1 Recommended Grass Species

Grasses 1 - *Cymbopogon citratus*

Cymbopogon citratus **Family** Poaceae **Common names** Sera, West Indian Lemongrass, Lemongrass	
Character	Perennial grass
Description	Stiff stems are arising from a short rhizomatous rootstock. Root system is fibrous. Leaves are long and normally the length is about 1 m.
Major Growing Areas	Well suitable for tropics. It grows best from 100 to 1200 metres elevation. Grown well under sunny conditions. It grows best in areas where annual daytime temperatures are within the range 23-30°c, but can tolerate more than that It prefers a mean annual rainfall in the range 1,500 - 3,000mm, but tolerates 700 - 4,200mm. Under heavy rainfall there may have large amount of well grown leaves, but oil content is less.
Soil Type	Requires a well-drained soil - commercial plantations often favour sandy soils. Slightly acidic loamy soil also better. It can tolerate weak soils. Prefers a pH in the range 5 - 5.8, tolerating 4.3 - 7.3. hard clay soil is not suitable.
Propagation	Seed propagation is possible. New seeds should be used since the liability of seeds are reduced rapidly. Direct sowing of seeds or nursery plants can be introduced to the field. Division of established clumps can be used. The offshoots are cut back to 10 - 15 cm, trimmed of dead and excess roots and then planted either direct or into nursery beds.
Cultivation and Maintenance	Spacing of planting is 60x60 cm for field establishment. Soil should be loosened before planting. For land with a slope the spacing should be 45x60 cm can be used to reduce soil erosion. Normally, 24,000-28,000 plants are required per hectare. Irrigation is not required except drought seasons. Fertilizer application should be done to increase yield. Weed growth is high during 1st month from planting. Weeding should be done during this time. Pest and diseases are lesser than other crops. Harvesting begins when the crop is 120 - 240 days old, and the plant is subsequently harvested every 90 - 120 days. Harvesting should be done 10 cm height from the ground. The average annual foliage yield is 30 - 50 tonnes per hectare.
Products and Uses	The heart of the young shoots is eaten as a vegetable with rice. The basal portions of the leafy shoots have a lemon-like aroma and are used as a flavouring in soups, sauces and curries. Older leaves can be cooked with other foods. The essential oil is used as a flavouring in the food industry in soft drinks and various foods. The essential oil obtained from the plant is an effective antifungal and antibacterial. An essential oil obtained from the plant is used in perfumery, scenting soaps, hair oils, cosmetics and as an insect repellent. The fresh leaves, crushed in water, are used as a hair wash and toilet water. The plant is used for cellulose and paper production.
Contribution for Soil Conservation	A good soil conditioner in worn out land. The plants quickly produce a bulk of organic material, attracting worms and other beneficial creatures and quickly enriching the soil. The grass is useful for soil improvement and erosion control.

Grasses 2- *Chrysopogon zizanioides*

Chrysopogon zizanioides ***Family*** *Poaceae* ***Common names*** *Vetivergrass, Savandara*	 
Character	Perennial grass
Description	Forms dense and erect 1-3 m tall clumps with narrow linear, tightly folded leaves. Fibrous roots are long and white. When crushed, they emit a somewhat earthy, sandalwood-like fragrance. It has an underground, horizontal stem known as a rhizome.
Major Growing Areas	A plant of the tropics. It is found at elevations up to 2,500 meters. It grows best in areas where annual daytime temperatures are within the range 22 - 35^{0}c, but can tolerate 12 - 45^{0}c. It prefers the areas which having a mean annual rainfall in the range 500 - 2,500mm, but tolerates 200 - 5,000mm. This species can tolerate occasional flooding. Floodplains, bank of streams and rivers, rich moist soil are some available sites.
Soil Type	Suitable for light (sandy) and medium (loamy) soils. Suitable pH is acid, neutral and basic (alkaline) soils and can grow in very acid, very alkaline and saline soils. It prefers moist or wet soil and can tolerate drought. Prefers a pH in the range 4.5 - 8, tolerating 3 - 9.9.
Propagation	Seed and divisions are used for propagation
Cultivation and Maintenance	A yield of 1 - 5 tonnes of dried roots per hectare can be harvested annually, at an oil content of 0.7 - 2.5%, this produces 40 - 100 kilos of essential oil.
Products and Uses	The essential oil obtained from the roots is used medicinally as a carminative, diaphoretic, diuretic, emmenagogue, refrigerant, stomachic, tonic, antispasmodic and sudorific. The plants are used as an anthelmintic. Oil extracted from the roots is used in 90% of Western perfumes.
Contribution for Soil Conservation	Unlike most grasses, which tend to have a more or less surface-rooting habit, the very dense root system has a strong tendency to grow downwards for 4 meters or more. This effectively anchors strips of plants and the soil behind them. The plant can be in strips as permanent field boundaries and planted to protect sloping drains. Its use as an erosion-control. Planting for erosion control and to protect terraces and road shoulders. Strips of densely packed, stiff and tough grass stems break the speed of run-off water and divide it evenly, reducing the risk of formation of run-off streams and gully erosion.

Grasses 3- Chrysopogon nardus

Chrysopogon nardus ***Family*** *Poaceae* ***Common names*** *Ceylon Citronella, Heen pangiri, Nawa citronella, Lena batu*	
Character	Perennial grass
Description	It is an aromatic, evergreen, clump-forming grass. It is growing up to 2.5 m tall from a shout rootstock.
Major Growing Areas	Grown in wet tropics and subtropics. It is grown well in the elevation up to 600 m, but it can grow more than that elevation. It can face well for drought conditions. Mostly grown in Hambantota area. Small cultivations are in Matale and Rathnapura districts. It grows best in areas where annual daytime temperatures are within the range 20-30°c, but can tolerate more than that. It prefers a mean annual rainfall in the range 1,300 - 2,000mm. It prefers sunny conditions.
Soil Type	Prefers moisture-retentive soils. Sandy soil also can be used for cultivation. Prefers a pH in the range 4.5 - 6, tolerating 4 – 8.
Propagation	Seed propagation is done using surface sowing or just covering or sowing the seed in a nursery. Division of established clumps can be used. Those are dipped in wet coir dust about a weak for rooting. The offshoots from this species often fail to establish.
Cultivation and Maintenance	Weeding and land preparation should be done before planting. Field establishment is better in rainy seasons.60x60 cm spacing can be used. 7,000-12,000 plants per acre is needed. Well drained condition is needed since it is more sensitive for moisture content. Irrigation should be done around 20 days after planting in drought seasons. It takes about 20 days for establishing in field. Synthetic or organic fertilizer can be used. Residues from the plant and other plant leaves are mostly used. Weeding is needed in 1st two months after planting. Severe pest and diseases are not recorded. Harvesting can be done after 6-8 months from planting. Harvesting interval is about 3 months. Around 6 well grown leaves per shoot is the harvesting indices.
Products and Uses	The leaves are used for flavouring the curries, soups etc. An aromatic tea can be obtained from leaves. The oil contains geraniol, citral and citronellal. It is much used by food industry to flavor a wide range of foods. The leaves are antispasmodic, diaphoretic, digestive and stimulant. Essential oil is obtained from whole plant distillation an it is used for different productions such as varnishes, insecticides, polishes, perfumery etc.
Contribution for Soil Conservation	Erosion control by using for live hedges in slope lands.

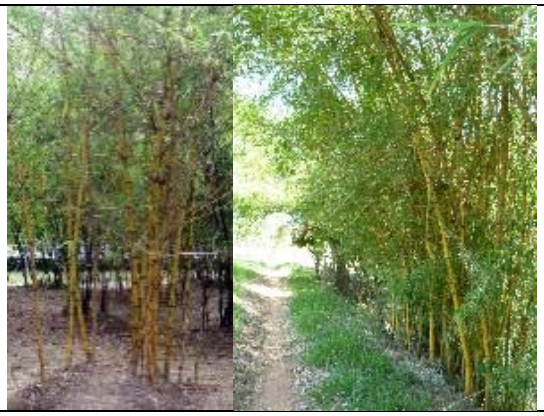
Grasses 4- *Imperata cylindrical*

Imperata cylindrical ***Family*** *Poaceae* ***Common names*** *Iluk*	 
Character	Perennial grass
Description	*I. cylindrica* is a perennial grass which varies in height (30-150 cm). The culms (above-ground stems) are short, erect and arise from rhizomes (underground stems). The rhizomes are tough, white, commonly 1 m long but can be considerably more, are extensively branched and covered with papery scale leaves at the nodes. Roots are fibrous, emerging from the base of the culm and the nodes on the rhizome. Leaves are stiff, linear-lanceolate, up to 120 cm long and 4-18 mm wide, with a prominent, off-centre, whitish midrib, scabrid margin and pointed tip. The ligule is an inconspicuous membrane. The inflorescence is a white, spike-like panicle, terminal, fluffy, 5-20 cm long and up to 2.5 cm in diameter. Spikelets are numerous, 3.5-5.0 mm long, each surrounded by a basal ring of silky hairs 10 mm long. The grain is oblong, pointed, brown and 1-1.5 mm long.
Bioengineering significance	Suspected allelopathic properties (Eussen et al., 1976) and a vigorous growth habit have made I. cylindrica one of the most competitive weeds. The aggressive and invasive nature of I. cylindrica is largely attributed to its extensive rhizome system which is concentrated in the upper 20 cm of soil. The lateral buds can remain dormant for long periods and give I. cylindrica its perennation habit. The bud from a single rhizome node can give rise to 350 shoots in 6 weeks, which can cover up to 4 m^2 in 11 weeks (Eussen, 1980). Other reports of I. cylindrica's productivity are that 2.73 m of rhizome can be produced in 109 days (Wilcutt et al., 1983) and that a 15 cm length of rhizome can produce 181 shoots per m^2 in 6.5 months (Lee, 1977).
Ecological significance	Worst perennial grass weed of southern and east Asia
Further readings	Invasive Species Compendium (https://www.cabi.org/isc/ datasheet/28580)

Grasses 5- *Arundo donax*

Arundo donax ***Family*** *Poaceae* ***Common names*** *Bata gas*	
Character	Large clumping perennial grass
Description	Giant reed (Arundo donax L.) is a robust erect perennial grass species reaching up to 14 m height under optimal growth conditions, growing in many-stemmed clumps. Individual tough and hollow stems, 3-5 cm in thickness, have a cane-like appearance similar to bamboo with alternate leaves, 30-60 cm long and 2-6 cm broad, tapered tips and hairy tuft, at the base. This stem structure is able to support the erect position of such a tall plant. Several stems grow from the rhizome buds during all the vegetative season, forming dense clumps. Arundo grow fast and produce huge biomass per unit land area. Propagate easily by stem and rhizome cuttings.
Bioengineering significance	Giant reed has a widespread network of rhizomes under the soil surface, 5-30 cm in depth. The fibrous roots originating from the rhizomes are able to grow into the soil to 5 m in depth in certain moist soils, whereas, most roots are more than 100 cm long. The rhizomes (3-8 cm wide and 10-25 cm in length) grow tough, fibrous and long tap roots.
Ecological significance	Worst perennial grass weed of southern and east Asia
Further readings	Alshaal, T.; Elhawat, N.; Domokos-Szabolcsy, É.; Kátai, J.; Márton, L.; Czakó, M.; El-Ramady, H.; Fári, M.G. Giant reed (Arundo donax l.): A green technology for clean environment. In Phytoremediation; Ansari, A.A., Gill, S.S., Gill, R., Lanza, G.R., Newman, L., Eds.; Springer International Publishing: Cham, Switzerland, 2014; Volume 1, pp. 3–20.

Grasses 6- *Bambusa vulgaris*

Bambusa vulgaris ***Family*** *Poaceae* ***Common names*** *Kaha-una*	
Character	Densely tufted culms
Description	Bambusa vulgaris, common bamboo, is an open-clump type bamboo species. Bambusa vulgaris forms moderately loose clumps and has no thorns. It has lemon-yellow culms (stems) with green stripes and dark green leaves. Stems are not straight, not easy to split, inflexible, thick-walled, and initially strong. The densely tufted culms grow 10–20 m high and 4–10 cm thick. Culms are basally straight or flexuose (bent alternately in different directions), drooping at the tips. Culm walls are slightly thick. Nodes are slightly inflated. Internodes are 20–45 cm. Several branches develop from mid-culm nodes and above. Culm leaves are deciduous with dense pubescence. Leaf blades are narrowly lanceolate. Flowering is not common, and there are no seeds.
Bioengineering significance	The average apparent cohesion of the bamboo root system is estimated in the range of 18.4–26.3 kPa and its reinforcement effect on the slope stability is very limited due to the very shallow rooting depth. The shallow root distribution depth (0.8–1.0m) and large growth height (>10m) are critical to the collapse failure of slope land with bamboo. The reinforcement effect of root systems on the slope stability is relatively small when compared with the influences of the wind loading and rainfall. The maximum stabilization capacity when compared with those of slope land with mild (<25◦) and steep slopes (>40◦).
Ecological significance	Most common bamboo type in Sri Lanka
Further readings	Lin DG, Huang BS, Lin SH (2010) 3-D numerical investigations into the shear strength of the soil-root system of Makino bamboo and its effect on slope stability. Ecol Eng 36:992 1006. Stokes A Lucas A Jouneau L . 2007. Plant biomechanical strategies in response to frequent disturbance: uprooting of Phyllostachys nidularia (Poaceae) growing on landslide-prone slopes in Sichuan, China. American Journal of Botany 94: 1129–1136.

2 Recommended minor export crop (MEC) species

MEC 1- *Coffea Arabica*

Coffea arabica ***Family*** *Rubiaceae* ***Common names*** Coffee	
Character	Globose, evergreen plant
Description	It is usually found as a compact shrub 1.5 - 3 meters tall. The bole can become up to 8cm in diameter. Have an open branching system. There are main vertical roots, tap roots, and lateral roots which grow parallel to the ground.
Major Growing Areas	It can find an ideal place in elevation ranging from 750m. It grows best in areas where annual daytime temperatures are within the range 18 - 24°c, but can tolerate 10 - 34°c. It prefers a mean annual rainfall in the range 1,500 - 2,750mm, but tolerates 750 - 4,200mm. Prefers a position in light shade. Shading improves leaf and shoot growth but reduces root growth. Kandy, Matale, Nuwara-Eliya, Badulla, Moneragala, Kegalle, Gampaha, Galle, Matara and partly Kurunegala are the districts suitable for coffee cultivation in Sri Lanka.
Soil Type	Prefers a deep friable soil on undulating land. Plants are unsuited to stiff clay or sandy soils, but are considered tolerant of acid soils. Prefers a pH in the range 5.5 - 7, tolerating 4.3 - 8.4.
Propagation	Propagation is usually by seed since it is easy and less expensive. The older the seeds, the longer they take to germinate, and they lose viability. They can be planted with the parchment attached but germination is quicker when it is removed. Layering, Air layering, Budding can be used. For rooting of coffee cuttings, the single leaf-bud cutting is commonly used.
Cultivation and Maintenance	Planting spacing is varying according to the slope of land. It can be cultivated as monocrop or as a member in the intercropping system. Spacing for monoculture is 1.8x1.8 m (3,000 plants/ha) or 1.8x2.5 m (2,200 plants/ha). Planting can be done during wet periods. Mulching with green manure is done for conservation of soil and controlling weeds. Fertilizer applications, earthling up, shade management, Pest and diseases control, liming and pruning and training should be done. The plant is often intercropped with food crops, such as corn, beans or rice, during the first few years of growth.
Products and Uses	The dried seeds are roasted, ground, and brewed to make one of the two most popular beverages in the world. Leaves - cooked. The cooked leaves have a strong brown colour, a good texture and a rather neutral flavour with only a hint of bitterness. The seed contains caffeine, a widely used stimulant that is also used in proprietary painkillers to potentiate the effect of aspirin and paracetamol. controls vomiting.
Contribution for Soil Conservation	Firmly hold on to soil, hold soil tightly, wind barrier. Erosion control can be done by cultivating coffee with low spacing.

MEC 2- *Myristica fragrans*

Myristica fragrans ***Family*** Myristicaceae ***Common names*** Nutmeg	 
Character	Evergreen perennial tree
Description	Strongly aromatic, slow-growing with a dense, conical crown. It usually grows 3 - 15 meters tall, but can reach 20 meters. There is some evidence to suggest that the Roman priests may have burned nutmeg as a form of incense. Nutmeg is reported to have been introduced to Sri Lanka at the beginning of the 19th century.
Major Growing Areas	Nutmeg prefers cooler climates hence mid country areas of Sri Lanka are ideal for the growth of nutmeg. The total extent of Nutmeg in Sri Lanka is 924ha and from which 80% of the extent is in Kandy district. Other major growing areas are Kegalle and Matale districts. It grows best in areas where annual daytime temperatures are within the range 22 - 34°c, but can tolerate. Areas which having well-distributed rainfall of 1,500-2500mm is better.
Soil Type	Deep well-drained loams and sandy clay loams rich in organic matter are preferable. Soils with high water table or liable to waterlogging are unsuitable. Prefers a pH in the range 6 - 7, tolerating 5.5 - 7.5.
Propagation	Seed propagation can be done. It is best sown when fresh. Cuttings of half-ripe wood, air layering, grafting of known female forms onto seedlings are other possibilities.
Cultivation and Maintenance	Spacing for field planting is 20'x20'(250 plants/ha.). Planting is done with the onset of monsoon rains. The soil around the plant has to be mulched adequately after the planting. Shading should be done after field planting. Fertilizer application, terracing and weed control are needed. It is essential to bench terrace the base of the seedling particularly in sloping lands. There are no economically important disease and pest problems. Peak harvest comes after 20 years of age. Average yield is 1500dry nutmeg/tree/year and 1-1.5kgdry mace/tree/year.
Products and Uses	The seeds are the source of the spice nutmeg. The dried flesh surrounding the seed is the source of the spice mace. Essential oils and extracts are often used in the canning industry, in soft drinks and in cosmetics. The essential oil has insecticidal, fungicidal and bactericidal activity. The seed of nutmeg is a bitter, astringent, spicy herb that acts as a warming, digestive tonic.
Contribution for Soil Conservation	Firmly hold on to soil, hold soil tightly may help to reduce soil erosion.

MEC 3- *Eugenia caryophyllus*

Eugenia caryophyllus ***Family*** *Myrtaceae* ***Common names*** *Clove*	 
Character	Evergreen tree
Description	The plant can grow around 20 metres tall. The short bole can be around 25cm in diameter. It has large leaves and flowers grouped in terminal clusters. The flower buds initially have a pale hue, gradually turn green, then transition to a bright red when ready for harvest. The trunk up to 30 cm in diameter is composed of very hard wood. The seedlings produce a pronounced tap root which remains relatively short and is quickly replaced by two or three primary sinkers which develop from it.
Major Growing Areas	Cloves thrive in lowland humid tropical areas up to 1000m elevation. The areas are having the average rainfall of 1750- 2500mm per annum and annual average temperature should be 20 - 30 o C without much seasonal variation. Clove is mainly grown in Mid Country wet zone of Sri Lanka. Total extent of clove is 7618ha.
Soil Type	Clove grows well in a variety of soils. Deep and rich loams with high humus content are best. Pure sandy soil is unsuitable. Soil should be well drained. Growth can be sustained on poor and acid soils. The soil pH should range from 4.0 to 5.6.
Propagation	It is propagated through seeds. Tree ripe fruits should be sown immediately since the viability of seeds is rapidly lost within 48 hours of collection. Cuttings of terminal leafy softwood, kept in a frame at high humidity until they have rooted also a possible propagation method.
Cultivation and Maintenance	Spacing of planting is 20'x20' for field establishment. Shading should be done during sunny seasons. Fertilizer application can be done according to the recommendations for synthetic fertilizers. There are no serious diseases and pests have been reported in Sri Lanka. The average yield of dry c Irrigation is necessary in the initial stages up to 2 years. If the clove garden has been raised in slopes, terraces are to be formed along the contour with 1.5m wide inward slope. loves in Sri Lanka is about 250kg/ha. Clove can be conveniently grown mixed with commercial crops like pepper, aricanut, tea, coconut, sweet oranges, coffee, banana, pineapple and tapioca.
Products and Uses	Flower buds - dried and used as a spice in a variety of foods. An essential oil obtained from the plant is used as a flavouring in a wide range of foods. Cloves, and the essential oil contained in them, are often used medicinally. The essential oil is applied externally in the treatment of toothache, headache, cold, arthritis and rheumatism. Clove oil is extracted by water distillation and an essential oil content in good quality cloves may exceed 15%.
Contribution for Soil Conservation	Anchors and Evaporators

MEC 4- *Theobroma cacao*

Theobroma cacao ***Family*** *Malvaceae* ***Common names*** *Cocoa, Cacao*	
Character	Small evergreen tree
Description	It is usually growing about 8 meters tall, though exceptionally it can reach 20 meters. The cocoa tree has tap-roots. The tap-root descends straight into the soil. The branch roots go down very deep. But many small branch roots also grow near the surface. The flowers are produced in clusters directly on the trunk and older branches. It has ovoid shape pod. The pod contains 20 to 60 seeds, usually called "beans", embedded in a white pulp. Cocoa can be considered as the most important tree crop for under-planting coconut and rubber provided suitable soils exist.
Major Growing Areas	A tree of the lowland tropics. Suitable conditions for growing cocoa are found in the Central, North Western, Sabaragamuwa, Uva, Western and Southern provinces of Sri Lanka. The total extent of cocoa is 2472ha. It can grow up to 600m. It succeeds where the mean annual temperature is in the of 21 - 32°c and an annual rainfall level of between 1,150 - 2,500mm is suitable.
Soil Type	The best soils are deep, well-drained clay loams rich in organic matter. Scattered stones are pebbles are tolerable up to 40% of the surface of such soils. Coarse gravelly soils, sandy soils, shallow soils, and soils are underlain by slab rock or hard laterite are unsuitable. pH of 5-6.5 is recommended.
Propagation	Seed propagation can be done. Sow the seed as soon as it is ripe, in individual containers in a shaded position. The seeds readily germinate when sown fresh. Air layering, leaf-bud cutting, and grafting are other possibilities.
Cultivation and Maintenance	Planting is done with the onset of monsoon rains. After the land preparation seedlings are planted in pits of 1 1/2' x1 1/2' in size and filled with topsoil and cow dung. Temporary shading and weeding can be done at very young stages. Recommended synthetic fertilizer mixture can be added. Pod rot disease, swollen shoot disease and Cocoa capsid bug and Cocoa Mealy bugs attach can be happened. Crop protection and pruning should be done according to requirement. Trees start bearing in the 4th year. Fruits take about 5 months to develop into maturity. Only fully ripened fruits, which are in yellow to orange in color, are harvested using a sharp knife. The tree is often inter-planted with bananas, coconuts and rubber.
Products and Uses	The dried, fermented and roasted seeds of this plant, called cacao beans, are the source of cocoa, chocolate and cocoa butter. The cured seeds are then roasted and ground into a powder to make cocoa. The seed contains a pigment that is said to be useful as a food colouring. Although used mainly

	as a food, cacao does also have some therapeutic value. Cacao powder and butter are nutritive, the latter also soothes and softens damaged skin. Cacao powder is taken internally in the treatment of angina and high blood pressure. The cacao tree provides a wide range of commodities for local peoples including fiber for cloth, thread and paper; wood for construction, making implements etc; coverings for their houses and many other items.
Contribution for Soil Conservation	Anchors and Evaporators

MEC 5- *Cinnamomum verum*

Cinnamomum verum ***Family*** *Lauraceae* ***Common names*** *Ceylon cinnamon, cinnamon*	
Character	Evergreen tree
Description	It is a small tree native to Sri Lanka. Trees are 10–15 metres tall. The leaves are ovate-oblong in shape and 7–18 cm long. The flowers, which are arranged in panicles, have a greenish color and a distinct odor. The fruit is purple drupe containing a single seed. Cinnamon roots can penetrate even through the cracks of the cracks of the parent material to deeper layers.
Major Growing Areas	Cinnamon can be found at elevations up to 2,000 m. Best area for commercial cultivations is elevation bellow 500 m. It requires warm and wet climate with an average temperature of 27 0C. It is grown in the areas which is having average annual rainfall around 2,000-2,500 mm. In Sri Lanka cinnamon cultivation concentrated along the coastal belt from Negombo to Matara. It has also made inroads to Kalutara to Ratnapura.
Soil Type	Prefers a fertile, sandy, moisture-retentive but freely draining soil in full sun or partial shade. Rocky and stony ground is unsuitable. Fine sandy and lateritic gravelly soils rather than rocky and stony substrates are best in Sri Lanka.
Propagation	The seed has a short viability and is best sown as soon as it is ripe. The seeds may be sown in nurseries or directly in the field. Cuttings of semi-ripe side shoots and division of old rootstocks can be used for propagation. Stems of old rootstocks are ready for cutting at about 12-18 months after planting and 3 years for seedlings.
Cultivation and Maintenance	Spacing 1.2 m x 1.2 m (Flat land), 1.2 m x 0.9 m (Flat land/Gentle slope), 1.2 m x 0.6 m (Steep lands) and have 3plants per planting point. Soil conservation should be done for slope lands and weeding should be done. Fertilizer application is important for commercial cultivation of cinnamon for higher productivity.
Products and Uses	The stem bark is used as a flavouring. It is used in curries and a wide range of sweet dishes. Essential oils, obtained from the leaves and the bark, are used as food flavourings in a range of foods. Cinnamon bark oil is employed in a range of dental and pharmaceutical preparations. Cinnamon bark oil possesses the delicate aroma of the spice and a sweet pungent taste. The wood has excellent working qualities.
Contribution for Soil Conservation	Anchors and Evaporators

MEC 6- *Areca catechu*

Areca catechu ***Family*** *Palmae* **Common names** *Betel Palm, Areca nut, Puwak*	 
Character	Single-stemmed palm tree
Description	It is an evergreen single-stemmed palm tree that can grow up to 30 meters tall. The straight, unbranched stem can be 25 - 40cm in diameter, topped by leaves up to 2 meters long. The leaves are 1.5–2 m (4.9–6.6 ft) long, pinnate, with numerous, crowded leaflets. Adventitious roots arising from the base of bulbous stem.
Major Growing Areas	Plants succeed in moist tropical climates where temperatures range is between 24-36°C, adversely affected by temperatures below 10ºC and above 40ºC. It can grow average annual rainfall range of 1750mm-4500mm. It grows well up to 500m elevation. In Sri Lanka areca nut is largely grown in the wet zone and wetter part of the Intermediate zone.
Soil Type	It is grown well in a diverse soil types and they perform well in fertile clay loam soils or in gravelly laterite soils of red yellow podzolic type. Plant tolerates water logging to a certain extent and preferred high moisture conditions. Sticky clay soils, sandy alluvial soils or calcareous soils are not suitable for the growth of areca plant. Prefers a pH in the range 5.5 - 6, tolerating 4.5 - 6.8
Propagation	Seed propagation can be done. The seed has a short viability so only fresh seed should be used. Areca nut is exclusively seed propagated. Seed nuts are allowed to ripen completely on the tree and then dried in the sun for 1-2 days before sowing 2.5 cm apart in shallow pits.
Cultivation and Maintenance	Planting has to be done with the on-set of monsoon rains. After the preparation of the field, young plants are established in pits of 60cmx60cm filled with the mixture of top soil and cow dung or compost. Spacing is 3mx3m. Shading can be done after planting. Permanent shade can be provided by intercropping with banana, papaw or cassava etc. In Sri Lanka farmers do not fertilize areca nut. However, under Sri Lankan conditions, application of organic residues, green manure or compost at the base of the plant at the rate of 20 kg per palm. No economically important pest and disease problems are reported.
Products and Uses	The stem bark is used as a flavouring. It is used in curries and a wide range of sweet dishes. Essential oils, obtained from the leaves and the bark, are used as food flavourings in a range of foods. Cinnamon bark oil is employed in a range of dental and pharmaceutical preparations. Cinnamon bark oil possesses the delicate aroma of the spice and a sweet pungent taste. The wood has excellent working qualities.
Contribution for Soil Conservation	Anchors and Evaporators

3 Recommended multipurpose tree (MPT) species

MPT 1- Gliricidia sepium

Gliricidia sepium **Family** *Fabaceae* **Common names** *Gliricidia*	
Character	Shrub or small tree
Description	It is a medium-sized, open crown; it can grow 2 - 15 meters tall. The bole is twisted, or grows at an angle, up to 30cm in diameter. It has composite leaves. Each leaf is composed of leaflets that are about 2 to 7 cm long and 1 to 3 cm wide. The flowers are located on the end of branches that have no leaves. The fruit is a pod about 10 to 15 cm long.
Major Growing Areas	It is a plant of the moist tropics, where it is found at elevations up to 1,600 meters. It grows best in areas where annual daytime temperatures are within the range 15 - 30°C. The plant prefers a mean annual rainfall in the range 1,200 - 2,300mm, but tolerates 600 - 3,500mm. Roadsides, gardens, tea plantations are some sites. It is widespread throughout the Sri Lanka.
Soil Type	Tolerates a wide range of soil types, both alkaline and acidic, including low-fertility soils. It grows well on the calcareous soils of atolls. Prefers freely draining soils but can tolerate some waterlogging. Prefers a pH in the range 5.5 - 6.2, tolerating 4.5 – 8. Plants establish well on steep slopes with up to 40% gradient.
Propagation	Fresh seeds can be used for propagation. It is propagated most commonly by cuttings, although this is not the most appropriate method for establishment in poor soils.
Cultivation and Maintenance	Soak the seed in hot water, cool off during the night, sow the next morning. Sow individual seeds in containers such as recycled milk cartons or forestry tubes. Transplant while the ground is still moist. Seeds are covered lightly and firm down. It can plant out at 1 - 2 m spacing. The seedlings establish better under shade than in full sun.
Products and Uses	Flowers are cooked and eaten as a potherb. The plant is reported to be expectorant, sedative and suppurative. It is widely cultivated as a shade tree for perennial crops such as tea, coffee and cocoa. The plant has found application as a rodenticide and general pesticide. The wood is utilized for railway sleepers, farm implements, tool handles, furniture, house construction and as mother posts in live-fence establishment. The wood is used for fuel and charcoal production.
Contribution for Soil Conservation	Rapid growth and establishment. simple and elongated roots penetrate down to 2 m depth, but has number of branches after any branching event never exceeded three. Laterals of G. sepium often grew towards different soil horizons.
Further readings	Petrone A, Preti F (2010) Soil bio-engineering for risk mitigation and environmental restoration in a humid tropical area. Hydrol Earth Syst Sci 14:239–250.

MPT 2- *Leucaena leucocephala*

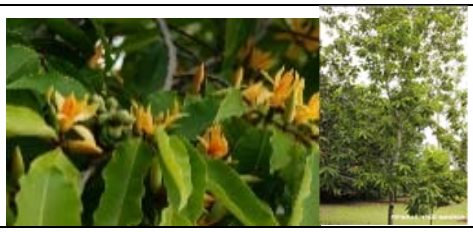
Leucaena leucocephala **Family** *Fabaceae* **Common names** *Ipil-ipil*	 
Character	A small fast-growing mimosoid tree
Description	Leucaena leucocephala is a small fast-growing mimosoid tree native to southern Mexico and northern Central America. However, L. leucocephala is considered one of the 100 worst invasive species. It grows quickly and forms dense thickets that crowd out all native vegetation. Use as a fodder, firewood, green manure and biomass crop.
Ecology and occurrence	An introduced species to Sri Lanka. It was promoted as a "miracle tree" for its multiple uses yet it has also been described as a "conflict tree" because it is used for forage production but spreads like invasive weed in some places. It grows quickly and forms dense thickets that crowd out all native vegetation.
Climate and soil Type	Tolerates a wide range of soil types, both alkaline and acidic, including low-fertility soils. It grows well on the calcareous soils of atolls. Prefers freely draining soils but can tolerate some waterlogging. Prefers a pH in the range 5.5 - 6.2, tolerating 4.5 – 8. Plants establish well on steep slopes with up to 40% gradient. Well adapted to tropical conditions from dry to wet climatic regions.
Propagation	Fresh seeds can be used for propagation. It is propagated most commonly by cuttings, although this is not the most appropriate method for establishment in poor soils.
Products and Uses	L. leucocephala is used for a variety of purposes, such as firewood, fiber, and livestock fodder. Also used as share tree, wind barrier and hedge tree in plantations and farm fields.
Contribution for Soil Conservation	The majority of root matrix of L. leucocephala was found within the first 80 cm of soil depth. was strong and deep taproot at 3 m of soil depth. Few lateral roots were oriented horizontally to the main taproot and most of the fine roots were surrounded by lateral roots. Lead tree achieved relatively high root reinforcement potentiality through the increment of root profiles, tensile strength, cellulosic composition and cohesion compared to copperpod. The soil shear strength and soil–root matrix of root-penetrated soil were controlled by the individual root tensile strength, amount of fine roots and cellulosic composition of roots. It has VH type roots.
Further readings	Saifuddin M, Osman N, Rahman MM, Boyce AN (2015). Soil reinforcement capability of two legume species from plant morphological traits and mechanical properties. Curr. Sci. 108:1340-1347.

MPT 3- *Jatropha curcas*

Jatropha curcas **Family** *Euphorbiaceae* **Common names** *Weta-endaru*	  
Character	A perennial shrub or small tree
Description	J. curcas is a semi-evergreen shrub or small tree, reaching a height of 6 m or more. It is resistant to a high degree of aridity. The seeds contain 27–40% oil that can be processed to produce a high-quality biodiesel fuel.
Ecology and occurrence	It is a semi-evergreen shrub or small tree, reaching a height of 6 m or more. It is adapted to wide range of climatic extremes as it occurs both in arid and wet climates.
Climate and soil Type	The plant can grow in wastelands and grows on almost any terrain, even on gravelly, sandy and saline soils.
Propagation	Jatropha curcas can easily be propagated by both seed or cuttings.
Products and Uses	The seeds contain 27–40% oil and it has been recognized as an excellent biofuel crop. It contains phorbol esters, which are considered toxic and some of other chemicals in plant parts are used as medicine in some parts of the world.
Contribution for Soil Conservation	It is a suitable bio-engineering plant because it easily propagates, grows fast, and is resilient. Root reinforcement in the first stage of growth needs high density plantation of up to 40,000 plants per hectare. This should then be followed by thinning down to 10,000 plants per hectare to optimize root reinforcement at 3 years' age. The lateral roots have the potential to decrease soil erodibility through additional soil cohesion, whereas the taproot and sinkers may increase resistance against shallow land sliding, enable exploitation of subsurface soil moisture and thus enhance vegetative cover, even in very dry environments.
Further readings	Giadrossich F, D. Cohen, M. Schwarz, G. Seddaiu, N. Contran, M. Lubino, O.A. Valdés-Rodrŕguez, M. Niedda (2016) Modeling bio-engineering traits of Jatropha curcas L. Ecol. Eng., 89 (2016), pp. 40-48, 10.1016/j.ecoleng.2016.01.005. Reubens B, W.M.J. Achten, W.H. Maes, F. Danjon, R. Aerts, J. Poesen, B. Muys (2011) More than biofuel? Jatropha curcas root system symmetry and potential for soil erosion control. Journal of Arid Environments 75 (2011) 201e205

4 Agroforestry species

Agroforestry 1- *Michelia champaca*

Michelia champaca **Family** *Magnoliaceae* **Common names** *Gini-sapu, Sapu*	
Character	A large tree
Description	It is an evergreen or semi-deciduous, small to medium sized tree up to 50 m tall; bole straight, cylindrical, up to 1.9m in diameter, without buttresses; bark surface smooth, grey to greyish-white, inner bark fibrous, yellow to brown, crown conical to cylindrical. Leaves simple, entire, arranged spirally; stipules adnate to or free from the petiole. Flowers on short, axillary brachyblast, solitary or rarely in pairs, large, tepals 6-21, in 3-6 usually sub equal whorls, white to yellow; stamens many, anthers with a short to prominently elongated connective; gynoecium stipitate, with spirally arranged, free or connate carpels containing many ovules. Fruiting carpels dehiscing along the dorsal suture when free or fused and forming a fleshy or woody syncarp.
Ecology and occurrence	It is found in Tropical and subtropical moist broadleaf forests ecoregions, at elevations of 200–1,600 m.
Climate and soil Type	Adapt to well drain loamy to clay soils. Prefers slightly acidic to neutral pH, tolerating 4 – 8.
Propagation	It can be grown from seeds that established in plant nurseries.
Products and Uses	It is known for its fragrant flowers, and its timber used in woodworking. Branches are good source of fuelwood. Can be prone and train to be an ornamental plant, for its form as an ornamental tree, as a dense screening hedge, and for its fragrant flowers.
Contribution for Soil Conservation	Has a well grown taproot with numerous lateral roots and a mesh of fine roots. Root penetrate to a comparatively deeper layers about 3m, but contribution from lateral root system for soil stabilization is high. Presence of roots increases the effective cohesion of the soil, resulting in the increase in shear strength.
Further readings	Kong D, Li L, Ma C, Zeng H, Guo D. 2014. Leading dimensions of root trait variation in subtropical forests. New Phytologist 203: 863–872.

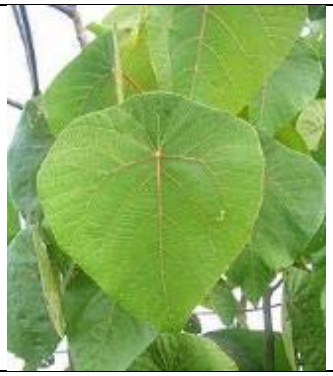
Agroforestry 2- *Azadirachta indica*

Azadirachta indica **Family** *Meliaceae* **Common names** *Kohomba*	  
Character	A large tree
Description	Neem is a fast-growing evergreen tree that can reach a height of 15–20 m. The branches are wide and spreading. The fairly dense crown is roundish and may reach a diameter of 20–25 m. The opposite, pinnate leaves are 20–40 cm long, with 20 to 31 medium to dark green leaflets about 3–8 cm long. The (white and fragrant) flowers are arranged in more-or-less drooping axillary panicles which are up to 25 cm long. The fruit is a smooth (glabrous), olive-like drupe which varies in shape from elongate oval to nearly roundish, and when ripe is 1.4–2.8 cm.
Ecology and occurrence	It is typically grown in tropical and semi-tropical regions. The neem tree is noted for its drought resistance. Normally it thrives in areas with sub-arid to sub-humid conditions, with an annual rainfall of 400–1,200 mm.
Climate and soil Type	Adapt to well drain loamy to clay soils. Prefers slightly acidic to neutral pH, tolerating 4 – 8.
Propagation	It can be grown from seeds that established in plant nurseries.
Products and Uses	Its fruits and seeds are the source of neem oil. Most of plant parts contain *nimbin*, which is traditionally used as an insecticide and believed to be anthelmintic, antifungal, antibacterial, and antiviral.
Contribution for Soil Conservation	Deep rooted woody trees. Larger and long tap root and tap root system. Root grown to a comparatively higher depth about 2m especially in dry and arid climates.
Further readings	Agroforestry Strategies for Climate Change: Mitigation and Adaptation, Pages 139–168, Edited by: K.T. Parthiban, R. Jude Sudhagar, C. Cinthia Fernandaz and K.K. Suresh, 2017, Jaya Publishing House, Delhi, India.

Agroforestry 3- *Vitex negundo*

Vitex negundo **Family** *Lamiaceae* **Common names** *Nika*	 
Character	An shrub or small tree
Description	Vitex negundo is an erect shrub or small tree growing from 2 to 8 m. The bark is reddish brown. Its leaves are digitate, with five lanceolate leaflets, sometimes three. Each leaflet is around 4 to 10, with the central leaflet being the largest and possessing a stalk. The numerous flowers are borne in panicles 10 to 20 cm in length. The fruit is a succulent drupe, 4 mm in diameter, rounded to egg-shaped. It is black or purple when ripe.
Ecology and occurrence	It is typically grown in tropical and semi-tropical regions. The neem tree is noted for its drought resistance. Normally it thrives in areas with sub-arid to sub-humid conditions, with an annual rainfall of 400–1,200 mm.
Climate and soil Type	Adapt to well drain loamy to clay soils. Grows on almost any terrain, even on gravelly and acidic soils. Prefers slightly acidic to neutral pH.
Propagation	It can be grown from seeds that established in plant nurseries. Can be propagated by cuttings as well.
Products and Uses	Various parts of the tree such as leaves, leaf oil, roots, fruits, and seeds are used in Ayurveda. A source of rural fuelwood.
Contribution for Soil Conservation	Has a well grown taproot with numerous lateral roots and a mesh of fine roots. Root penetrate to a comparatively deeper layers about 5m in dry soils, but contribution from lateral root system for soil stabilization is high. Presence of roots increases the effective cohesion of the soil, resulting in the increase in shear strength.
Further readings	Schroth, G. 1995 Tree root characteristics as criteria for species selection and system design in agroforestry. Agrofor. Syst. 30, 125–143.

Agroforestry 4- *Macaranga peltata*

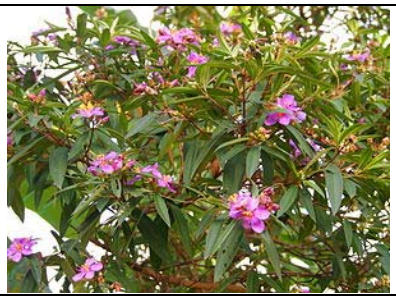
Macaranga peltata **Family** *Euphorbiaceae* **Common names** *Kenda, Patkenda*	 
Character	Native evergreen tree
Description	Early successional medium sized native tree growing up to 15 m in height. Branchlets stout, g1abrous younger parts densely rusty tomentose, glabrescent. Leaves: lamina 10—22(—32) x 7.5—18(—26) cm, broadly ovate, acute to caudate, shortly acuminate, entire.
Ecology and occurrence	The plant can be found in wet and intermediate zone secondary forests, up to 750 m. As it is a pioneer species with high growth rate, a last maintenance is required.
Climate and soil Type	Adapt to well drain loamy to clay soils. Grows on almost any terrain, even on gravelly and acidic soils. Prefers slightly acidic to neutral pH.
Propagation	Seeds can be stored for about 3 months without losing viability. Seeds either treated with GA3 or acid scarified seeds could be germinated in regularly water sandy soil. Seedlings can be raised in polythene bags of size 22.5 into 17.5 cm and maintained under shade. It also has a good coppicing power.
Products and Uses	Leaves could be used as green manure where they are rich in Nitrogen and Potassium. Wood is light weight and suitable for match, paper and pulp industries.
Contribution for Soil Conservation	Twenty-two-year-old trees have a rooting depth of > 1.5 m with a root spread about 1 m. Consist of VH type root system thus, could be used in soil reinforcement. M. peltata contains a broad leaf with about 22 x 18 cm leaf area. Thus could assume a high evapotranspiration.
Further readings	Kunhamu, T.K., Aneesh, S., Mohan Kumar, B. et al. Biomass production, carbon sequestration and nutrient characteristics of 22-year-old support trees in black pepper (Piper nigrum. L) production systems in Kerala, India. Agroforest Syst (2018) 92: 1171. https://doi.org/10.1007/s10457-016-0054-5

Agroforestry 5- *Murraya paniculata*

Murraya paniculata **Family** *Rutaceae* **Common names** *Atteria*	 
Character	Shrub or small tree
Description	A fine-textured, medium-sized shrub, with an upright and spreading, compact habit and dense crown of glossy green leaves. The small, orange-blossom scented, white flowers and small, red berries appear throughout much of the year. Adapted to wide range of soil tolerance (alkaline, clayey, sandy, acidic and loamy soils). The shrub is well-suited to shearing into a formal hedge or screen. Plant three to four feet apart for a hedge.
Ecology and occurrence	*Murraya paniculata* is a tropical, evergreen native plant. It has a moderate growth rate; a least maintenance is required.
Climate and soil Type	They thrive in alkaline soils and do not tolerate salty conditions.
Propagation	The *Murraya paniculata* is sexually propagated by its seeds. It may also be artificially propagated by softwood cuttings.
Products and Uses	Traditionally, *Murraya paniculata* is used both in traditional medicine as an analgesic and for wood (for tool handles)
Contribution for Soil Conservation	Has a well grown taproot with numerous lateral roots and a mesh of fine roots. Root penetrate to a comparatively deeper layers about 2-4m, especially in dry and arid climates. Contribution from lateral root system for soil stabilization is high.
Further readings	Rahardjo, H., Satyanaga, A., Leong, E. C., Santoso, V. A. & Ng, Y. S. (2014). Performance of an instrumented slope covered with shrubs and deep-rooted grass. Soils Found. 54, No. 3, 417–425.

5 Recommended natural and native vegetation

Natural and native vegetation 1- *Melastoma malabathricum*

Melastoma malabathricum **Family** *Melastomataceae* **Common names** *Bowitiya, Mahabowitiya, Katakaloowa*	
Character	Evergreen shrub
Description	Plant is a perennial shrub up to 3 m in height. Branchlets covered with appressed to spreading, narrowly triangular-ovate, fimbriate, brownish scales. Leaves are elliptic in shape. Flowers in solitary clusters with widely elliptic.
Ecology and occurrence	It can be found at elevations up to 900 m in the wet zone of Sri Lanka. It requires warm and wet climate with an average temperature of 27 0C. It is grown in the areas which is having average annual rainfall around 2,000-2,500 mm. It is mainly occurring in the secondary vegetation as a pioneer species it occurs in disturb areas, roadsides and dumpsites. As plant is a pioneer species no hard maintenance is required if transplanted when it reached 0.5 m height.
Climate and soil Type	Adapt to well drain loamy to clay soils. Grows on almost any terrain, even on gravelly and acidic soils. Prefers slightly acidic to neutral pH.
Propagation	Seeds are orthodox in storage behavior and thus could be stored long if stored under dry low temperature conditions. The seeds may be sown in nurseries and raised to the suitable size as seedlings emerge from seeds is about 1 mm. Hardwood cuttings are also used in propagation as they are easily rooted.
Products and Uses	Plant has a high potential to be used as an ornamental plant with a showy flower. It has an edible fruit. Whole plant has a high medicinal value as an astringent, and is used as a dye.
Contribution for Soil Conservation	This plant had shown high performance on improving the slope environment and alleviating the erosion. Especially in morning sun slopes had the highest physiological performance of the species and positively influenced the erosion rate. *M. malabathricum* had a tensile strength of 29.72 MPa. Although the plant has a root system reaching about 1-2 m with M-type root system. The average pullout resistance of the plant is 2.02 kN.
Further readings	Aimee H. and Normaniza O. (2014). Physiological responses of *Melastoma malabathricum* at different slope orientations. J. Trop. Plant Physiol. 6 (2014): 10-22.

Natural and native vegetation 2- *Wendlandia bicuspidata*

Wendlandia bicuspidate **Family** *Rubiaceae* **Common names** *Wana edala, Rawan edala*	
Character	Evergreen small tree
Description	W. bicuspidata is an endemic shrub or small tree with bark light brown, fissured, thin stem. Leaves elliptic to obovate. Flowers subsessile and not prominent in dense clusters. Dehiscent fruits.
Ecology and occurrence	The plant can be found at elevations up to 900 m in the wet zone of Sri Lanka. It requires warm and wet climate with an average temperature of 27 0C. It is grown in the areas which is having average annual rainfall around 2,000-2,500 mm. It is mainly occurring in the secondary vegetation as a pioneer species. As it is a pioneer species, high growth rate is observed. No special maintenance is required.
Climate and soil Type	Adapt to well drain loamy to clay soils. Grows on almost any terrain, even on gravelly and acidic soils. Prefers slightly acidic to neutral pH.
Propagation	No information of propagation, however, the shoot cuttings and root cutting seems to be a promising propagation method as root sprouting has been seen in the species.
Products and Uses	Leaves, bark and stem is used in medicinal preparations in treating dysentery, fever, Diarrhea and ulcer. Stem used in light contractions.
Contribution for Soil Conservation	No direct information on W. bicupsidata as it is an endemic species. However, Wendlandia spp. with same external morphology has been used in reinforcement of slopes especially in Nepal (Devkota et al., 2006). Further, W. exserta with similar external morphology has been used for bioengineering of slopes, this species further reported with deep root system with a spread of 1.9 m, thus, could be suggested for slope reinforcement as it created a network of roots holding soil particles.
Further readings	Devkota, B. D., Omura, H., Kubota, T. and Morita, K. (2006). State of Vegetation, Erosion Climatic Conditions and Re-vegetation Technology in Mid Hill Area of Nepal. 51.

Natural and native vegetation 3- *Trema orientalis*

Trema orientalis **Family** *Cannabaceae* **Common names** *Gadumba*	 
Character	Native medium sized evergreen tree
Description	Medium-sized evergreen tree, to 12 m high; bark greyish-brown, lenticellate, smooth or finely fissured; branchlets with simple and multicellular glandular hairs. Leaves ovate-lanceolate to elliptic-lanceolate, 6-12 (-15) x 2.5-6 cm. Inflorescence axillary much-branched panicle or thyrsoid cyme, male and female borne on separate branches. Drupe ± globose, 4 x 3 mm, topped by the style, black when mature. Seed ovoid, 3 x 2 mm; endosperm present or scanty.
Ecology and occurrence	The plant can be found in wet and intermediate zone secondary forests. As it is a pioneer species with high growth rate, a last maintenance is required. Also very common in cleared areas and waste places in dry, wet and intermediate zones up to 1525 m of elevation.
Climate and soil Type	Best grown in well-drained, sandy soil. However, succeeds on a wide range of soils from heavy clay to light sand, tolerating moderate alkalinity and salinity.
Propagation	Dry storage of seeds for 4 months is required to break dormancy. Seeds require light to germinate. Seed viability can be maintained for 6 months at room temperature. Plant could also be propagated with hardwood cuttings.
Products and Uses	The plant is vermifuge. Leaves and bark used in medicinal preparations used to treat coughs, sore throat, asthma, bronchitis, gonorrhoea, yellow fever, toothache. The tree can provide plenty of firewood and excellent charcoal which is even suitable for making gunpowder and fireworks.
Contribution for Soil Conservation	The tree has an extensive root system that enables to hold soil together and categorized as a tree with high anchoring root index with moderate capability in reinforcing slopes.
Further readings	Kurniatun H. et al. (2006). Root effects on slope stability in Sumberjaya, Lampung (Indonesia). International symposium towards sustainable livelihoods and ecosystems in mountainous regions, 7-9 March 2006, Chiang Mai, Thailand.

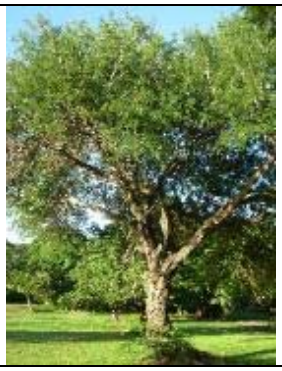
Natural and native vegetation 4- *Pterocarpus indicus*

Pterocarpus indicus **Family** *Fabaceae* **Common names** *Walahela*	 
Character	Native evergreen large tree
Description	It is a large deciduous tree growing to 30–40 m tall, with a trunk up to 2 m diameter. The leaves are 12–22 cm long, pinnate, with 5–11 leaflets, the girth is 12–34 m wide. The flowers are produced in panicles 6–13 cm long containing a few to numerous flowers. It is a premium timber species suitable for high grade furniture, lumber and plywood for light construction purposes.
Ecology and occurrence	Native tree species, yet many populations of *Pterocarpus indicus* are seriously threatened. In agroforestry, it maintains ecosystem fertility and soil stability. Narra is a leguminous plant that is capable of fixing nitrogen by forming endosymbiotic relationships with nitrogen-fixing bacteria that lives in its root nodules.
Climate and soil Type	The tree can be found in wet and intermediate zone forests. Tree succeeds on a wide range of soils from heavy clay to light sand, tolerating moderate acidity.
Propagation	Propagate by seeds.
Products and Uses	The hardwood, which is purplish, is termite-resistant and rose-scented. It is a premium timber species suitable for high grade furniture, lumber and plywood for light construction purposes. It is also used for cartwheels, wood carving and musical instruments.
Contribution for Soil Conservation	Root branching pattern of P. indicus exhibited strong tap root and its lateral roots grew horizontally and profusely. About 80% of its root matrix was found within the top 60 cm of soil depth. This type of root has three roles in slope stabilisation, namely, soil reinforcement, slope stability and wind resistance.
Further readings	Saifuddin M, Normaniza O (2016). Rooting characteristics of some tropical plants for slope protection. J. Trop. For. Sci. 28:469-478.

Natural and native vegetation 5- *Bauhinia racemosa*

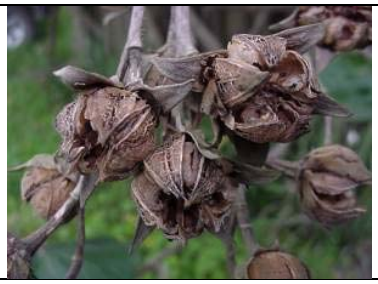
Bauhinia racemosa **Family** *Fabaceae* **Common names** *Maila*	  
Character	Small to medium-size deciduous tree
Description	This is a deciduous, 3-5 m tall tree. The bark is dark brown, rough and longitudinally fissured. The leaves are sub orbicular, cordate at the base, bilobed, glabrous above and pubescent beneath, also petiolate. The flowers are creamy yellow in 4 to 7 cm. long terminals and racemes. The pods are linear oblong, woody slightly curved, dark brown or brownish black, constriction between all or few seeds. The seeds are oblong compressed, smooth, glabrous and brown. The flowering season is January to June.
Ecology and occurrence	The plant can be found in dry and intermediate zone secondary forests, up to 750 m. As it is a pioneer species with high growth rate, a last maintenance is required.
Climate and soil Type	They thrive in alkaline soils and do not tolerate salty conditions.
Propagation	Propagation of Bauhinia species is from seeds or cuttings. Full sun exposure is preferred but they can be grown under partial sun.
Products and Uses	A low grade timber, fuelwood and fodder. Use as share tree in urban landscaping.
Contribution for Soil Conservation	It has ability to develop deep root system. Has high root strength and shear resistance. Consist of VH type root system thus, could be used in soil reinforcement.
Further readings	Das DK, Chaturvedi OP. 2008. Root biomass and distribution of five agroforestry tree species. Agrofor Syst. 74:223–230.

Natural and native vegetation 6- *Acacia catechu*

Acacia catechu **Family** *Fabaceae* **Common names** *Katu-andara*	 
Character	Medium size deciduous thorny tree
Description	Acacia catechu is a small or medium-sized, thorny tree up to 15 m tall; bark dark grey or greyish-brown, peeling off in long strips, or sometimes in narrow rectangular plates, brown or red inside; branches slender, puberlous when young but glabrascent, with 2 curved, 8-mm prickles at the base of each petiole.
Ecology and occurrence	The plant can be found in dry and intermediate zone secondary forests. As it is a pioneer species with high growth rate, a last maintenance is required.
Climate and soil Type	They thrive in alkaline soils and do not tolerate salty conditions.
Propagation	Propagation of Acacia catechu is from seeds or cuttings. Full sun exposure is preferred but they can be grown under partial sun.
Products and Uses	A low grade timber, fuelwood and low quality fodder.
Contribution for Soil Conservation	Has a well grown taproot with numerous lateral roots and a mesh of fine roots. Root penetrate to a comparatively deeper layers about 2-4m, especially in dry and arid climates. Contribution from lateral root system for soil stabilization is high.
Further readings	Dhital, Y.P; Kayastha, R. B.; Shi, J. (2013). Soil Bioengineering Application and Practices in Nepal. Environmental Management, 51:354–364.

6 Introduced and naturalized species

Introduced and naturalized 1- *Hibiscus tiliaceus*

Hibiscus tiliaceus **Family** *Malvaceae* **Common names** *Belipatta*	  
Character	Shrub or small tree
Description	Hibiscus tiliaceus reaches a height of 4–10 m, with a trunk up to 15 cm in diameter. The flowers of H. tiliaceus are bright yellow with a deep red center upon opening. The branches of the tree often curve over time. Hibiscus tiliaceus can be found at elevations from sea level to 800 m in areas that receive 900–2,500 mm of annual rainfall.
Ecology and occurrence	It is a tropical, evergreen native plant. It has a moderate growth rate; a least maintenance is required.
Climate and soil Type	It is well adapted to tolerats salt and waterlogging and can grow in quartz sand, coral sand, marl, limestone, and crushed basalt. It grows best in slightly acidic to alkaline soils (pH of 5–8.5).
Propagation	It can be easily propagated by softwood cuttings.
Products and Uses	Wood is easy to plane and turns well, so it is regarded by many as a high quality furniture wood. Its tough bark can be made into durable rope.
Contribution for Soil Conservation	The roots of the live pole can increase the apparent cohesion of the soil by about 300%. Roots have higher mechanical strength. Live cut stems and the branches provide immediate reinforcement; secondary stabilization occurs as a result of the growing roots along the length of the buried stems. The live poles can be used on the suspect slopes providing low-cost and environmentally suitable alternatives to the conventional methods of the slope stabilization.
Further readings	Prasad, A., Kazemian, S., Kalantari, B., Huat, B. B. K., Mafian, S., 2012. Stability of Tropical Residual Soil Slope Reinforced by Live Pole: Experimental and Numerical Investigations, Arabian Journal for Science and Engineering Volume 37, Number 3, 601-618.

Natural and native vegetation 2- *Dillenia suffruticosa*

Dillenia suffruticosa **Family** *Dilleniaceae* **Common names** *Diyapara*	  
Character	Shrub or small tree
Description	It is a large, evergreen shrub to 6m high. It flowers continuously with yellow flowers 10 to 12 cm wide. The plant is found in tropical South East Asia in secondary forest and swampy grounds that are undisturbed forest such as riversides up to 700 m altitude. They can also be found on alluvial places such as swamps, mangroves, riversides, but sometimes also present on hillsides and ridges, which have clayey to sandy soil texture.
Ecology and occurrence	It is a tropical, evergreen non-native plant. It has a high growth rate; thus easily becomes an invasive tree under suitable environment. Thus, it is considered as a highly invasive weed in Sri Lanka.
Climate and soil Type	They can also be found on alluvial places such as swamps, mangroves, riversides, but sometimes also present on hillsides and ridges, which have clayey to sandy soil texture. Grow well in water logging conditions as well.
Propagation	It can be easily propagated by softwood cuttings.
Products and Uses	Dillenia suffruticosa has other uses, these include medicine and storage.
Contribution for Soil Conservation	The roots of the live pole can increase the apparent cohesion of the soil by about 600%. Roots have higher mechanical strength. Live cut stems and the branches provide immediate reinforcement; secondary stabilization occurs as a result of the growing roots along the length of the buried stems. The live poles can be used on the suspect slopes providing low-cost and environmentally suitable alternatives to the conventional methods of the slope stabilization.
Further readings	Prasad, A., Kazemian, S., Kalantari, B., Huat, B. B. K., Mafian, S., 2012. Stability of Tropical Residual Soil Slope Reinforced by Live Pole: Experimental and Numerical Investigations, Arabian Journal for Science and Engineering Volume 37, Number 3, 601-618.