A GUIDE TO ESTABLISH A NATURAL WIND BARRIER

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CONTENTS

INTRODUCTION

Several regions around the world experience strong wind velocities which affect crops, causes erosion, damages roads and buildings, etc. Specific to farms and plantations that experience such high velocities of winds, there are several advantages of establishing natural wind barriers.

Natural wind barriers also known as natural wind breaks or natural shelter belts are strips of vegetation constituting rows of trees, shrubs, crops or grasses, that help to reduce the velocity of wind thus acting as a natural buffer for crops, agroforests, roads, etc.

The advantages of establishing natural wind barriers include the following:

- Buffer crops, livestock, and people against high wind velocities
- Modify the microclimate on the sheltered side, thus improving plant growth and production
- Economically useful plants can be used in these strips, that would benefit people and plantation owners
- Reduce soil erosion due to wind
- Conserve soil moisture
- Protect plants from wind related damage
- Enhances biodiversity
- Improves irrigation efficiency

Although windbreaks reduce the area for crop production, the benefits from establishing one, far outweighs this loss.

HOW DOES A WIND BARRIER WORK?

Three zones can be recognized in areas with wind barriers - the zone from which the wind blows or the windward side, the zone on the side where the wind passes or the leeward side and the protected zone where the effect of the wind barrier is felt.

When wind blows against a wind barrier, air pressure builds up on the windward side and decreases on the leeward side. Some of the approaching wind flows through the windbreak, some goes around the ends, but most of it is forced up and over the top of the barrier.

Effectiveness of a barrier is dependent on several factors, which includes the height of vegetation, denseness of the vegetation cover, length and width of the barrier, species composition, orientation and continuity of the barrier. These factors determine the wind path, and as a result, will determine how effective the barrier will be in reducing wind speed and in changing the microclimate.

DESIGNING A NATURAL WIND BARRIER

HEIGHT AND LENGTH OF BARRIER

Height and length of the barrier are the most important factor determining the extent of the protected zone. For maximum efficiency, the uninterrupted length of the windbreak should be at least 10 times its height.

Wind tends to curl around the ends of a barrier. Hence, the barriers should extend beyond the area to be protected.

On the windward side, wind speed reductions are effected upwind for a distance of 2 to 5 times the height of the tallest row of trees in the barrier. On the leeward side, wind speed reductions occur downwind of the barrier up to a distance equal to 20 times the height of the tallest row of trees in the barrier. For example, in a windbreak where the height of the tallest tree row is 20 ft, lower wind speeds are measurable for 40 to 100 feet on the windward side and up to 400 feet on the leeward side (fig1)

Determine the height of the barrier you want to establish based on the area that requires protection. Ensure the barrier is longer than the width of the area that needs to be protected.

DENSENESS OF VEGETATION

The more dense barriers let very little wind through, resulting in low pressure on the windward side. This makes the wind going over the top of the barrier to come down to the ground closer to the barrier resulting in a smaller protected zone.

A barrier that is too dense results in a smaller, more calm protected zone, while

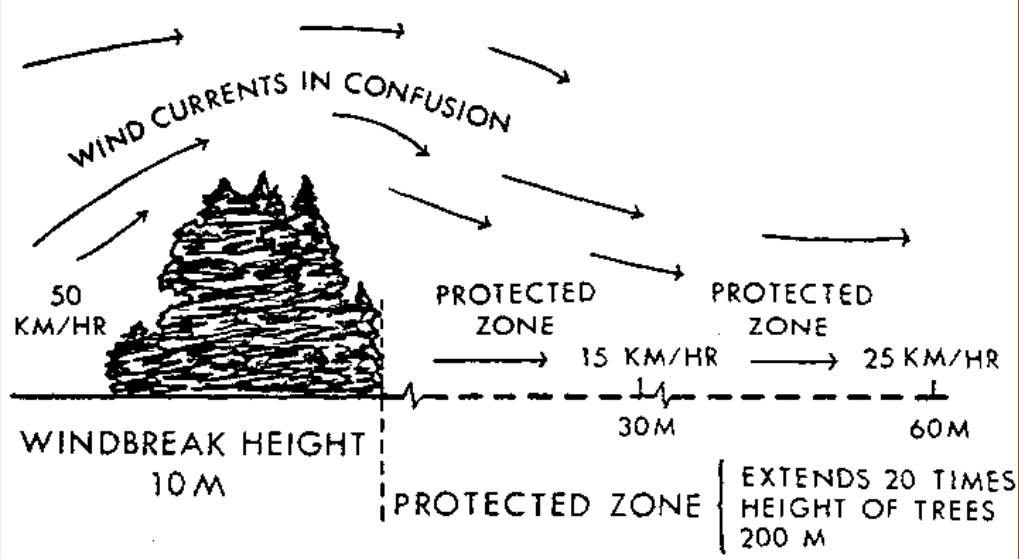


FIGURE 1: ZONES AROUND A WIND BARRIER. AN EXAMPLE OF HOW WIND SPEEDS ARE AFFECTED IN THESE ZONES IS SHOWN (SOURCE: http://www.fao.org/docrep/t0122e/t0122e0a.htm#2.%20windbreaks%20and%20shelterbelts

more porous barriers result in larger protected zone, that are less calm. Very porous windbreaks let too much wind to be effective.

Some porosity can be achieved by planting fewer rows, spacing trees farther apart within rows, and using trees with less dense crown.

From field experience determine the wind velocity that causes least damage to rubber. In the fields that are being affected by strong winds, determine the maximum wind velocity. Based on these, you can determine if your natural barrier needs to be very dense.

PROFILE OF THE BARRIER

The cross-sectional shape of a barrier affects its efficiency. Barriers that rise abruptly on the upwind side result in larger protected zones. The cross-sectional shape of a windbreak affects how wind is directed up and over and thus affects the protected area. Barriers that start short and become tall act like dense windbreaks resulting in shorter protected zones.

SPECIES COMPOSITION

While selecting species for a wind barrier, some key plant characteristics should be taken into consideration. This includes, species that grow rapidly, that have a straight bole, species that are wind hardy and resistant to drought, that have good crown formation, and have a deep root system rather than one which spreads into nearby production fields. In addition, depending on the region and wind conditions, phenological characteristics, i.e evergreen or deciduousness, should be taken into consideration.

Native species should be chosen as these will be well adapted to the local climatic conditions. Also those that are well suited to the soil conditions and terrain should be selected. It is prudent to use several species, to counter any failures in a row.

Several native species that can be used are also economically important or are of value to the local endangered wildlife - where possible, these could be opted for.

A list of species native to the Shencottah Gap, and information on their qualities and usage is given at the end of this document. Consider choosing species from this list.

CONTINUITY OF THE BARRIER

Gaps in the barrier diminish its effectiveness as they act as funnels that accelerate wind flow, creating areas on the leeward side of the gap where wind speeds could be accelerated.

If there is a requirement for paths or field access to connect the two sides of the barrier, these should be located at the ends. If a path must go through the barrier, it should be located such that the opening is at an angle to the wind direction.

ORIENTATION OF BARRIER:

Barriers, oriented perpendicular to the prevailing winds are most efficient as they protect the widest area.

To protect large areas, a number of separate barriers can be created as part of an overall system. When prevailing winds are mainly in one direction, a series of parallel barriers perpendicular to that direction should be established; a checkerboard pattern is required when the winds originate from different directions.

Before establishing the barrier(s), it is important to make a thorough study of the local wind pattern.

SPACING BETWEEN ROWS

Optimal spacing between planted rows should be maintained to ensure the barrier does not fail. This is based on the habit, size and phenological characteristic of the plant species chosen. Trees typically need more spacing than shrubs and evergreen tall species need more space than deciduous species.

Suggested spacing between planted rows:
Deciduous shrubs: 4 -6 ft
Shrub and tree: 15 - 20 ft
Medium-sized evergreen trees: 10 - 20 ft
Medium-sized deciduous trees: 12 - 20 ft
Tall deciduous trees: 16 - 24 ft
Tall evergreen trees: 20 - 30 ft
Tall evergreen & deciduous trees: >25 ft

KEY CAUSES FOR WIND BARRIER FAILURE

- Inadequate care
- Weeds
- Lack of water
- Using Poor planting practices
- Uncontrolled livestock grazing
- Careless handling of farm equipment while planting
- Spraying weedicide in nearby cropland
- Poor planning

Windbreaks and shelter-belts require a high plant survival rate, as well as uniform and rapid growth; supplementary irrigation may be required during the establishment phase. Gaps cannot be tolerated, and, when plants are lost replace them promptly.

Gaps in windbreaks due to dead trees or for road access funnel wind and cause reduced protection. Replace dead trees and angle any planned openings through the windbreak at right angles to the prevailing wind direction.

USEFUL TIPS FOR PLANTING BARRIERS

When saplings arrive from the nursery, inspect for damage, mold, overheating and settlement of packing away from the tree roots. Repack the roots and moisten the packing if needed. If saplings are to be planted within a few days, they may be kept in bundles in a cool, shaded place. If planting must be delayed for a longer period, the trees should be **heeled in** - dig a trench in a shady location protected from the wind, spread the roots along the trench with the sapling upright. Cover the roots with moist soil, refill the trench and pack firmly. When you are ready to plant the windbreak, remove from the bundle or trench as needed and place in a bucket of water or wet packing material for transporting. Keep the roots wet until the tree is planted. Do not plant in dry soil.

PLANNING YOUR WIND BARRIER

1. Locate the windbreak where it will be most effective.
2. The design must allow for proper spacing for tree growth.
3. Select Trees and Shrubs well adapted to your soil and climatic conditions. Order trees early.
4. Arrange for proper planting labor and equipment
5. Prepare the planting site properly
6. Arrange for proper storage of seedling trees in case planting is delayed by weather.

1. Identify the areas that experience high wind velocities that are detrimental for the rubber plants.

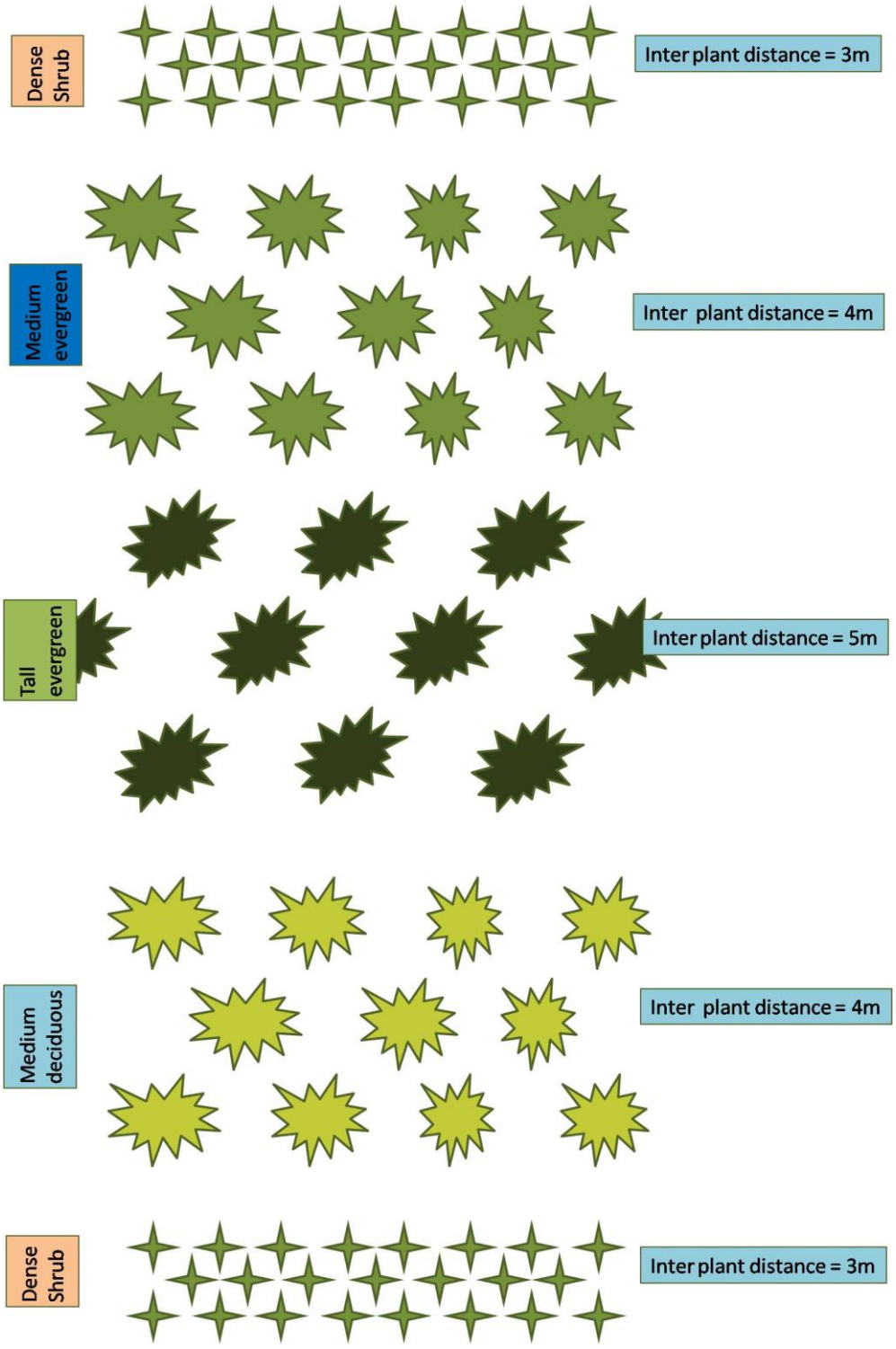
Many managers and field workers are likely to have been on the estate for several years, and some families over two or three generations. This community is bound to have rich knowledge of the field conditions on the estate. Using a participatory approach, such as a geo-PRA exercise, the management will be able to identify and map the areas of high wind velocity, wind directions and the time of the year these are experienced.

2. Once fields where a wind barrier is required has been identified, specifics based on location and requirements should be worked out

The following checklist of main considerations can be used:

1. Required length of the barrier:
2. Required height of tallest tree row in the barrier (calculated as distance upto which protection on the leeward side is required/20)
3. Required denseness of the barrier
4. Number of rows of trees and shrubs that should be planted
5. Species composition of the barrier
6. Spacing between rows
7. Pattern in which these should be planted
8. Requirements of breaks, where and at what angle should they be oriented?
9. A management plan drawn to ensure the barrier is maintained to ensure continuity

3. Figure below shows suggested pattern for planting with spacing. The design here is to ensure that while there is sufficient cover, the barrier does not become very dense, so as to become a sheer wall.



4. Plant species chosen for the barrier should ideally be native species found locally. For example, for the Shencottah gap landscape, we give below a representative list of plant species that has been recorded from this region which could be planted in a wind barrier in this landscape. The colour code reflect the strip (see figure in previous page) where they can be planted. For tall trees both evergreen and deciduous species are suggested. Evergreens are preferable as they provide protection through out the year. However a mix of both could be used.

Species	Tree height	Evergreen/Deciduous
FICUS HETEROPHYLLA	<8m	Evergreen
WRIGHTIA TINCTORIA	<8m	Deciduous
CINNAMOMUM MALABATHRUM	<8m	Evergreen
MALLOTUS TETRACOCCUS	<8m	Evergreen
MURRAYA PANICULATA	<8m	Evergreen
OLEA DIOICA	<8m	Evergreen
PTEROSPERMUM DIVERSIFOLIUM	<8m	Evergreen
ALBIZIA ODORATISSIMA	8-20m	Deciduous
GMELINA ARBOREA	8-20m	Deciduous
LAGERSTROEMIA MICROCARPA	8-20m	Deciduous
SCHLEICHERA OLEOSA	8-20m	Deciduous
STERCULIA GUTTATA	8-20m	Deciduous
TERMINALIA PANICULATA	8-20m	Deciduous
VITEX ALTISSIMA	8-20m	Deciduous
ARTOCARPUS HETEROPHYLLUS	8-20m	Evergreen
BACCAUREA COURTALLENSIS	8-20m	Evergreen
CINNAMOMUM VERUM	8-20m	Evergreen
GARCINIA GUMMI-GUTTA	8-20m	Evergreen
MANGIFERA INDICA	8-20m	Evergreen
ALBIZIA LEBBECK	>20m	Deciduous
MELIA DUBIA	>20m	Deciduous
TERMINALIA BELLIRICA	>20m	Deciduous
TETRAMELES NUDIFLORA	>20m	Deciduous
ARTOCARPUS HIRSUTUS	>20m	Evergreen
HOPEA PARVIFLORA	>20m	Evergreen
KINGIODENDRON PINNATUM	>20m	Evergreen
MYRISTICA DACTYLOIDES	>20m	Evergreen

5. Planting and after care:

Nursery

Collecting plant propagules

Matured fresh seeds fallen on the ground or seedlings collected from the forest edges, referred as 'wildlings', can be used as propagating materials in the nurseries. Seeds of desired species can be collected from the forest edges or along forest roads and trails in the same area. Similarly, seedlings along forest trails and edges, which have lesser chances of survival can be collected for nurturing in the nursery. In the absence of a desired species list, seeds and seedlings shall be collected from the reference sites identified in the area.

Preparing the nursery

In high rainfall areas a raised nursery bed is recommended. The recommended height of the nursery bed is 25 – 50 cm with a width of 1 m. The soil should be cleared of all debris and loosened and well aerated for planting of smaller seeds. Nursery bed should be raised under the shade of a suitable canopy tree; however, a complete shading of the nursery should be avoided. Drainage channels should be provided around the nursery beds. Once the nursery bed is prepared, it should be well drenched.

Sowing

Seeds (wildlings) should be placed 10-15cm apart from each other at a shallow depth. Some of the seeds which can get infected by fungus when completely covered with soil should be placed such that it is partly exposed above the soil surface. Pre-sowing treatment of seeds is required to break the dormancy in some of the rainforest species.

Watering and weeding

Nursery beds should be always moist. In the absence of rain it should be watered everyday in the first few weeks/ months. However, care should be taken to avoid water logged conditions. Weeds should be removed regularly, at least once in a week from the nursery beds and sleeves.

Transplanting from the nursery beds

Seedlings which are 15 – 30 cm tall can be transplanted into polythene bags of approximate size (15 cm to 1.5 m) filled with sand, organic compost and soil in the proportion of 1:1:6 (Mudappa and Raman 2010) before planting.

Hardening of seedlings

Prior to planting the nursery raised seedlings need to be acclimatized for the harsh field conditions. Seedlings are hardened through regular exposure to direct sun and reduced watering for 3 – 4 months prior to planting. The seedlings should be gradually exposed to sun by keeping them under sun for few hours and then putting back in shade. The period of exposure can be increased every week until finally the plants can be kept in the open.

Planting

Site preparation

The boundaries of the planting sites should be measured and clearly demarcated. All invasive weeds should be cut and uprooted one to four months prior to planting. All cut finer stems and leaves, other than larger woody stems that can re-sprout, should be left on the site to avoid soil erosion and to retain moisture. Special care should be taken not to cut any naturally regenerating native vegetation while removing the weeds.

Planting activities

Activity 1. Preparation of planting pits

Planting pits should be prepared at prescribed spacing, which should take into account spacing requirement for the plant species as well as required denseness of vegetation. The recommended pit size is 30 cm deep and 45 cm wide. Remove all the roots, weeds, large rocks, and other debris from the planting hole and from the dug up soil. Do not add gravel, sand, fertilizers, organic matter, or other amendments to the planting hole. Do not loosen or otherwise disturb the soil at the bottom of the hole.

Activity 2. Installing the plant

The hardened nursery raised seedlings of selected plants need to be at least 45cm – 75 cm tall at the time of planting. The root-stock along with the polythene cover should be placed in the

middle of the pit, and slowly the cover should be removed. Care should be taken that no damage is inflicted to the roots. Native soil with no amendments should be placed around the root stocks and gradually the soil be firmed until the end. Water the plant well to help soil settling. If any holes appear fill it with the soil. In high rainfall situations it is recommended to raise the soil at the plant base to avoid water-logging conditions. Add leaf litter as mulching material around the plant. Make sure that mulching material does not touch the stem of the seedling planted.

Provide light shade, if possible, to the plant till it is established, to prevent shock due to direct exposure to sun. This is very essential during the hot summer months.

Activity 3. After care

Watering - Watering should be done regularly in the absence of the rains and throughout the dry season.

Mulching - It is recommended that a 3-4 inch thick mulch layer, litter, shall always be maintained around the plant.

Weeding - Invasive weeds like *Lantana camara, Chromolaena odorata and Mikania sp.* should be removed regularly. Weeding may be required 3-6 times in the first year of planting and 2-3 times in the second year (Muddappa and Raman 2010).

Activity 4. Protection and replanting

Care should be taken to protect young seedlings from livestock and wild animals in the nursery and in the field. A regular visit to the land and maintaining fences are recommended. In case of any casualties, the empty space shall be replanted with the same species of plant.

BIBLIOGRAPHY

1) Food and Agriculture Organisation (1989). Windbreaks and Shelter Belts. In: Arid zone forestry: A guide for field technicians. FAO corporate document Repository. (http://www.fao.org/docrep/t0122e/t0122e0a.htm#2.%20windbreaks%20and%20shelterbelts)
2) Hanley, D. P. and Kuhn, G. (2003). *Trees against the Wind.* A Pacific Northwest Extension Publication. (http://public.wsu.edu/~pmc_nrcs/Docs/PNW005.pdf).
3) Mudappa, D. and Raman, T. R. S. 2010. Rainforest Restoration: A Guide to Principles and Practice. Nature Conservation Foundation, Mysore (http://www.moef.nic.in/downloads/public-information/Rainforest_Restoration_NCF_India_Web.pdf)

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