

## Roadside Bio-Engineering - Site Handbook (DFID, 1999, 160 p.)

### ➔ Section Five - Maintenance of bio-engineering

 *(introduction...)*

 **5.1 Introduction**

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## Roadside Bio-Engineering - Site Handbook (DFID, 1999, 160 p.)

### Section Five - Maintenance of bio-engineering



## Figure

### This section:

- **defines bio-engineering maintenance and the principles behind it and lists the requirements (Section 5.1 );**
- **gives guidelines on how to plan for the maintenance of bio-engineering and other roadside vegetation (Section 5.2);**
- **describes routine bio-engineering maintenance activities (Section 5.3), including site protection, weeding, mulching, grass cutting and watering;**
- **describes preventative maintenance activities (Section 5.4), including the thinning and pruning of trees and shrubs, the repair of bio-engineering structures, vegetation enrichment and the removal of unwanted shrubs and trees: these are long-term management activities;**
- **includes a code of practice for working with rural road neighbours (Section 5.5); full guidelines on this subject are given in the *Reference Manual*,**

**Detailed technical guidelines on the management of shrubs and trees for the principal purpose of slope stabilisation, are given in the *Reference Manual*.**

**A guide to the law, as it applies to all roadside vegetation, is also given in the *Reference Manual*.**

## **5.1 Introduction**

### **What is the maintenance of bio-engineering?**

**Vegetation must be managed for the maximum advantage to be gained from it in order to realise the long-term benefits of bio-engineering in slope stabilisation. Sound management will also maximise productivity and improve appearance. In the road reserve, this work becomes part of *roadside support maintenance*<sup>1</sup>.**

**<sup>1</sup> Definition of Maintenance and Maintenance Activities. Department of Roads, Mangsir 2051 (November 1994).**

**Routine maintenance involves simple protection and care of plants, such as weeding, mulching and grass cutting.**

**Preventative maintenance is more complex. Larger plants (shrubs and trees) require treatments such as pruning and thinning. Pruning is the removal of the lower branches of large plants. Thinning is the careful removal of whole shrubs and trees to allow more light to penetrate. All forest areas must be thinned on a recurrent basis. Under this long-term management of vegetation comes the repair and replacement of vegetation structures, and the removal of unwanted large plants.**



**A recently rehabilitated road pavement: its longevity depends on the protection and maintenance of the adjoining slopes.**

**For some activities, legal questions may arise. A Guide to the Law regarding roadside vegetation is given in the companion *Reference Manual*.**

**In rural areas, the road neighbours ('local people') must be taken into consideration. The Department of Roads may be able to collaborate with them for mutual benefit. Section 5.5 gives a code of practice for collaboration with road neighbours and more detailed guidelines are given in the *Reference Manual*.**

**'Maintenance' of vegetation in engineering is equivalent to 'management' in forestry, horticulture and agriculture. Vegetation on roadsides must be maintained on a long-term basis in order to maximise their engineering contribution, productivity and appearance. Most operations are similar to normal forestry practices. However, there are some particular needs for bio-engineering which are specific to the road sector.**

**In general, routine maintenance activities can be carried out by lengthmen and gangs should carry out preventative maintenance. However, the mode of operation depends on the scale of each site and should be kept flexible.**

**The timing of checking and intervention for each activity is given in Section 5.2.**

### **General principles of vegetation maintenance**



**Well-maintained roadside slopes. The vegetation is managed and cut on a regular basis**

**In bio-engineering, the aim is to stop all forms of erosion and shallow mass movement. It is usually necessary to manage vegetation in order to achieve this since a semi-natural (or unmanaged) community of vegetation does not always provide the functions required for engineering. Often, unmanaged vegetation leads to a dense canopy of trees with relatively little vegetation underneath. Although the trees have deep roots, they do not stop erosion on the surface. That is why soil erosion often takes place under natural or protected forests.**

## **Mixed structure**

**You should aim to manage the vegetation to produce a mixed vegetation community<sup>1</sup> with a variety of trees, shrubs and grasses on a single site. Single species, or vegetation communities dominated by one or a few species, are unlikely to have either an irregular structure or variety of ages.**

**<sup>1</sup> A vegetation community can be defined as 'an established group of plants living more-or-less in balance with each other and their environment; the group can be either natural or managed'.**

## **Mixed age**

**Try to achieve a collection of plants of mixed ages for each site (an uneven-aged structure). This means that all plants do not need to be replaced at the same time and there will always be some strong, healthy plants protecting the slope.**

## **Low maintenance**

**Aim to establish a vegetation community that does not need too much intervention from outside to maintain it. For example, choose species that can regenerate naturally (without planting); species that do not grow too fast or too tall (need cutting and removal less frequently); species that live longer, *etc.***

## **Managed progression**

**In bio-engineering it is often necessary to start with pioneer species<sup>2</sup> and move**

**towards a climax community<sup>3</sup>. Examples of this include:**

- **tilka/dhanyero scrubland → mixed sal forest (eventually → mixed tropical hardwoods);**
- **khayer/sisau plantation → mixed sal forest (eventually → mixed tropical hardwoods);**
- **khote salla plantation → mixed broad-leaved forest (tooni; chilaune; katus);**
- **utis plantation → chilaune/katus forest;**
- **gobre salla plantation → khasru/gurans forest.**

**2 Pioneer or colonising species are the first plants to appear on bare ground and are naturally adapted to living on sites with harsh conditions. Examples are: grasses: babiyo, dhonde, kans, khar; shrubs: areri, bhujetro, keraukose, saruwa; trees: bakaino, khayer, salla, sisau, utis.**

**3 Climax community species are plants that can form permanent natural forest or natural vegetation. They tend to require better sites to grow, and grow more slowly. Examples are: grasses: amliso, dangre khar, padang bans; shrubs: bainsh, simali, sajiwan; trees: chilaune, katus, lankuri, sal.**

## **5.2 Planning the maintenance of bio-engineering and other roadside vegetation**

### **Vegetation and bio-engineering maintenance activities**

**It is important to plan the maintenance of roadside vegetation in order to ensure that the necessary work is carried out at the best time of year, and to avoid future**

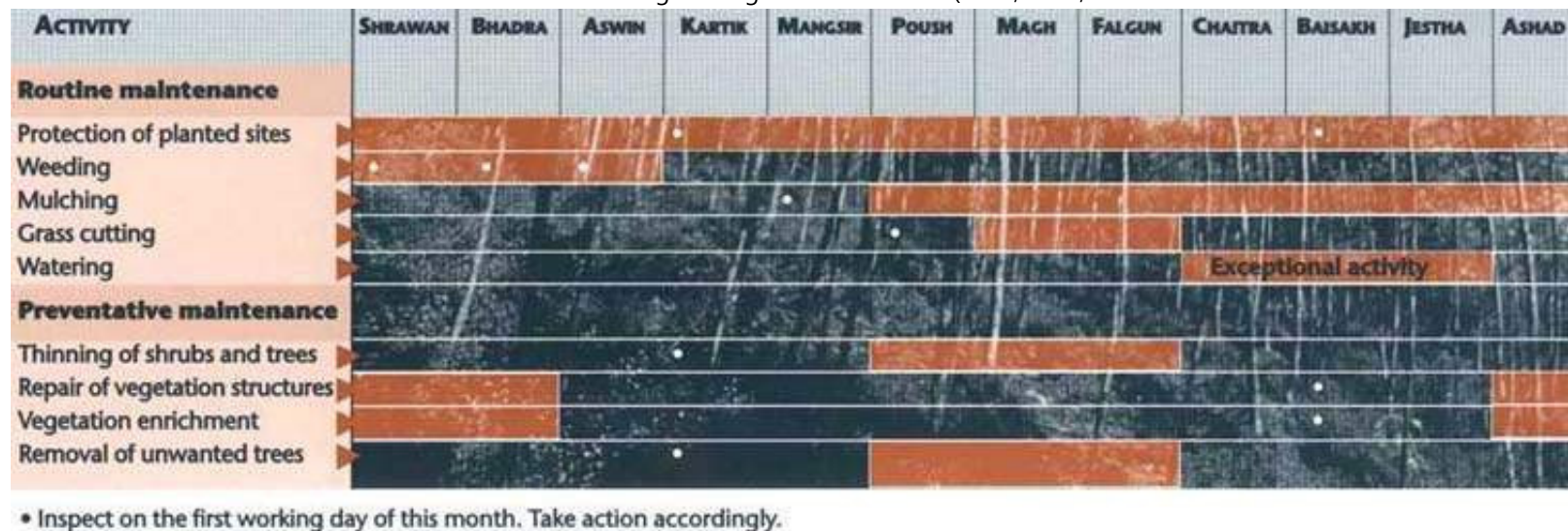
**problems resulting from lack of maintenance. Since each site requires its own maintenance budget, planning ensures that budgets are allocated in good time and priority work can be carried out.**

**Consider each site separately, because maintenance interventions are extremely site-specific for each slope. Consider the history and future plans for each site independently.**

**Each site has a different combination of conditions, which affects its maintenance, including:**

- **physical conditions (e.g. slopes, materials, local climate, existing vegetation, extent of site);**
- **legal position (e.g. land ownership, existence of disputes, distance from road, type of road);**
- **road neighbours (e.g. occupations, populations, level of interest and previous involvement in road maintenance, existing local groups such as forest user groups, NGOs, societies).**





**Figure 5.1: Maintenance activity calendar**

**Before starting to plan, assemble as much information as you can on these three categories. A plan can then be prepared (and budgeted, if necessary) before starting the work.**

**Most maintenance operations are seasonal. The calendar in Figure 5.1 summarises the recommended timing for the operations described in these guidelines.**

### **Planning the maintenance programme**

**Follow these steps to plan the maintenance of roadside support carefully.**

#### **Step 1**

**Identify the maintenance needs of vegetation on the roadside slopes. This should cover both vegetation planted under a bio-engineering programme, and other**

**existing vegetation. This will entail a detailed survey of all slopes adjacent to your road section.**

## **Step 2**

**Quantify the work that must be done regularly, as part of a yearly programme.**

## **Step 3**

**Devise a programme of regular checks. This must state which sites are to be checked, when they are to be checked, what they are to be checked for, and who will do the checking.**

## **Step 4**

**Implement the maintenance programme.**

## **Step 5**

**Monitor the maintenance programme and evaluate its effectiveness. Improve it as necessary.**

**The table in Figure 5.2 specifies precisely the timing of interventions to maintain roadside support. These should be followed in every case.**

**Figure 5.2: Detailed timing of the maintenance activities for vegetation on roadside slopes**

<b>ACTIVITY</b>	<b>CATEGORY</b>	<b>SITES TO CHECK</b>	<b>TIMING OF CHECKS</b>	<b>TIMING OF</b>
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				<b>ACTION</b>
Protection of planted sites	Routine	All roadside slopes.	Carry out checks on 1 Baisakh and 1 Kartik.* If protection is given, make weekly inspections.	Protect immediately, if necessary.
Weeding	Routine	Sites where bio-engineering has been used in the past three years.	Check on 1 Shrawan, 1 Bhadra and 1 Aswin.*	Weed immediately, if necessary.
Mulching	Routine	Sites where bio-engineering has been used in the past three years.	Check on 1 Mangsir.*	If mulching is necessary, start work on 1 Poush.*
Grass cutting	Routine	All roadside slopes.	Check on 1 Poush.*	If grass cutting is necessary, start work on 1 Magh.*
Watering	Routine	Only those sites where bio-engineering has been used within the past 12 months.	Check weekly in Chaitra, Baisakh and Jestha.	Water immediately, if necessary.
Thinning of shrubs and trees	Preventative	All roadside slopes with forest cover and all sites where bio-engineering was	Check on 1 Kartik.*	If thinning is necessary, start work on

		used more than two years ago.		1 Poush.*
Repair of vegetation structures	Preventative	All sites where bio-engineering has been used.	Check on 1 Baisakh.*	If repairs are necessary, start work on 1 Ashad.*
Vegetation enrichment	Preventative	All roadside slopes.	Check on 1 Baisakh.*	If enrichment is necessary, start work on 1 Ashad.*
Removal of unwanted trees	Preventative	All roadside slopes.	Check on 1 Kartik.*	If removal is necessary, start work on 1 Poush.*

**\* Or on the first working day after this date.**

### **5.3 Routine bio engineering maintenance activities**

#### **Protection of planted sites**

#### **Why protect?**

**People may cut grasses, shrubs or trees too much, or at the wrong time of year. This can stunt growth and prevent plants from fulfilling their functions. If plants**

**are cut before the seeds fall, there will be less natural regeneration, especially from grasses. However, at certain times, local people can be very helpful.**

**Animals may eat small plants and damage the slope with their hooves. Animals are very difficult to control if they are allowed on to a site.**

## **How to protect slopes**

**Planted sites can be protected in one of four main ways.**

- **A warden<sup>1</sup> can be employed to watch the site. If this is done, he or she should be told also to do weeding, mulching and other work, rather than just to walk around watching the site. This would need encouragement from the Engineer, Overseer and Supervisor.**
- **Protection after planting can be made a compulsory part of a contract package. However, this can be used for only 6 to 12 months.**
- **The protection of roadside sites can be made part of a road lengthman's duty. In certain cases it may be necessary to reduce the length of road covered by the lengthman.**
- **An arrangement can be made with local people to protect the area. This is often the most long-lasting, but is also the hardest to achieve. It can be done only if there is a clear incentive for the people involved, such as providing large quantities of fodder from the road reserve. This is considered in more detail in the *Reference Manual*.**

**1 The function of a warden is more than that of a chowkidar or heralu. He or she has to carry out a number of maintenance activities.**

**Whatever system is used, it is very important that both the areas to be protected and the duties to be performed are clearly defined. The Division staff must ensure that the people doing the protection really understand what is expected of them. The box below gives an example of the duties that a site warden should be expected to perform.**

**How to check that sites are adequately protected**

**Basic checks can be made easily by walking through a site that is being protected and looking for signs of damage. Do not just walk along a main path but also go into some other corners of the site. The signs to look for are:**

- **regular spacing and growth of plants;**
- **plants are carefully weeded and mulched;**

**The following signs suggest poor protection:**

- **physical damage to plants (e.g. growing shoots or leaves eaten off);**
- **animals or signs of animals (e.g. dung) in the area.**

### **DUTIES OF WARDENS IN PROTECTING PLANTED SITES IN ROADSIDE AREAS (EXAMPLE)**

Site wardens should be active in a range of duties, including:

- watching all sites (in their road section) and ensuring that no domestic or wild animals graze the areas;
- explaining to local people the importance of protecting the areas; asking them to graze animals and to cut fodder and firewood well away from the road, and enforcing this as necessary;
- tending the plants, weeding and mulching the site carefully to promote and improve growth;
- cutting weeds (mainly annuals) in the adjoining road reserve and forest areas to make mulch for the plants on the site;
- alerting the Engineer, Overseer or Supervisor to any untoward events, such as damage to any of the site structures, blocking of drains, etc;
- helping to replace and enrich the bio-engineering planting during the rains;
- at other times, carrying out minor repairs of up to 0.25 cu. m to physical structures on the slopes.

The warden should be given the best possible support from the Division. This should be as for lengthmen.

Local wardens are often the most effective in reducing damage. This seems to be partly because they know personally all the people who use the area.

See also *Standard Specifications for Bio-engineering*, item 2881, 'provision and role of site

watchmen' (given in the *Reference Manual*).

## **Weeding**

### **What is weeding?**

**Weeding is the removal of unwanted vegetation that is competing with the growth of the desired plants.**

### **Why do weeding?**

- **To improve the growth of the desired species by removing competing vegetation. In some dry forest types, it may also be necessary to reduce the risk of fires.**
- **To remove dense vegetation (especially invasive weeds such as ban mara and tite pate) in order to allow more desirable plants to regenerate naturally.**
- **To improve drivers' sight lines and the visibility of pedestrians, where these have been reduced.**

### **When should weeding be done?**

**When the plantation age is young, and also in older sites when there is a need to encourage better growth or natural regeneration.**

**Weeding is normally required only during the monsoon rains, once unwanted**



**plants have grown up. The most important time is from Shrawan to Aswin.**

## **How to weed a site**

**Select individual sites according to their situation and treat them at one time.**

**Carefully cut and remove only undesirable species, but take care to retain plants of the desired species. Always avoid deep soil working, which can damage plant roots.**

**Small plants with weak, shallow roots, such as ban mara (*Eupatorium adenophorum*) and tite pate (*Artemisia vulgaris*) can simply be pulled up if this will not damage the remaining plants. Unwanted plants with stronger roots should be cut about 50 mm above ground level using a hasiya (sickle).**

## **Products from weeding**

**Weeding can produce material for mulching or composting, and sometimes for fodder.**

## **Materials and tools for weeding**

**Most weeding operations will only require a hasiya (sickle).**

## **Mulching**

### **What is mulching?**

**Mulching is the positioning of inert dead vegetation around seedlings to keep the**

**soil cool and moist. Mulch is usually made by cutting up the stems and leaves of unwanted plants**

### **Why do mulching?**

**Mulching is required to improve the growth of plants less than three years old.**

**By keeping the soil cool and moist, mulching increases the rate of growth. Plants become big more quickly and their roots help to strengthen the slope.**

**Where grass seeding has been done, mulching also protects delicate new grass plants from both scorch by hot sun and damage by rain splash.**

### **When should you mulch?**

**Mulching is most needed when there is too much sun and too little water. This means any time during the dry season and early rains, from Poush to Ashad.**

**All new shrub and tree seedlings should be mulched directly after planting.**

### **How to mulch**

**Mulch can be made from the stems and leaves of any plants. It is important not to use plant parts carrying seeds, as this will lead to a big weeding problem.**

**If possible, make mulch from annual and perennial weeds with poor rooting characteristics, such as ban mara (*Eupatorium adenophorum*) and tite pate (*Artemesia vulgaris*). The greenery should be collected when there is most**

**material available, but before it forms seeds. This is most often in Shrawan and Bhadra. However, requirements always have to be assessed specifically and local sources checked.**

**Straw and thatch grasses can also be used.**

**Collected material should be chopped: the maximum size is 150 mm. It can be stored until required if necessary.**

**Spread the mulch around the plant being treated in a layer 50 mm to 100 mm thick. A circle of radius 150 mm should be left next to the plant itself. Outside this, the mulch should form a circle of about 750 mm radius.**

## **Materials and tools for mulching**

**Most mulching operations will require:**

- a hasiya (sickle) for cutting the plants;**
- a khukuri for chopping the weeds into small pieces;**
- a doko and namlo for transporting the mulch.**

## **Grass cutting**

### **Why cut grasses?**

- Cutting grasses encourages them to remain vigorous and to put out new shoots. It also allows better inspection of slopes and provides useful products.**

- **To improve drivers' sight lines and the visibility of pedestrians, where these have been reduced.**

### **When should grasses be cut?**

**Grasses are cut once a year, after the seeds have fallen. This means that cutting must not take place before the beginning of Magh. Grasses should be cut on all accessible bio-engineering sites and other roadside slopes with grass cover.**

**Grass cutting can take place any time during Magh and Falgun. If the grasses impede road traffic at other times, they should be cut immediately.**

**Fodder grasses (but not tree fodder or dale ghans), which are not commonly planted in roadside areas, should be cut every one to two months during the wet season. Cutting should be done whenever a good crop can be taken.**

### **How to cut grasses**

**Cut grasses about 150 mm above the ground, using a karauti or hasiya (sickle). Care must be taken not to pull out the roots of the grass clump. Also, other plants must not be damaged; especial care must be taken of small shrub and tree seedlings.**

### **Products from grass cutting**

**Any cut grass can be used for mulching the plants on the site.**

**Otherwise, the cut grass can be used for thatching, fodder, fibres, kuchos or other**

**uses, according to the species. Government regulations must be followed for the disposal of products grown on road reserve land. Products from other land should normally be given to the land owner or community group responsible for the land.**

## **Materials and tools for grass cutting**

**Most grass cutting operations will only require a karauti or hasiya (sickle).**

## **Watering**

### **Why do watering?**

**Watering<sup>1</sup> can help enormously to improve the growth of plants on harsh sites during the later dry season (Chaitra to Jestha). If watering is done, mulching is normally done as well.**

**<sup>1</sup> Note: watering of plants is only required in special cases. It is most commonly used on critical sites where planting is carried out well before the monsoon, such as in Baisakh or Jestha.**

### **When should you water?**

**Watering is done only in these situations:**

- on all bamboos planted in dry sites;**
- on critical sites, where good plant cover must be established before the start of the monsoon rains; or**

- **when water is easily available on site, such as from a nearby khola or a spring; or**
- **when a dry period occurs soon after planting in the early monsoon, and resources allow; or**
- **where a warden has no other duties and water is available close to the site.**

**Watering is done on days without rain, normally in Chaitra, Baisakh and Jestha. It is done in the morning or evening. It is not done during the middle of the day when it is sunny (because too much would evaporate).**

### **How to water**

**Water must be applied slowly and allowed to infiltrate, preferably using a sprinkler. It must not run off. If necessary, the ground can be lightly cultivated to increase infiltration. For shrub and tree seedlings, the water can be poured into a small trench just up the slope.**

Watering rates:

grass plants: 0.25 litres per plant per day;

shrub and

tree seedlings: 5 litres per plant per day;

bamboo plants: 10 litres per plant per day.

### **Materials and tools for watering**

**If possible, water should be brought by pipe. Otherwise, it can be carried in buckets or watering cans.**

## **5.4 Preventative maintenance of roadside vegetation**

### **Pruning and thinning of shrubs and trees**

**A detailed technical appraisal of pruning and thinning is given in the *Reference Manual*; that should be followed for large sites and in special cases. However, this section gives guidelines applicable to most sites, and most maintenance requirements.**

#### **What are pruning and thinning?**

**Pruning is the removal of the lower branches of a tree or large shrub.**

**Thinning means removing selected shrubs or trees to decrease the density of the plants. In practice, this usually means removing about half the number of trees on the site.**

**There are three forms of thinning:**

- pollarding: a tree is cut 2 to 3 metres above the ground and new shoots grow up;**
- coppicing: a tree is felled and new shoots come from the stump;**
- selection thinning: a tree is felled and the stump allowed to die.**

**Most thinning operations involve selection thinning: *i.e.* the removal of whole**

## **trees.**

### **Why do pruning and thinning?**

- **To increase the light penetrating through the canopy. This will improve the plants growing on the ground underneath, especially grasses, and reduce surface erosion.**
- **To remove trees of species that are no longer required in the final, mature site.**
- **To improve drivers' sight lines and the visibility of pedestrians, where these have been reduced.**

### **When should you prune and thin?**

**When a plantation is dense and shrubs or trees have crowns that are touching. This may be about every five years, but every site should be inspected annually.**

**Shrubs and trees are best removed during the winter (Poush to Falgun) when disturbance is least likely to hinder the growth of the remaining plants.**

### **How to prune and thin**

- **Start by pruning. First cut off the bottom branches, up to half the total height of the shrub or tree. For large mature trees only, cut branches up to two-thirds the total height of the tree.**



- **Cut branches cleanly and as close to the trunk as possible without causing damage. Cut the branches nearest the ground first and move upwards.**
- **Use sharp tools to cut branches. Where the branch is more than 50 mm in diameter, make a small cut underneath the branch first. The bark should never be torn: this can damage the plant badly.**

**Now ask this question:**

**Has the canopy been opened enough just by pruning, so that there is now enough light penetrating to allow grasses to grow under the trees?**

**If 'yes', then the operation is complete.**

**If 'no', then thin the trees.**

**Thinning is carried out by following this procedure.**

- **Inspect the site carefully and decide which trees should be kept and which trees should be removed.**
- **Choose to keep vigorous, healthy trees that will continue to grow well if they are given more space.**
- **As you choose the trees to be felled, select them in this order:**
  - 1. All dead, dying or seriously damaged trees.**
  - 2. Trees of unwanted species.**
  - 3. Trees of bad shape and large crown.**
  - 4. Next, select trees to leave a variety of sizes and ages.**

- **Mark with paint the trees that should not be felled.**
- **Fell the unmarked trees.**
- **Thin a site according to its requirements, to achieve 50 to 67 per cent open space and only 33 to 50 per cent canopy.**



**An open canopy with grasses growing underneath.**



**Too little light is penetrating this canopy to allow grasses to grow; pruning or thinning is required**



**A plantation of utis (*Alnus nepalensis*) where the trees are thin and weak due to dense planting and intense competition for light. Pruning and thinning are required to improve the spacing, as well as to allow better understorey vegetation to develop**

### **Products from pruning and thinning**

**Firewood is the main product from pruning operations, but very little will be produced from plants that have been regularly pruned for several years.**

**A range of sizes of poles will be produced from thinning, suitable for many uses (building, fences, etc.). However, much of the cut material will be suitable only for firewood if plants are not straight, or if they are unsuitable for timber.**

**Government regulations must be followed for the disposal of products grown on road reserve land. Products from other land should normally be given to the land owner or community group responsible for the land.**

**The Department of Roads can heat bitumen with firewood from trees grown in the road reserve.**

### **Materials and tools for pruning and thinning**

**Most pruning operations require a khukuri, secateurs or small saw.**

**Most thinning operations require a saw or axe.**

**Paint for marking trees that will not be thinned or pruned.**

**Use very sharp tools; working with blunt tools can damage trees.**

## **Repair of vegetation structures**

### **What is the repair of vegetation structures?**

**The repair of any form of bio-engineering treatment: mainly palisades, fascines and brush layering, and re-turfing. This should be done as and when required.**

### **Why repair vegetation structures?**

**To maintain the effectiveness of the treatments and to ensure that they become stronger over time.**

### **When should vegetation structures be repaired?**

**Bio-engineering sites should be checked regularly. This should normally be once every six months or less.**

**Repairs should be programmed as part of the Division's work plan.**

**Repairs to living structures should be done during the monsoon rains (*i.e.* Ashad to Bhadra).**

### **How to repair vegetation structures**

**Employ a small specialist gang to repair bio-engineering treatments.**

**The minimum amount of disturbance should be made to the site.**

**The work to be done depends on the particular bio-engineering treatment and the type of damage.**

**A suitable lengthman or site warden can undertake very small repairs.**

**Materials and tools for repairing vegetation structures**

**These are normally the same as for the original construction of the structure being repaired. The materials and tools required are given in the appropriate rate analysis norms.**

**Vegetation enrichment**

**What is vegetation enrichment?**

**Vegetation enrichment means planting more grasses, shrubs or trees within the site area or in gaps within the existing vegetation.**

**It can also involve the planting of shrubs and trees to replace those removed for certain reasons (see below).**

**Why enrich vegetation?**

**To establish more plants in places where there are gaps.**

**To introduce or change the species composition on a site: for example to increase the range of species or to move away from a single species (e.g. utis), by planting seedlings of other species.**

## **When should vegetation be enriched?**

- **Whenever there are gaps in the vegetation in which erosion might start.**
- **When it is necessary to change the mixture of species. This might be to move from pioneer to climax community species (following the principles described in the *Reference Manual*).**
- **When trees that have had to be removed need replacing. This is when the other remaining vegetation is not adequate to protect the slope.**
- **Actual enrichment planting should be done during the monsoon rains (*i.e.* Ashad to Bhadra).**

## **How to enrich vegetation**

**Carefully select plants that are desired on the site and should grow well, and raise them in the nursery**

**Plant only in gaps, not under a dense forest canopy. Follow this with regular weeding.**

**Spread the planting over several years and concentrate on successful establishment in a small area each year, if the total area available for planting is large.**

**Vegetation enrichment is best combined with other operations that increase the amount of light penetrating the canopy (such as thinning and tree removal). In**

**this case, enrichment should be concentrated in gaps or open areas in the canopy.**

## **Materials and tools for vegetation enrichment**

**These are normally the same as for the original planting of the vegetation being enriched. The materials and tools required are given in the appropriate rate analysis norms.**



**Thinning roadside plantations can yield significant volumes of firewood**

## **Removal of unwanted shrubs and trees**

### **Why remove unwanted shrubs and trees?**

**A tree may be removed for any of the following reasons:**

- The tree is dead and may fall down.**
- The tree is obstructing traffic or drivers' sight lines.**
- The tree is surcharging a steep slope, or is too big and unstable for the slope on which it is growing.**
- The tree needs to be cut as part of a thinning programme. This will allow more light to penetrate and help the understorey grow.**

- **The tree needs to be cut to allow coppice shoots to come from the stump.**
- **The tree needs to be cut to allow widening of the road.**

**When should unwanted shrubs and trees be removed?**

**Whenever a problem occurs where a tree needs to be removed.**

**If possible, shrubs and trees are best removed during the winter (Poush to Falgun) when the disturbance is least likely to hinder the growth of the remaining plants.**

**How to remove unwanted shrubs and trees**

**Follow the legal guidelines shown in the *Reference Manual*.**

**Organise labourers or a contractor to fell the shrub or tree and dispose of the produce according to regulations.**

**Large trees should be felled so that they do not damage young trees and shrubs unduly. If a tree with a very large crown has to be felled, it should be pruned first to remove the crown branches. It should also be felled across the slope to avoid excessive damage.**

**Materials and tools for the removal of unwanted shrubs and trees**

**Most removal operations require the same tools as for thinning. These are: a saw, or an axe, and paint for marking trees to be left. All tools used should be very**



**sharp. This is to avoid damage to trees from bad working with blunt tools.**



**A positive relationship with road neighbours is advantageous for all concerned**

### **A CODE OF PRACTICE CONCERNING ROADS AND OTHER LAND USES**

1. This is a practical guide which, if followed by Departmental staff, will help to ensure that roads do not conflict with other land uses. It will also help to improve relationships with rural road neighbours ('local people').
2. The impact of every operation on the surrounding land must be considered before it is undertaken. A full site investigation must be made. Consideration must be given to the potential for damage to surrounding farmland.
3. No operation should be permitted (without due compensation) that gives rise to damage

to farmland, water supply lines, irrigation systems, or other forms of local infrastructure.

4. Where there is likely to be any adverse impact or conflict, then contact should be made with the people concerned. Adequate time must be allowed for discussion and agreement. Possible alternatives should be considered.

5. In every case, the requirements of the law should be followed where compensation may be due.

6. On every road section, a number of safe tipping sites must be designated. All staff must be instructed to use them. Such sites must be away from houses and farmland; they must be on stable slopes; and they must be well marked on the lower side.

7. No tipping of material should be permitted anywhere except in designated tipping sites.

8. The discharge of all drains should be checked on a recurrent basis. Any damage resulting from excess flows should be rectified.

9. Any changes (e.g. small landslides) to roadside slopes that might affect either the road or adjoining land should be investigated promptly. Repairs, if necessary, should be undertaken at the earliest opportunity.

10. Any complaint by a road neighbour should be investigated promptly and action taken as necessary.

11. Where a road neighbour is undertaking activities causing damage to the road, a thorough investigation should be made. This should start from a sympathetic approach, but where the Department's interests are affected, reference should be made to the laws.

The legal standing of the Department of Roads should be ascertained as early as possible in each particular instance.

12. Where there is a conflict, a compromise solution that suits both parties should be sought wherever possible.

## **5.5 Liaison with rural road neighbours**

**Roads should blend with the landscape through which they pass. They should not be permitted to show a negative impact on other land uses. In rural areas, they must enhance agriculture, and not have a damaging effect on the activities of farmers. A positive relationship between road maintenance offices and the people who live beside their roads is advantageous for everyone.**

**To move in this direction, the code of practice given above should be followed for reasons of good technical working, good professionalism and good ethics. It applies specifically to roadside maintenance, rather than to the construction of new roads.**

