

5 **BIOENGINEERING FOR EROSION CONTROL**

This section considers the plant species that are suitable for stabilizing soil slopes against the various types of erosion viz., splash, rill, sheet, land slippage/slumping, gully, river and stream bank, and beach edge and coastal areas on both agricultural and non-agricultural lands. The desired architecture of the vegetation for soil protection depends on both the type of erosion and on land use. Selection of the species must take into consideration physical or engineering properties of the vegetation together with aesthetics, and implications for the prevailing land use. For example, the maximum height of the vegetation on roadside embankments or as barriers on agricultural lands will determine the suitability of the species in these situations. The responses of the species to specified environmental conditions are provided so that species selection can be appropriate to the environment.

For simplicity and a logical framework, plant species are grouped firstly by the type of erosion likely e.g. rill, or sheet erosion and secondly by the type of slope or structure e.g. embankment or verge. The magnification of the drawings are given in Appendix A, and the relevant botanical and ecological characteristics of the species are given in Appendix B.

5.1 ***Plant Species for Protection against Splash, Rill and Sheet Erosion***

The vegetation must provide for:

- ground cover
 - vegetative barrier
- on the following types of roadside verges or slopes
- flat roadside verges
 - verge of the downward sloping roadside embankment
 - downward sloping roadside embankments
 - upward sloping roadside embankments
 - gently sloping hillsides
 - steeply sloping hillsides

5.1.1 *Flat Roadside Verges*

Ideally, the cross-section of a road built on the hillside should have the components shown in Figure 1. The road shoulder should be paved with a thinner layer of bitumen or asphalt and road verges should be vegetated. The roadside drain should be paved. Frequently in the Caribbean, however, the road shoulder may be unpaved or absent and there may be no roadside drain. If there is no road shoulder, the vegetation would abut the road. This is not ideal because the plant roots would invade the road edges with time. If a road shoulder or verge is not required for pedestrian traffic, or “pulling-over” of vehicles then the road can abut the roadside drain.

The vegetation for a roadside verge can be either:

- (1) a short drought tolerant perennial grass or sedge:
- (2) a short drought tolerant, perennial, decorative shrub which would also enhance the aesthetics of the roadside, or
- (3) a combination of (1) and (2)

Grasses for road verges

- *Cynodon dactylon*
- *Imperata brasiliensis*
- *Ischaemum timorense*
- *Panicum maximum*
- *Paspalum pulchellum*
- *Sporobolus indicus*
- *Sporobolus poiretti*
- *Zoysia matrella*

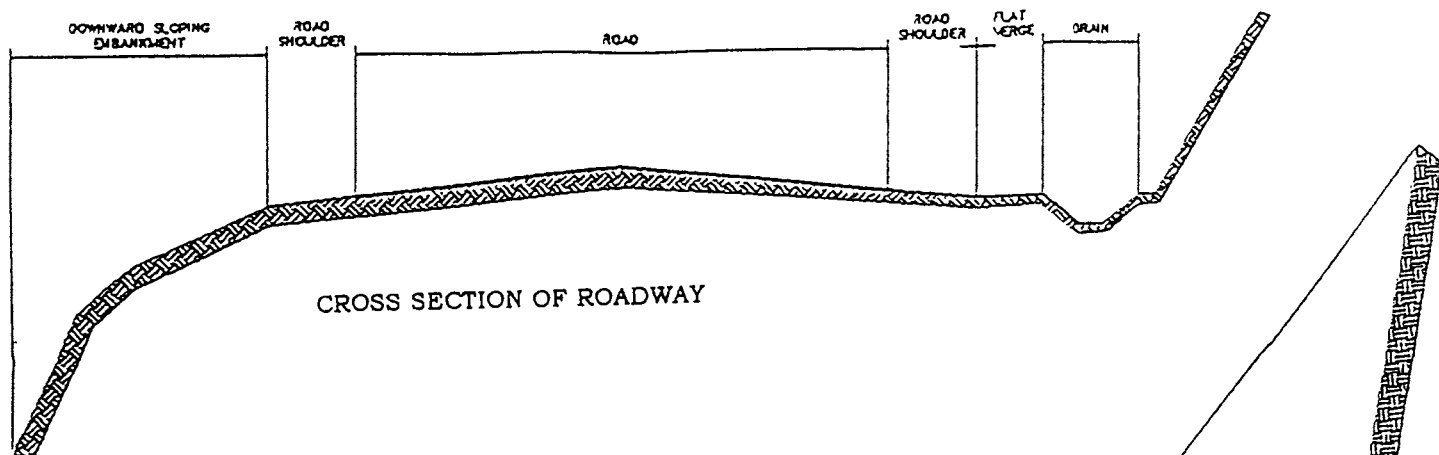
Sporobolus spp. produce an abundance of fertile seeds and therefore the invasion of cultivated pastures can be a problem.

Sedges for road verges

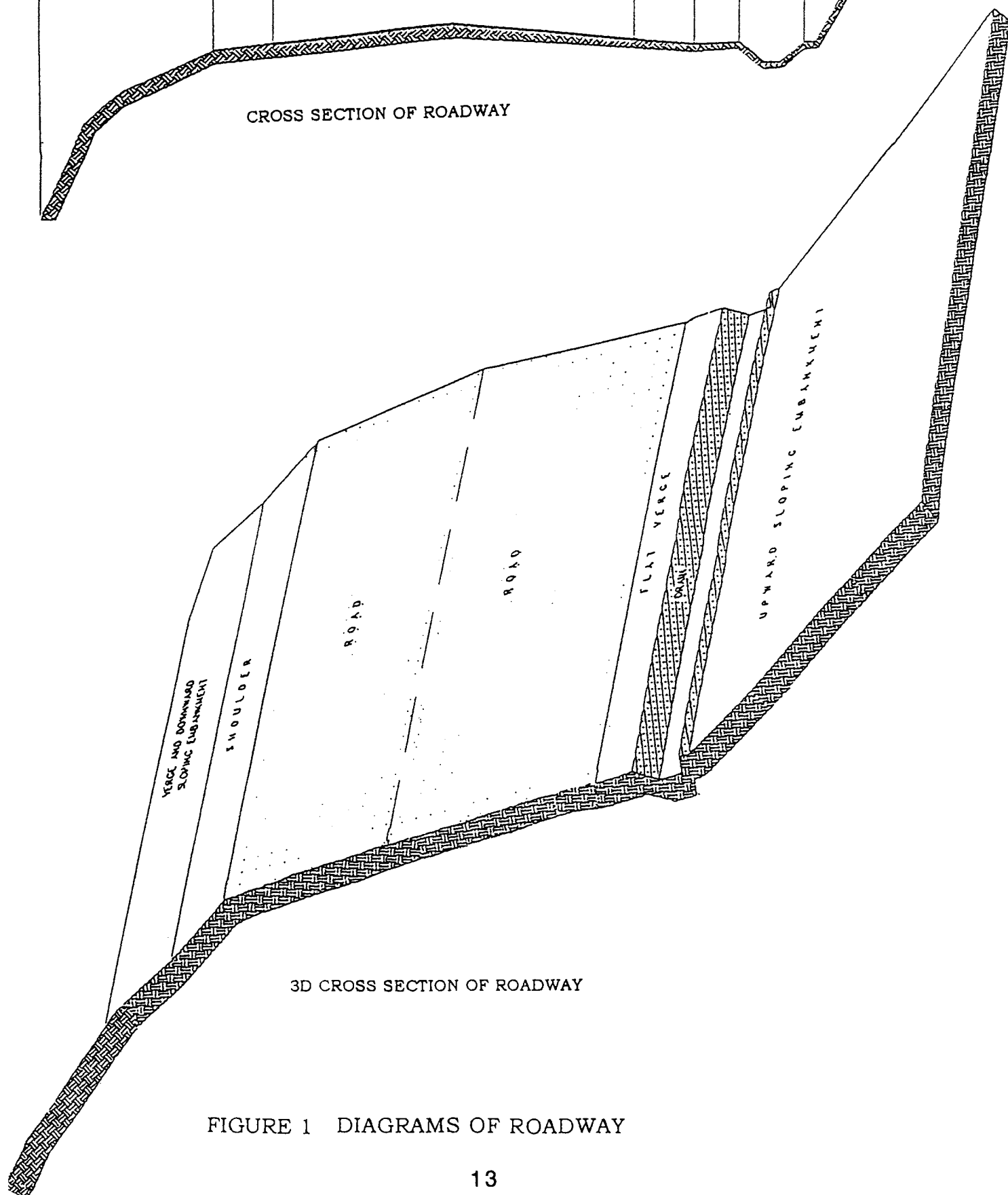
- *Lagenocarpus guianensis*
- *Rhyncospora cephalotes*

Shrubs for road verges

- *Heliconia psittacorum* (shrub)
- *Agave sisalana*



CROSS SECTION OF ROADWAY



3D CROSS SECTION OF ROADWAY

FIGURE 1 DIAGRAMS OF ROADWAY

5.1.2 *Protection of the Verge of the Downward Sloping Roadside*

Embankments

This roadside verge needs to be protected against land slippage as well as splash, rill, and sheet erosion. Therefore, larger species with deep roots are more suitable. The recommended species are:

- *Actinisthus arborescens*
- *Arundinella confinis*
- *Cortaderia selloana*
- *Cymbopogon citratus*
- *Dicranopteris pectinata*
- *Nephrolepis multiflora*
- *Panicum maximum*
- *Vetivera zizanioides*

5.1.3 *Protection Of Upward Sloping Roadside Embankments*

To protect upward sloping roadside embankments against splash, rill, and sheet erosion the vegetation must be a ground cover or vegetative barrier planted on the contour. If the selected species have relatively shallow roots, they will not protect against deep landslippage. Trees can be used to protect against landslippage on steep embankments and the trees considered under the protection of steeply sloping hillsides (5.1.5) are suitable.

Ground cover

The plant species that are recommended above for road verges are also suitable for protecting roadside embankments against splash, rill, and sheet erosion. *Cynodon dactylon* is relatively slow growing and does not provide rapid ground cover. It, however, can be grown in conjunction with *Sporobolus indicus* and *S. poiretti* for improved ground cover of embankments.

In addition to those grasses and shrubs, a few ferns and grasses have been found to dominate some embankments and are recommended.

These are:

- *Arundinella confinis* (grass)
- *Dicranopteris pectinata* (fern)
- *Nephrolepis multiflora* (fern)

Vegetative barriers for roadside embankments

The barrier can be a grass or short shrub, preferably decorative, to enhance the aesthetics of the roadside, but the selected species should not spread or tiller rapidly and the barrier must retain its integrity.

Grass barriers

- *Cortaderia selloana*
- *Cymbopogon citratus*
- *Vetivera zizanioides*

The non-flowering feature of *V. zizanioides* (vetiver) makes it an ideal candidate for grass barriers. The other species produce flowers and viable seeds. They therefore have the capacity to spread by seed dispersal if they are not managed by cutting. They do not spread rapidly by tillering.

Shrub barriers

- *Agave sisalana*
- *Isertia parviflora*
- *Palicourea crocea*
- *Sansevieria guineensis*

5.1.4 *Gently sloping hillsides*

Species that are suitable for gently sloping open hillsides or sheltered hillsides (as vegetation on the forest floor or lower storied vegetation in the forest) are:

- *Acnistus arborescens* (open)
- *Andropogon bicornis* (open)
- *Bromelia plumeri* (sheltered)
- *Cnemideria spectabilis* (sheltered)
- *Cortaderia selloana* (open)
- *Cymbopogon citratus* (open or sheltered)
- *Dracaena fragrans* (open)
- *Heliconia psittacorum* (open or sheltered)
- *Miconia acinodendron* (sheltered)
- *Panicum maximum* (open)
- *Pisonia eggersiana* (sheltered)
- *Vetivera zizanioides* (open)

5.1.5 *Steeply sloping hillsides*

Species which occurred commonly on steep hillsides are:

- *Arundinella confinis*
- *Croton gossipifolius*
- *Dicranopteris pectinata*
- *Panicum maximum* (particularly recommended for high elevation)
- *Pitsairna integrifolia* (particularly rocky/stony outcrop areas)

Many tree species have deep root systems and can stabilize steep slopes against erosion. The following tree species are suitable:

- *Anacardium occidentale*
- *Andira inermis*
- *Calliandra* spp.
- *Cassia* spp.
- *Causaina equisetifolia*
- *Ficus benamina*
- *Gliricidia sepium*
- *Sesbania* spp.

The species must however, be selected in relation to the soil type and climate.

5.2 *Plant Species for Protecting against Landslippage/Slumping*

Many tree species with deep well distributed roots will protect against landslippage. Any hillside which is prone to slippage must therefore be protected by suitable tree species. Fruit tree orchards with standard spacing on hillsides, are also usually adequate to protect the soil against slippage.

To protect against soil slippage which would affect civil works e.g. roads, buildings, and bridges, selected tree species can be planted alone or in combination with engineering structures. The trees must be planted sufficiently close to each other to avoid landslippage occurring between the trees. The canopy or crown of the tree must not be too wide i.e. the architecture of the tree must allow close planting without affecting the growth and rooting depth of the plant. In addition to the tree species which have been recommended for protecting steeply sloping hillsides (5.1.5) the following species are also suitable for protecting against landslippage:

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- *Byrsonima coriacea*
- *Pandanus odoratissimus*

5.3 ***Plant Species for Protecting against Gully Erosion***

Erosion in small gullies can be controlled by planting shrubs at intervals across the gully. Plant species that are suitable should be planted in a criss-cross manner by themselves or in combination with a small earth dam on the upstream side of the shrub cuttings. The cuttings should be at least one metre above the ground after they are planted. The species that are suitable are:

- *Calliandra* spp.
- *Gliricidia sepium*
- *Leucaena leucocephala*
- *Sesbania* spp.

Grasses such as

- *Cortaderia selloana*
- *Cymbopogon citratus*
- *Imperata brasiliensis*
- *Vetivera zizanioides*

can be used for grassing the gully head, in addition to the planting of the shrubs, to provide extra protection. Large gullies often require engineering structures.

5.4 ***Plant Species for River and Stream Bank Protection***

The species must be capable of withstanding high moisture or even flooding conditions and include:

- *Arundo donax*
- *Gynerium sagittatum*
- *Pandanus odoratissimus*
- *Spathiphyllum cannifolium*

5.5 ***Plant Species for the Protection of Beach Edge and Coastal Areas***

The recommended species must be able to withstand saline and sandy soil conditions, e.g.

- *Chrysobalanus icaco* (beach edge and coastal areas)
- *Rhyncospora barbata* (beach edge)
- *Tridax decumbens* (beach edge)

Tridax decumbens provides very good ground cover on beach edges, but it is a pantropical weed and therefore the adoption of this species should be carefully considered.