STABILIZING STEEPLANDS

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THE interplay of seismic uplift and geological erosion upon ancient sea beds in the Rangitikei-Wanganui region has produced mudstone and sandstone hills which have been developed into pastoral lands probably as steep as may be found anywhere. Slopes of between 20 and 35" predominate but may range up to the order of 50".

The soils are of medium to high natural fertility. A well distributed rainfall and a high percentage of partly cloudy days which result in relatively low evaporation rates produce an ideal grass and tree growing climate.

Included in the Rangitikei Catchment Board's district which embraces the catchments of the Rangitikei, Turakina and Whangaehu rivers and totals some 2,700 square miles, is about 1,400 square miles of hill country which requires quite intensive soil conservation measures.

Soil Erosion

Soil erosion occurs in several forms on these soils. Debris avalanches, or slips, as they are known locally, and sheet erosion are widespread, while gullying is severe in some areas.

Slips follow saturation of soil during the prolonged low intensity rains to which the district is subject. The increased weight of the sodden soil and decreased friction at the junction with the impervious rock causes the soil to slide into adjacent watercourses from where it is transported into the main rivers. The exposed rock may be regrassed, its recovery rate being dependent upon its weatherability — soft mudstones weather quickly while standstones may require many years before regrassing is possible.

Slipping has been associated with the clearing of steep forested land since these operations were first undertaken and the frequency with which this type of erosion occurs has induced a complacency which must be overcome if the fertility of these steepland soils is to be maintained.

For example, a storm in 1961, having a recurrence period of 10 to 15 years, resulted in about 18,000 acres of slip-

damaged land in the Rangitikei Catchment district alone. In one locality — Mangaweka — about 7% of the surface was lost. Excluding the very considerable damage to the transport and communication system, soil erosion in this storm caused losses in grazing, stock, fencing and internal access which would amount to not less than an estimated £500,000. No calculation can be made of the value of the land fertility irretrievably lost in this storm.

Slipping is a function of rainfall, slope and soil depth. Differing farming methods appear to have little effect on the incidence of slipping, although revegetation of bare surfaces is faster on better farmed land. The grass species at present used have not sufficiently developed root systems to hold masses of soil on steep slopes. The soil mantle therefore must be pinned in place by trees.

Sheet erosion, which is progressive removal of topsoil by rain splash and water wash, is widespread on sandy mudstones and is most severe on slopes with a northerly aspect. It is an insidious process, insignificant on an annual effect per square yard basis but highly significant on a long term whole catchment basis. Calculations made by C. Toebes of Soil Conservation and Rivers Control Section of Ministry of Works, indicate that the Turakina River, for example, has an erosion rate coefficient of 1,700 tons/day per square mile for a one in two year return period flood. This rate is surpassed in New Zealand only by a few of the most severely eroding catchments on the east coast.

By casual observation, erosion in the Turakina catchment is not severe. It is assumed therefore that the very high sediment discharge rate for this river indicates an abnormal incidence of sheet erosion.

Sheet erosion is reduced to a minimum by dense pasture.

The overall soil conservation problem in this area then is to hold the topsoil and subsoil complex in place and to minimize surface soil losses. In addition, some strengthening of gully vegetation is also required.

Soil Conservation Activities

Perhaps at this stage the term "soil conservation" should be defined. It is using the land according to its capabilities and treating it according to its needs. In other -words, soil conservation is not only the treatment of past or potential erosion but is also aimed at maintaining maximum production compatible with the preservation of the soil, in a sustained, fertile condition.

How then is the Catchment Board attempting to fulfil its soil conservation function?

When catchment boards were first set up (about 20 years ago) they were looked upon with considerable disfavour by the farming community. They had very wide land use powers and much enforced retirement of land was anticipated. In practice, boards have relied on education rather than coercion and this policy has proved to be the correct one. Anti-erosion techniques have been developed generally allowing for the presence of stock and this has resulted in only minimum areas of land being permanently retired.

It has been found through trial and error that the best method of carrying out erosion control on a farm basis is through what is termed farm conservation planning.

A farm conservation plan is a record of proposed farming operations extending over a period of years, in which soil conservation requirements are integrated with development to form a balanced programme aimed at not only increased stability but also more efficient land use.

Following a detailed inspection of the property, a map indicating the capability of the land is drawn up. This is used as the basis for planning. After acquainting himself with the problems of the farm and the existing management policy, the soil conservator prepares a development programme in which optimum subdivision of the property, detailed pasture improvement procedures and subsequent management recommendations are worked out. Subsidizable soil conservation works such as spaced planting, gully control, contour works and subdivisional fencing designed to separate eroded from non-eroded land to permit management to restore the depleted area, are also programmed. Included in the report as well is a paddock by paddock description of proposals, a topdressing and oversowing schedule, estimates of costs and of carrying capacity following completion of the programme.

On a map showing existing features of the property is superimposed the programme with the work for each year indicated in different colours. This presents a concise clear picture of the future farming operations.

At the completion of this financial year there should be in this district about 100 farm conservation plans in operation covering about 90,000 acres.

Farm planning was initiated in this district in 1960 and the following results have been achieved from 18 of the earlier plans which have been in operation for an average of 2.7 years.

Within this period carrying capacities have increased by an average of 31.3% while wool production has increased by 14.2%. Top carrying capacity achieved to date in this district on unploughable hills under a farm plan is 6.4 ewe equivalents per acre with wool production on this property being 74.4 lb per acre, having risen by one ewe equivalent and 10 lb of wool per acre respectively over a two-year period. By comparison, carrying capacity has increased in the Rangitikei County by about 1.4% in the years 1961-3.

Low cost subdivisional fencing aimed at giving heavy per acre concentrations of stock normally precedes pasture improvement and appears to give about 25% increase in carrying capacity alone.

The following method is used to invigorate hill pastures. The paddock to be treated is managed so as to have a minimum vegetative cover in March/April when 3 to 4 lb of white clover (plus 2 lb of subterranean clover on sunnv faces) and 5 to 6 cwt of superphosphate per acre is applied. In the following summer, stock are removed from the paddock for 2 to 4 weeks to permit clover reseeding and this is followed by an autumn topdressing of 3 to 4 cwt of superphosphate.

On land carrying 2.5 to 3.0 ewe equivalents per acre it is normal to carry 4.0 to 4.5 ewe equivalents through the first winter following treatment and about 5 ewe equivalents per acre through the second winter.

These results apply consistently to most soil types in this area and have been applied successfully to land up to at least 1,800 feet above sea level.

Costs of superphosphate and seed work out at between £4 and £5 per increased ewe equivalent.

One of the most difficult jobs that the Catchment Board has, is to promote the concept of a balanced vegetation — grass plus a limited number of trees.

Inbred in many farmers is a deep mistrust and suspicion of trees. This is not too difficult to. understand when it is remembered that the pioneers had a tremendous job to clear the indigenous forest from the hills when establishing their farms and must have regarded the bush as an enemy to be overcome. This was followed in succeeding generations by the constant enervating battle against encroachment of manuka scrub. In addition, the haven for stock diseases created by the baring of ground under the ubiquitous *Pinus radiata* can be a source of economic loss to the farmer. However, an increasing number of farmers are now

realizing that trees on steep pastoral lands are essential for stability.

The main trees used for soil conservation in this area are willows and poplars. Willows have dense fibrous roots ideal for trapping silt and building up eroded gullies, while poplars with their broad-reaching roots are used for hillside stabilization. These trees are also quick growing, are easily obtained and can be grown in the presence of stock.

Poplars, 10 to 15 years old, have the ability to stabilize very steep slopes within about one chain radius of the tree trunk while the effect of mature trees extends for a radius varying from one to two chains from the tree. Therefore, for control of slipping a spacing of from 1 to 2 chains apart is required. This is between 10 and 3 trees per acre respectively. Narrow crowned, fast growing, Italian black hybrid poplars are the most desirable types to use in order to achieve rapid effects and to reduce shading to a minimum.

German and Dutch experience indicates that no pasture damage occurs when populars are spaced up to ten per acre on poor soil, twenty per acre on medium soils, or thirty per acre on rich soils. General observations in this country tend to support this, although it is probably very hard to conclusively prove one way or another.

While spaced trees undoubtedly bring about a reduction in summer soil moisture, this is offset by the reduction of the effect of evaporating winds at ground level. Other advantages of spaced poplars on pasture are:

(1) The effect of the deciduity of the trees on the humus level of the soil.

(2) Reduction of insect damage in pastures by supporting a larger bird population.

(3) Provision of shade at such a distance from the trunk (owing to the characteristic shape of the tree) that there is no bare ground to act as host for disease.

(4) Provision of supplementary fodder during droughts.

About 2,000 acres of stability planting of poplars is completed in this district each year. The net cost to the farmer for spaced planting is between 10s. and £1 per acre of treated land. Poplars are planted out as poles about 10 ft. long and 2 to 4 in. in diameter. Cattle tend to damage the poles particularly during spring growth and the following management has been evolved to minimize damage. This is

simply to carry out pasture improvement work prior to planting, producing a pasture which may be controlled by sheep alone while trees are establishing and using cattle only for minimum periods to clean up pastures when the trees are dormant. Providing that planted paddocks are kept well grazed, particularly in the late spring period, this method works reasonably well.

As a result of aerial topdressing and consequent pasture improvement, the role of cattle on hill country has changed. The traditional rate of one cattle beast to 4 to 6 acres used for cleaning up purposes may be reduced considerably following the upgrading of pastures.

During poplar establishment a temporary reduction in cattle has been undertaken on a number of farm planned properties with no deterioration of pasture nor increased growth of manuka scrub being observed.

Conclusion

With an increasing quantity of poplar trees being grown both on soil conservation and other plantings, a continuity of supply — nonexistent at present -will be assured and a demand for this timber built up. The planting of poplars at, say, seven trees per acre could return a yield, based on a rotation of 25 years, of about £4 per acre per annum — an income equivalent to an extra ewe per acre and this could be achieved with little alteration in farm management. It should be noted here that poplars, differing from the coniferous timber species normally grown in New Zealand, will produce good timber even when grown in small numbers per acre, usually the only silvicultural work required being pruning.

At present in this country there is a tendency to produce grass on one piece of land and to grow trees on another piece. The growing of poplars in conjunction with pasture is now an accepted practice on steep erodible hills. Planting purely for timber production could profitably be extended to more accessible unploughable grassland.

As land utilization intensifies, arboriculture must be more intimately linked with agriculture to produce maximum returns. A two storey concept of land use must be developed.

Steep hill soils, particularly the sandy ones, have a physical characteristic which enables very high stocking rates to be achieved. The potential carrying capacity of the Wanganui-Rangitikei hill country will undoubtedly be increased to heights not thought possible today. To date,

over six ewe equivalents per acre may be achieved with inferior pasture species. What will be the capacity when improved grass species are established on hills?

From the soil conservation viewpoint, water run-off will tend to be more rapid as a result of increased soil compaction by heavy concentrations of stock and gully erosion may thereby increase. However, with stability planting of slopes and gullies and an improved pasture cover, soil erosion on the steeplands in this area will be reduced to tolerable limits.

Acknowledgement

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DISCUSSION

Are there any species of ornamental trees which would serve the same purpose and stabilization of steep slopes as poplar?

Planes (*Plantanus orientalis*) have been used on some areas but are found to grow slowly in this district. The prerequisites for suitable trees for conservation are:

(1) Availability.

(2) A suitable root system.

(3) The ability to withstand the impact of the grazing animal without recourse to expensive protective devices.

(4) Rapidity of growth.

These requirements severely limit the field of suitable species. Willows and poplars fulfil them reasonably well.

COMMENT (SIR E. BRUCE LEVY): Poplars should be kept free of branches for up to about 8 ft so that light can penetrate to the bole thus enabling grasses to grow right up to and around these trees.

(Sir Bruce commented also on the matter of spelling hill country pasture for clover reseeding, suggesting that this was a wasteful practice, that long spelling damages pasture, and that it would be better if seed from a bag was used.)

COMMENT (L. P. C. WOLFF) : Hard seed produced by allowing clover to resced could have a long term advantage.

COMMENT (J. A. H. INGLIS): I never have to worry about reseeding clover ; further, *Lotus* **major** plays quite an important role in stabilizing clay banks.

ANSWERS TO COMMENTS: Emphasis is placed on the use of narrow crowned poplar to reduce shading to a minimum and, with these species, even under quite high numbers of trees per acre, grass may well grow completely up to the base of the tree.

Spelling for reseeding in the year following initial oversowing vastly and quickly increases the number of clover plants in the sward. The paddock is shut up when clovers are flowering strongly for about a month to allow seed to set, and then the paddock is grazed as quickly as possible. Pasture damage does not occur in this time. It should be emphasized that the paddock is ***not*** shut up for several months.

Lotus major has not been used in most parts of the district under discussion as white clover grows very well.

COMMENT (N. WATSON): Sir Bruce may not have been quite fair in his comment on spelling for reseeding as F. E. T. Suckling at Te Awa has in point of fact done this very thing. It is not necessary to shut up completely for clover reseeding; light grazing by lambs may be quite satisfactory.

What is the criterion for optimum fencing in farm plans, and, in particular, as related the farms of J. N. Tripe and J. A. H. *Inglis?*

As a general guide, 40 to 50 acres per thousand ewes is regarded as optimum subdivision though this would be varied according to topography, existing subdivision, class of stock carried and availability of finance.

More paddocks allow easier and more flexible management plus maximum utilization.

Mr Tripe has been able to obtain good utilization with relatively little subdivision because of the high proportion of dry stock carried.

I have not been on Mr Inglis's property, but it appears that subdivision has been emphasized from the labour-saving angle.