

8. SOIL CONSERVATION

Bush to Pasture on Hill Country

New Zealand's development depended largely on the growth of the agricultural industry. Except in some dry eastern areas, the land surface was rapidly converted from a continuous bush cover to pasture for sheep and cattle, with remnants of bush left on steep or inaccessible land.

A.R.Acheson in his book on "River Control and Drainage in New Zealand" spoke of the rapid development of hill country to farmland with the use of aircraft for topdressing and seeding. He said that overseas authorities would probably be appalled at the risks New Zealand farmers and tractor drivers were prepared to take in discing steep country.

This development continued, particularly in years of good farm prices, or with Government subsidy, until the 1970s.

Less than a quarter of the land surface lies below about the 200 m contour, and the climate is such that fairly frequent high-intensity rainfalls occur over many parts of the country.

Even when they happened in heavy bush, slips were common enough in high country under such heavy rain. The healing of these slips was very slow, with areas visible in differing stages of recovery hundreds of years after the event.

With the bush replaced by grass, erosion became a much bigger problem in some soil types—both for the loss of pasture on the hills, and for the siltation of valleys and plains below.

Government, with advice from the Ministry of Works, passed the Soil Conservation and Rivers Control Act 1941, with four main objectives:

- (a) Promotion of soil conservation;
- (b) Prevention and mitigation of soil erosion;
- (c) Prevention of damage by floods;
- (d) Utilisation of the land in a manner tending toward the attainment of these objects.

Formation of Catchment Boards

The country was divided into natural catchment districts, and Catchment Boards were set up to implement the requirements of the Act under the Soil Conservation and Rivers Control Council. These early Boards had elected members, but from 1953 any additional authorities established were Catchment Commissions, with members nominated by local authorities.

There were 20 such Catchment Authorities when they were finally incorporated into the new Regional Councils in 1989. While some of the new Regional Councils continued to provide soil conservation services in a similar manner to the Catchment Boards, others have become policy-regulatory bodies, and their advisory services have been down-sized.

There are fewer soil conservators providing on-farm advisory services to individual landholders than when the Catchment Boards were operating, due partly to greater reliance by Regional Council on group or media promotions to get their message across and partly to decreased demand as a result of the loss of Government subsidies.

While much of the work of the Catchment Authorities was in major flood control, individual farmers became more involved in the prevention of erosion on their properties by a combination of tree planting and draining, with the staff of



Bundling poles that have been soaking for 2 weeks after harvest at the Otago Catchment Board Poplar and Willow Nursery.

the Catchment Authority able to advise them on suitable trees, planting methods, and positioning of trees to stabilise soil.

Willows were widely used to hold stream banks, and while this could be most effective, trees washed down rivers in floods could add to problems by blocking bridges or diverting water. Pieces of willow could easily root and cause blockages.

Some Catchment Authorities set up their own poplar and willow nurseries, to supply poles, wands, or cuttings to farmers. With the work of the National Plant Materials Centre at Aokautere in breeding and trialling new species and hybrids, and a good liaison between Authorities and Aokautere, new material and good advice quickly became available.

Subsidies were available to help with soil conservation work, with higher rates where downstream benefits would be felt. Rates varied from 3:1 or higher where whole catchments worked together in a scheme, to 2:1 for streambank protection or gully control, and 1:1 where the individual farmer was the only beneficiary.

These subsidies have been reduced or phased out since 1984, but the whole combination of active Catchment Authorities and farmers, well advised and assisted by subsidy, achieved very considerable progress in stabilising many eroding areas. The farms very often became much more attractive from a landscape point of view, and inspired further planting of woodlots, shelter, or amenity trees.

With the low farm incomes of today, and with a lower level of assistance from Regional Councils and no subsidy, soil conservation has become a luxury item, carried out from (now rare) surplus farm income.

Soil Conservators Play Important Role

Chris van Kraayenoord became particularly well known to farm foresters, firstly as Soil Conservator for the Department of Agriculture in Palmerston North, and later as Scientist in Charge of the National Plant Materials Centre at Aokautere.

In *FF* 1/4 August 1959, Chris described the Chilean or semi-evergreen form of Lombardy poplar which had been introduced by a Napier nurseryman, A.J.Anderson from South Africa. This tree was very popular for a time, extremely fast-growing and retaining leaves all year in the north, but deciduous for a short time in the south. It succumbed to the poplar leaf rusts in the 1970s.

Chris van Kraayenoord wrote more of the timber values of poplars in *FF* 3/3 August 1961. Although not widely planted for their timber value, in recent years many trees have been milled and the timber used for a variety of end-products. It is a big advantage to have a tree planted for soil erosion that has a timber value at the end of its life.

J.L.Porter from the Hawke's Bay Catchment Board spoke to the 1963 Conference in Napier on tree planting for soil conservation. He described the benefits of willows and poplars, with their rapid growth and extensive root systems. He explained how to position trees to get the most benefit from their root systems, for gullies, streambanks, or open planting to prevent slips.

Murray King, Chief Soil Conservator for the Wairarapa Catchment Board, was a great believer in farm forestry and soil conservation, leading the way in Wairarapa with many innovative ideas. He addressed the 1967 Conference in Masterton.

Murray said soil conservation was more than bemoaning the loss of original forest, that it was a concept of optimum sustained land-use based on capability assessment of the soil, with built-in safeguards against fertility depletion and erosion. Tree planting was a prominent part of this management. He described the severe erosion following the initial clearing of hill country, the subsequent low productivity, and then the drive to increase production by intensive use of critical hill land where there was no known precedent.

Murray King said that in the last 10 years, 3 200 000 trees had been planted on soil conservation projects in the

FF = the journal *Farm Forestry*, *TG* = *Tree Grower*

Board's district, currently at a rate of 686 700 per year. This was equivalent to 1.05 trees to every sheep, or 18 trees per head of cattle, planted over the previous 10 years.

Murray went on to outline the function of trees, and the species suited to various problems, and gave the subsidy rates available.

A Letter to the Editor in *FF 15/2* June 1973 by Hew McKellar of Feilding, pointed out the different approaches to tree planting by the Forest Service purely for production, and by Catchment Authorities purely for erosion control. He suggested there could be a middle course where returns from timber would help pay for erosion control.

Dave Milligan wrote in *FF 15/4* December 1973 of the prize-winning farm forester in Southland's conservation section, John Bulleid of Benmore. Dave described the stop banks built to contain the Oreti River, and the way John Bulleid had erected a light fence along the river frontage so that stock were prevented from grazing thousands of willow and poplar cuttings. These had now developed into a forest that contained the river, with timber and shelter trees planted behind the barrier. As well as being effective river control, the area now looked like a park.

In 1975 Jim Pottinger, Murray King, and Bruce Treeby inspected conservation plantings at Hiwinui, Wairarapa. Here, 738 ha of the total 750 ha Hiwinui property had been purchased by the Soil Conservation and Rivers Control Council, vested in the Wairarapa Catchment Board, and retired from farming because of active erosion along a fault line. Fencing to keep out stock began in 1959, with riverside and gully planting started, and a programme of pest control.

The opportunity presented by such an area was used to try out a wide range of tree species, which Bruce Treeby reported in *FF 18/1* March 1976. The list read more like a parks planting than an erosion control project.

Tens of thousands of trees were planted and 16 years later showed a very different property. The roots of willows and poplars formed protective mats, a stabilised water channel had degraded to its original level, and native species were

showing up in the spaces between exotic plantings. Areas of *P. radiata* had successfully stopped soil movement.

No tending of trees had been carried out, as the only aim was to stabilise the soil. Future efforts in a similar situation could aim at timber production in places where contour allowed, so that some productivity from the land could continue.

Murray King and his team had been provided with an encouraging example of what was possible when sound conservation methods were applied.

A field day for the Wairarapa Association in 1978 was hosted by the Catchment Board, and concentrated on the planting of trees on dry erosion-prone hills where poplars and willows were unlikely to survive. Murray King had recently been to Australia looking for species that would survive in such conditions, and provenances for seed collection. Bob Hathaway from Aokautere outlined the trials. Planted in June 1978 at Te Whiti and Patukawa Stations, these trials included over 40 species, mainly eucalypts, but also some acacias, pines, and poplars. Herbicides and slow-release fertiliser were used to speed establishment. Different types of tree protectors such as netlon, several types of wire mesh, and electric fences were included in the trials.



There is a marked reduction in width of growth rings with infection by poplar rust (*finger tip*). From the subsequent increase in annual ring widths, it would appear that the tree was developing an increasing resistance, and that growth rates were moving toward pre-rust levels.

J.C.Aspinall wrote in *FF 18/4* February 1976 of the planting of willows and poplars at Mt Aspiring Station. Between 500 and 1000 poles were planted annually to protect stream banks and prevent slips. Poles had been carted in from Wanaka or Cardrona until the station established its own nursery. The different shades of colour at both bud-burst in spring and leaf-colour in autumn made a fine contrast against beech forest or bracken.

There were disappointments, mainly through possums and poplar rust, but good pest control measures of poisoning and shooting, together with the use of new rust-resistant poplars, were being employed.

J.C.Aspinall concluded by saying that on hot summer days, tourists enjoyed picnicking in the shade of the trees,

and it was not uncommon to see trout taking flies and beetles underneath those trees that overhung the pools and eddies in the river.

Wind Erosion in Canterbury

Dave Stringer, Soil Conservator for the South Canterbury Catchment Board (SCCB), wrote in *Soil and Water* and *FF* 20/2 May 1978 of a different form of soil erosion. The SCCB had instituted a Wind Erosion Control Scheme in the area between the Rakaia and Waitaki catchments covering four regions—plains, drier lowlands, wetter lowlands and foothills, and high country. An area of 400 000 ha was covered by the scheme, of which 250 000 ha were currently receiving priority for subsidy assistance.

The scheme consisted of two parts—the establishment of windbreaks where the subsidy was 3:1 within the catchment control scheme and 2:1 elsewhere, and the management of soil to minimise wind erosion over the whole farm. At that stage, 174 soil and water conservation plans had been approved by the SCCB, including 474 km of windbreaks to be established within 5 years. By 1976, 100 km of these had been completed.

Following a farmer's application, a complex plan was drawn up to show future development and shelter design, with a timetable of all operations from fencing to ground preparation, herbicide application, planting, irrigation, release spraying, and blanking. The subsidy claim would be made at the completion of the job, which was checked by an inspection from a SCCB officer. By following good management, high survival rates and good growth of trees could be achieved—a big improvement on earlier less-controlled plantings.

The management of soil was not so easy to define, but suggestions for cultivation methods and irrigation systems least likely to create a fine soil which could blow in a gale, were made to farmers. SCCB recorded erosion events and queried management prior to the blow. The disaster that could occur if a wind like that of 1 August 1975 came in spring, when large areas were finely cultivated and dry, would be catastrophic.

W. Malcolm of Wakefield was concerned at the number of trees planted for erosion control that died in their first year due to drought or stock browse. He wrote in *FF 21/1* February 1979 of planting in what he called up-roots, or holes formed when a previous big old tree had fallen over, and which he said often occurred in groups. They made for easy planting, the soil was fertile, and the humus created a mulch against drought. To complete the job, an electric fence was run around each up-root on 30-cm-high pegs in about a 2-m square. Stock would not reach over these low wires and so the tree got a safe start. The biggest job was running underground wires (insulated) between up-roots, or connecting the fence to a high overhead lead wire.

Innovative Farmers

Nick Ledgard reported on his impressions of the 1987 Conference in Masterton, particularly of his visit to the Pottinger's farm at Tinui, in *TG 8/3* August 1987. He described flying over Wairarapa hill country and observing the number of slips, mostly not large but together adding up to 56% of the hill slopes in a 100-year period.

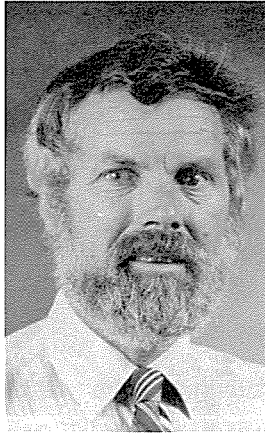
Nick quoted *National Soil and Water Authority Publication No.19*, which showed that large areas of Wairarapa hill country were producing only 80% of the grass they would have produced before the slips. Scar sites grew grass more slowly, and burned off more quickly in a drought, than areas with topsoil intact. Even 60 years after the slip, grass growth was 20% below that of the surrounding area.

Nick questioned the continuing drop in production plus the rise in aerial topdressing, increasingly needed to counter the loss of topsoil, and wondered how long the land could remain tenable. He said, while not advocating mass tree planting over the hills, some planting as practised by Jim and Airini Pottinger was a fine example to others with the same problem.

The Davies-Colley farm near Whangarei has become synonymous with most farm forestry topics, but the story began when Richard and Wilma planted over 4000 poplar poles and 1000 willow poles between 1966 and 1977, to help

control tunnel gully and slumping. Most of the Italian hybrid poplars were used, and rust became a problem, but I 214 proved quite resistant.

Peter Davies-Colley, when leasing the farm in 1988, wrote in *TG 9/1* February 1988 of the growth of these trees and their additional uses as stock fodder and timber. Peter mentioned research by Bob Hathaway on the quality of feed from trees, and went on to give his experience of pruning poplars for fodder.



Bob Hathaway, well known for his work on willows.

Jim Pottinger had also found poplar fodder a saviour in drought conditions, described by Bruce Treeby in *FF 20/4* 1978.

Further work on the use of willows for fodder was done at Aokautere and reported in *TG 11/2* May 1990. Figures showing the amount of fodder available from poplars and willows for Otago farmers in drought-prone areas were given by O.Hewson, Otago Regional Council, in *TG 14/1* February 1993.

Michael Halliday, current Executive member, wrote of his experience in using willows for fodder during droughts in *TG 19/3* August 1998. His trees had been planted for erosion control. Michael cautioned of the dangers of cutting large willow branches with a chainsaw, and recommended frequent cutting of young material which would produce more fodder as well as being a safer operation.

Chris van Kraayenoord's retirement was announced in *TG 9/1* February 1988. Bruce Treeby outlined his career, particularly referring to the valuable work done in the breeding of poplars and willows at the National Plant Materials Centre. The staff of this organisation reached 25 scientists and technicians by 1980. The close relationship Chris had with farm foresters and the Catchment Authorities, meant the material being produced at Aokautere was quickly distributed throughout the country.

In August 1988, Chris wrote an obituary on Bob Hathaway who had died suddenly at the age of 41.

Cyclone Bola

Conference 1989 was in Gisborne only 2 years after Cyclone Bola, and so delegates were able to see the incredible damage caused by this storm. Bob Miller, Chief Soil Conservator with the East Cape Catchment Board, had written of the problems in *TG 9/4* November 1988, and spoke to delegates at several field day stops during the conference.

Although Bola caused enormous movement of soil from hill country on to the plains, Bob explained the farming and forestry clearing of the area. Even by 1910 riverbeds were beginning to rise with silt and debris, and by 1930 it had reached alarming proportions. In 1948 the Catchment Board established a large-scale trial of conservation forestry in the headwaters of the Waipaoa catchment which proved very successful at controlling extreme erosion, and led to the establishment of the Mangatu Forest by the Forest Service.

Bob Miller said that by 1988 there were 107 soil and water conservation plans for individual farmers, with planting and earthworks being subsidised. A number of larger schemes were also being implemented where several farmers joined to work on a whole catchment scheme. Bob said that with no financial incentive now to encourage landowners to join



Erosion control planting in a gully just north of Gisborne.

control schemes, it was unlikely that any more would be promoted, with much of the benefit of completed sections being lost.

Bola showed up the success of earlier works, and showed the disastrous consequences of leaving hill country unprotected.

Government was moved to act on this evidence, promoting a large afforestation scheme in which landowners paid 5%, Gisborne City 19%, and the County 9%, leaving two-thirds funding from central Government.

Bola showed that pines under 8 years of age did little to prevent slips, areas of recently felled pines held soil for about 20 months, and areas under grass had 10 times more erosion than areas under trees. Where still under native bush, the land fared very well during Bola, so some wanted to know why the area was not just de-stocked and allowed to revert. This apparently does not work, as erosion is always faster than vegetative cover can restore itself, and so help is required.

Breeding to Resist Browse

The impact of possums, goats, and deer on both indigenous bush and soil conservation plantings is considerable and, as well as the normal poisoning and shooting controls, Aokautere developed bio-degradable PVC protectors with a smooth surface to use around willow poles. Poplar clones that were unpalatable to possums had been developed, and made up a large proportion of trees planted by 1992.

Allan Wilkinson, Chairman of the New Zealand Poplar Commission, reported on the 1995 breeding programme for poplars in *TG 16/4* November 1995. The objective was to cross *Populus angustifolia* with *P. deltoides* to produce a possum-resistant tree with rough bark, suitable for planting in pasture with cattle.

Farmers Need Help

It is easy to look back over farming development in New Zealand to see what should not have happened to create so

many erosion problems, but individual farmers could not see the bigger picture in the development days, nor was the advice or financial assistance in place to change land development methods.

The country went through a good period with active Catchment Authorities from the 1950s to the 1980s, when both advice and subsidies were available to begin to change the situation and many farm foresters have benefited individually from this period but, more importantly, whole catchments with downstream developments have been made secure against severe flood events.

There must be concern for the future with removal of incentives, the continual lowering of farm returns for sheep products and beef, and currently the drop in forestry planting, particularly in more remote areas where returns do not appear to justify individuals or companies investing.

The drop in staff at research and breeding facilities such as Aokautere also raises concerns for the country in keeping ahead of pests and diseases likely to affect our existing species and hybrids.

With the threat of climate change making Cyclone Bola type events more likely, or perhaps the development of a dust bowl in South Canterbury and North Otago, soil conservation should be considered more a national issue. If sustainable land management is not affordable by individual farmers, then regional or national assistance will reduce the likelihood of future disasters.

The chance of such assistance being forthcoming in today's political climate seems remote.