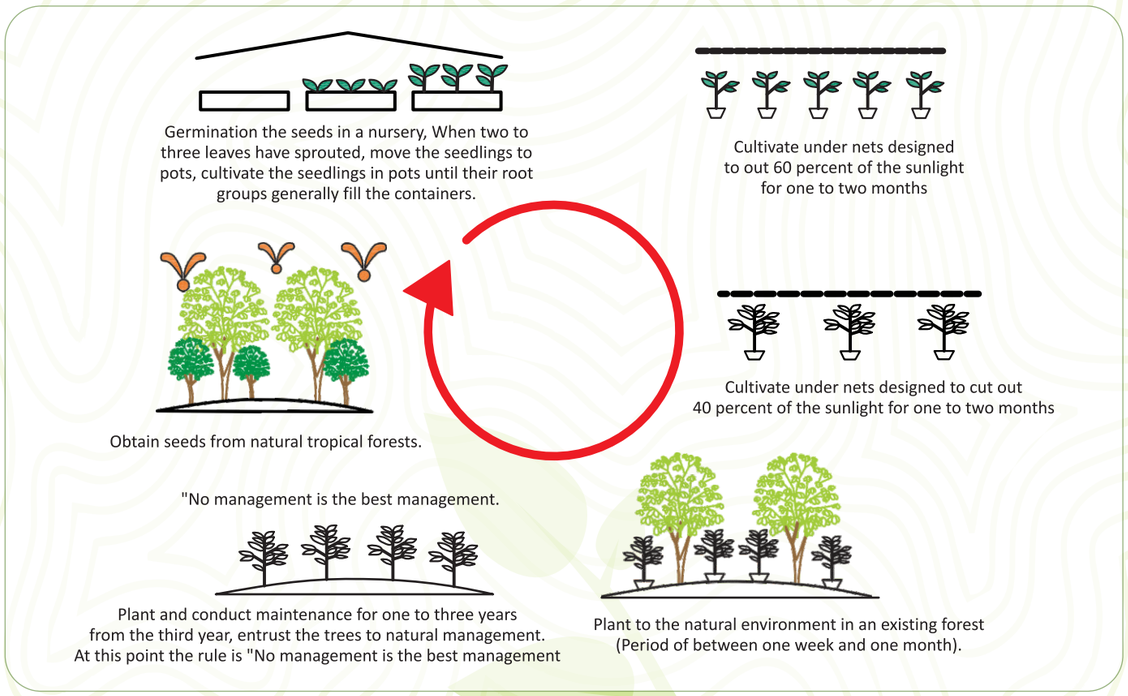
CLUSTER SAMPLING:

Cluster sampling is a sampling technique used when "natural" groupings are evident in a forest. Elements within a cluster should ideally be as heterogeneous as possible, but there should be homogeneity between clusters. Each cluster should be a small scale representation of the total population and should be mutually exclusive and collectively exhaustive. A random sampling technique is then used on any relevant clusters to choose which clusters to include in the study.

In present research study, such clusters were surveyed in the natural habitats and identified to grow in similar kind of habitat in MMR. The survey includes two natural forests to identify the clusters and also urban green areas to reveal the existing clusters in MMR. Plant species most commonly occurring in same habitats were identified and their similar (homogeneous) characters were listed. Study of their ecological functions, carbon storage values and other economic values revealed the best heterogeneous group of plant species that can be planted to restore the native ecosystem in Mumbai Metropolitan Region.

Cluster plantation methodology had been introduced first in Japan by Prof. Miyawaki (1987) and is in practice in many tropical countries and islands.

THE MIYAWAKI METHOD FOR RESTORING TROPICAL FORESTS



The outline of pot seedling plantation method is provided below in the form of a flow chart for easy understanding. The flow chart explains different steps involved in the pot seedling plantation techniques according to Miyawaki method.



PLAN YOUR RESOURCES

To plan and phase greening project for given site, you need to allocate various resources such as time, space, labor, material, for different stages of the planting project.

Below is the chart showing stages for actual execution of the work and how much resources intensive each stage is. Let us say that you have now identified the site and planting layout. Now plan phase wise implementation of the planting program.

STAGE	Time (Period)	Time (Intensity)	Space	Labour	Material
Seed/ Sapling Collection	0-1 year	Maximum	Moderate	Minimum	
Preparation of Saplings	3-6 months				
Acclimatization for saplings	3-6 months				
Soil Preparation	1-6 years				
Transfer from Pot to Soil	3-6 months				
Primary Nurturing	1-2 years				
Periodic Maintenance as Required					

NOTE :

Stage 1, 2, 3 can run simultaneously.

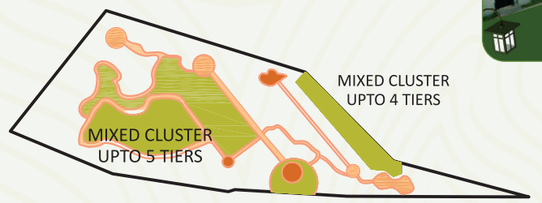
Stage 1, 2 will precede Stage 3

Stage 3, 4 will precede Stage 4

STEP 5

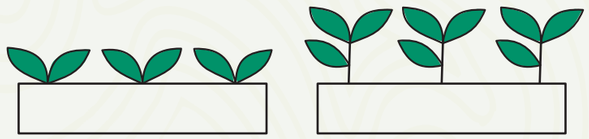
Make a plantation plan using the principles outlined in the cluster plantation technique including functional plan of the space. Refer to Chapter 2.2 .





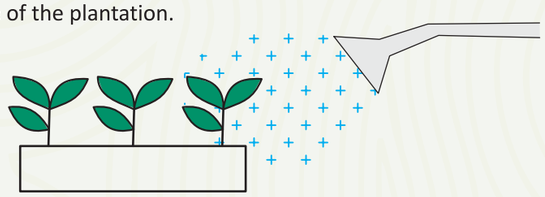
STEP 6

Procure saplings and prepare the ground



STEP 7

Plan for the maintenance of the plantation.



STEP 8

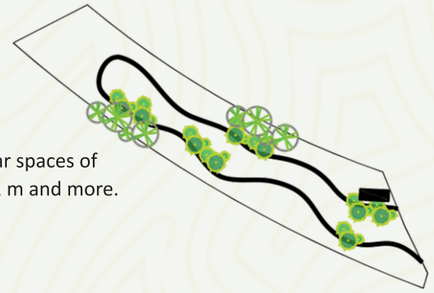
Begin the plantation program.



PLANNING FOR DIFFERENT TYPES OF OPEN SPACES

STEP 3

Classify the space in terms of its shape and size.



Linear spaces of
width 1 m and more.



Small garden/ Small pockets
upto 1000 sq.m



Large garden more
than 1000 sq.m.

STEP 4

Prepare a plantation layout. Select the species from the five tiers (big trees, small trees, shrubs, herbs, climbers) and as per the Physiographic Conditions Refer to Chapter 2.3 .



BIG TREE



MEDIUM TREE



SHRUBS



HERBS



PLANTS

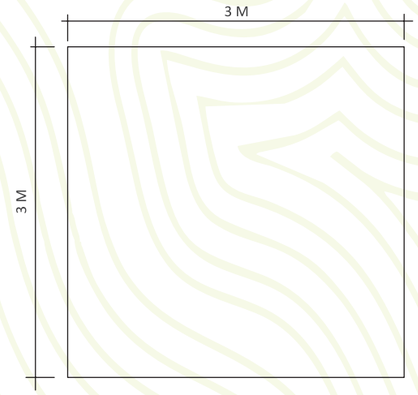


CLIMBER



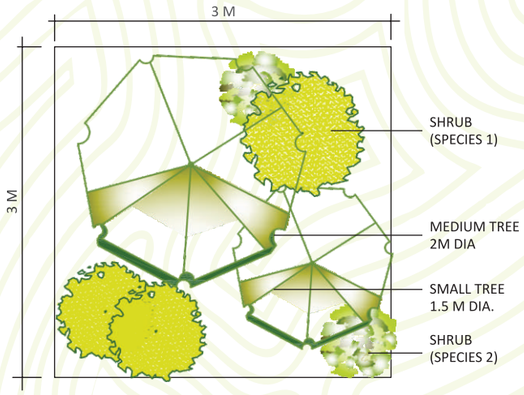
GREEN COVER/
GROUND COVER

PREPARING A CLUSTER FOR SPACE OF MIN 3M X3M



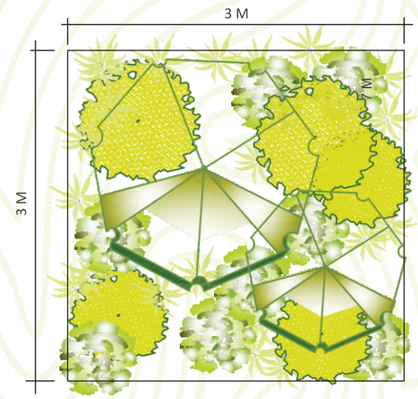
STAGE 1

Soil preparation with mulching act if required for barren hardened surfaces.



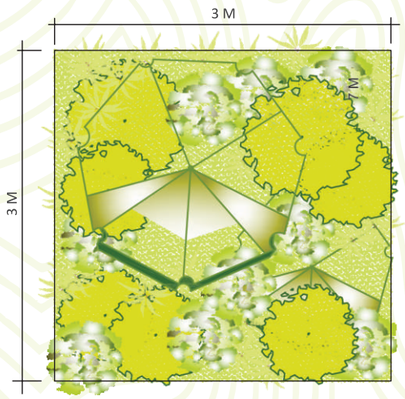
STAGE 2

Selection & procurement of mixed indeginous species of bottom four tiers.



STAGE 3

Use one or two trees per small cluster. Select shrubs of different 2-3 species, plant 7-8 no of shrubs (combination of small and large shrubs) in total.



STAGE 4

Cover rest of space with ground cover and Herbs. Introduce climbers in alternating clusters.

NOTE: Refer the original research document titled 'Survey of biological resources in forest areas in MMR to develop strategic manual for rejuvenation of native plant species, in and around urban Mumbai' for details.

PREPARING A CLUSTER FOR SPACE OF MIN 3M X 3M



CLUSTER PLANTATION INDICATING INTERMEDIATE STAGE



CLUSTER PLANTATION INDICATING FINAL STAGE

NOTE: Refer the original research document titled 'Survey of biological resources in forest areas in MMR to develop strategic manual for rejuvenation of native plant species, in and around urban Mumbai' for details.

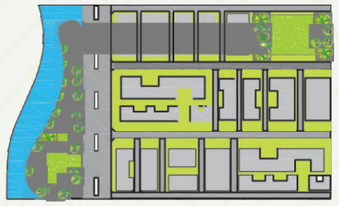
STARTING WITH THE PLANTATION PROGRAM

The spatial arrangements given in the following pages is only a suggestive layout for achieving the derived mixed species plantation. Many more alternatives of spatial plans can be possible using this guideline.

Once the site is finalised, then starts the plantation program. The table given below explains how to go about it and steps to follow the same.

STEP 1





Identify the place for plantation.

STEP 2

Classify the space in terms of its physiography.



Plains



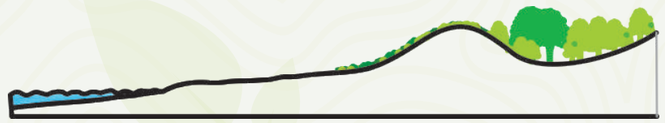
Hilly Slopes



Creek



Rivers/Fresh Water Buffer Zon



Tidal Water Buffer