THE AFFORESTATION OF OPEN-CAST MINING SPOILS
IN THE UNITED KINGDOM –
SOME TECHNIQUES AND OBSERVATIONS

by

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The decision as to whether to afforest former open-cast mineral workings is mainly determined by economic considerations. On the better soils, and where the topsoil has been conserved, a return to agriculture is to be expected. Where there is a high water table, on river floodplains, lakes and ponds are the result, valuable for recreation and amenity. On poor soils, under heath or moorland vegetation, and on former woodlands, the sites are usually afforested.

When carrying out reclamation we usually have the benefit of a survey, where slopes and other features can be considered. Our studies have emphasized the need for land-forming to provide gradients of around 4° to 5°. Where the area concerned is level, or less than this, we specify ridging, 30 m x 1.5 m (Figures 1 and 2). The site is then deep-ripped to 75 cm, with a Caterpillar D8, with 3 winged tines in a multi-shank ripper parallelogram frame (Figure 3). The 75 cm of rooting depth (Figure 4) provides around 15 cm of rainfall equivalent, essential for trees, but not always for grass or herb cover.

Where the surface has been ridged, the land is cross-ripped to lead excess rainfall to the gullies and on to a permanent watercourse. On heavy-textured spoils, a set of heavy discs is used to raise the planting position.

Many of the sites returning to forestry have no topsoil, or else it has been lost during mining, particularly in the uplands of South Wales. On such sites, and also on some topsoiled areas, deficiencies in the plant nutrients, nitrogen, and occasionally phosphorus, can be identified by foliage analysis of the young tree. We have found that in several geological strata - coal measure shales, brick clays, and sometimes in overburden materials - that there is some fossil nitrogen, which is released during the first 5 to 6 years after mining, after which the trees become severely deficient.

Our recent practice, when planting trees on shale spoils, has been to sow seeds of the unpalatable *Lupinus* and *Lathyrus* species between the rows to build up nitrogen capital to the 700 kg/ha needed to achieve canopy closure.
FIGURE 1

LAND FORM FOR RESTORATION OVER POROUS SANDS. RIDGES RIPPED ACROSS BY D8 WITH MULTI-SHANK RIPPER, TOOL POINTS AT 75 cm. VERTICAL SCALE 2 TIMES HORIZONTAL.

FIGURE 2

LAND FORM FOR RESTORATION OVER IMPERVIOUS MATERIALS. RIDGES RIPPED ACROSS BY D8 WITH MULTI-SHANK RIPPER, TOOL POINTS AT 50 cm. DRAIN PUT IN BY SIDE-ACTING DIGGER. VERTICAL SCALE 2 TIMES HORIZONTAL.
FIGURE 3

DIAGRAM OF WINGED TINE SET AT 30°, PATTERN OF SOIL DISTURBANCE IS SHOWN IN FIGURE 4

FIGURE 4

DEGREE OF SOIL DISTURBANCE RESULTING FROM PLAIN AND WINGED TINES
Older, slow-growing tree stands, on mining spoils are much more difficult to treat. Foliage analysis - a standard system among foresters in most countries - has shown that nitrogen is usually the limiting nutrient element. We have to either spray sewage liquids or other cheap organic wastes, or try to introduce nitrogen-fixers such as alders. The wildlife, mainly deer, hares and rabbits, plus free-ranging sheep trespassing on the sites, rapidly remove all seedlings of nitrogen-fixing species which seed in naturally, or the palatable species, where sown, and prevent the natural build-up. In consequence, fencing as well as a choice of unpalatable or even toxic legumes are essential.

Among the commercial tree species being planted, we find the larches particularly successful at obtaining mineral nutrients from spoils, and are tolerant of low nitrogen supply. Corsican and Muricata pines are also very suitable, particularly in the lowlands. Lodgepole pine has been found to be surprisingly inefficient at taking up phosphorus from the high pH coal spoils, and also suffers severe bud damage from the moth Rhyacionia buoliana. Among the broadleaves, the maples and birches are valuable, especially in mixture with one of the alder species, to fix nitrogen. Alnus litter seems particularly palatable to worms, on base-rich spoils.

Regarding mycorrhiza, we have found that nursery stock is usually well furnished and there is little indication that the trees lack suitable organisms. With nitrogen as the main limiting factor, the ability to fix atmospheric supplies is the most useful attribute.

We consider that foliage analysis and replicated trials offer the best system to enable the experimenter to concentrate on those nutritional factors limiting tree-growth, especially at a time when economic pressures are pressing.