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PWNews

Managing poplars and willows on farms

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From the Project Leader

Peter Gawith

As this is now the completion of our second three-year project involving poplar and willow trees on the land it is a chance to reflect from my own perspective as a hill country farmer. Contact with many farmers who are using poplars and willows has been a highlight for me. I can report that the Kiwi "Can Do" attitude is alive and well in the NZ farming sector!

The two projects offered the opportunity to bring scientists, Regional Council land management officers and other people with specialist skills alongside farmers and this has resulted in the development of some very useful tools.

Information we gathered ranges from feeding animals in times of drought, disposal of dairy effluent through nutrient uptake by willows, planting and managing poplar and willow trees for protection of erosion-prone land, and this has been collated, together with information on the many varieties of poplar and willow clones, into a valuable book that is now available through the Project Manager. I commend this publication to you as an ongoing source of information and advice for managing poplars and willows. Indeed its production when land owners are being urged to plant more trees for sustainability is very timely.

Science involved in this project has given farmers some good practical information they can use with confidence. The value of condensed tannins found in these two tree groups was shown to be of value when fed to stock. We now know more about these trees, especially in terms of the quantities of fodder they can contribute during drought, and how and when their root systems affect land stability.

I hope you find this final issue of *PWNews* of interest and wish you well for the future.

Peter Gawith, Gladstone, Wairarapa

Final Progress Report

From Project Manager Grant Douglas, AgResearch, Palmerston North

This is the sixth and final issue of *PWNews* as our project ends on 30 June after three years featuring much activity in several areas. I wish to reflect on the project's highlights.

Grant Douglas

1) **Poplar and willow guidelines:** A 72-page, full-colour booklet has been produced on establishing and managing poplars and willows on farms. It includes sections on commercially available clones; novel tree systems such as browse blocks; research results on killing large trees, pests and diseases; and economic analyses of feeding tree fodder. A team of farmers, regional council staff, consultants and scientists has contributed to the booklet, which emphasises the practical aspects of tree establishment and management.

2) **Trials on farms:** Several research and/or demonstration trials have been conducted on farms including:

- Pollarding of poplar (Otago) and willow (Hawke's Bay) trees to determine total and edible yields and regrowth responses.

- Willow browse blocks at Massey University's Riverside Farm (Wairarapa) used to determine the potential of willow in the diet for control of parasites in lambs and hogget mating.
- Effluent/nutrient management potential of willows and poplars in Otago, Wairarapa and Manawatu.

3) **Economic analyses:** Cost-benefit analyses of feeding tree fodder have been conducted for three tree systems using case study farms involved in the project. The systems are a poplar pollard block in Otago, willow browse blocks in Wairarapa, and a willow coppice block in Otago. The analyses have included consideration of labour (inclusive or exclusive) and use of on-farm or purchased planting material, and short and longer-term timeframes have been evaluated.

4) **Disseminating information:** A number of different methods have been used, including this newsletter (two issues per year) distributed to 200-250 people, one or two field days per year, conference presentations (NZGA, NZFFA, the NZ Agronomy Society), press releases, radio interviews, and feature articles in popular magazines. The publicity 'machine' has been really busy.

This project has made a valuable practical contribution to the use of poplar and willow trees on farms. This is largely due to the efforts of a number of people who were brimming with enthusiasm for this project, who willingly contributed their experiences, time, and support (some even had to be held back!!), and who never let up in ensuring that we achieved what we originally aimed for. Congratulations to you all. We were very fortunate to have Peter Gawith leading this project, and I wish to publicly acknowledge the guidance and insights he provided.

I have enjoyed our 'tree journey' immensely and I sincerely thank many of you who have supported me so much in my capacity as Project Manager. I wish you all the best for the future, and hope that some of our paths may cross again at some stage.

Poplars on slopes - what happens underground?

From Ian McIvor, HortResearch and Grant Douglas, AgResearch, Palmerston North

As part of the Sustainable Land Use Research Initiative (SLURI), we have been determining structural root (> 2 mm diameter) development in Veronese poplars growing on slopes at Ballantrae, AgResearch's hill country research station near Woodville. This work has given us better understanding of the rate at which root networks develop and the implications of root development for soil stability.

The figures show that structural root length and dry weight were low in early growth stages and then the root system developed rapidly. The smallest tree was excavated 5 years, and the largest 12 years, after planting as 3 m poles. The rooting vigour is matched to the trunk growth, not the age of the tree. This is important since trees growing on drier slopes and/or slopes with shallow soil depth will grow more slowly and so extend their root network more slowly.

Figure 1. Relationship between structural root length and diameter at breast height for 'Veronese' poplar growing on a slope.

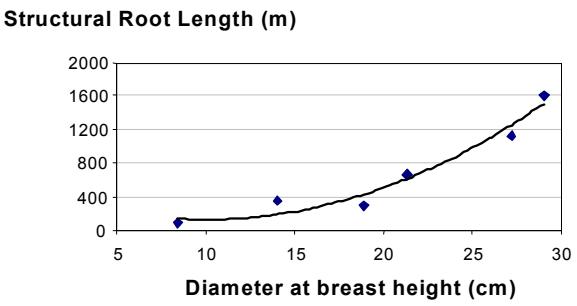
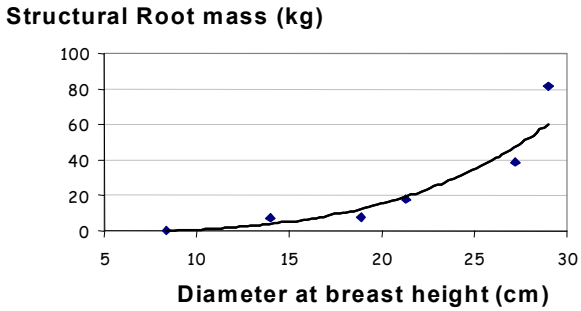


Figure 2. Relationship between structural root mass and diameter at breast height for Veronese poplar growing on a slope.



This suggests two options in using poplars for soil stabilisation on slopes. Option 1 is to plant at a final spacing (12-15 m apart) and wait for 10-12 years to achieve slope protection. Option 2 is to plant at a closer spacing of around 8 m apart and achieve slope protection in 7 or 8 years after which the trees can be progressively thinned to a wider spacing as they grow.

Our work to date has shown that roots are arranged non-uniformly around the trunk and occupy the space around the trunk more fully as the tree grows. Most roots occur within 40 cm of the soil surface where the nutrients are more available. Vertical roots on the slope at Ballantrae grew into the base rock where the soil depth was around 30-40 cm, but root penetration of base rock was negligible where the soil depth was around 1 m. For the 5-year tree, roots had grown to 8 m from the trunk, and for the 12-year tree, roots had grown to 12 m from the trunk.

Ballantrae root trial area

Fine roots represent over 90% of total root length, so for the largest tree represented in Figure 1 with a structural root length of 1.6 km, total root length is more like 30-35 km within a surface area of around 400 m^2 and a soil depth of 1-1.2 m. For another tree of the same age but planted on an old slip upslope, in a soil depth of 30-40 cm, the comparable soil volume available was 30% but the comparable root length was only 18%, i.e. the lower nutrient and water availability have retarded growth. Trees higher on a slope are likely to take longer to provide slope protection than trees lower down the slope.

Our experience at Ballantrae suggests that pruning will have minimal reduction on poplar root mass, however we do not yet know how other management options such as pollarding will reduce root development. Future work in SLURI will address these issues and provide quantitative information to develop practical management recommendations.

Successful Field Day in Hawke's Bay

From Deric Charlton, Greenfields Communications, Palmerston North

Around 70 people, including media representatives, enjoyed a field day in March at Alec Olsen's award-winning farm Valhalla, in Glengarry Road, not far off the Napier-Taupo Highway. The main focus was on willow and poplar management aspects, and the opportunities to use them as supplementary fodder for livestock and for environmental benefits in addition to soil conservation.

Several speakers who have been key participants in the SFF Project summarised the progress made over the past three years for the farmers and landowners who attended from as far away as Gisborne and lower North Island regions. All those attending in perfect weather also enjoyed seeing examples of Alec Olsen's trees, some of which are used exclusively for supplementary fodder during drought periods. Other willows had been pollarded at regular intervals since the early 1980s without detrimental effects, and were still producing good yields of edible fodder.

"Farmers have suffered from some severe storms and flooding in several regions over recent years," commented project leader Peter Gawith in his introduction to the day's programme. "Poplars and willows help to prevent damage to land when storms occur, but farmers need to manage these trees to prevent them becoming too large and dangerous."

Alec Olsen's 1980s willow in 2007

Alec Olsen was awarded the Hawke's Bay Regional Council's Environmental Award in 1999 and received an award from the Farm Forestry Association in 2001. The farm is also used to educate Hawke's Bay students in various subjects. Alec runs 3,000 sheep and 150 cattle on 300 ha effective pasture in winter, but in serious droughts he leaves his gates open for water access and prunes his willows for valuable feed. He has been using trees as supplementary fodder since the 1982-83 drought and still grows some willow trees he harvested in those days.

After an overview of the project by Peter Gawith, Alec Olsen explained how he "pollards" willows and poplars by cutting through the trunk when the tree is still young. It regrows as an extended bush, a bit like a standard rose, but growing valuable drought fodder as a cluster of slender branches above stock height that are easily pruned. During the afternoon Alec demonstrated pollarding on a willow, working with a high-revving pruning chainsaw from a "pruning nest", which he finds much easier and safer than when operating from a ladder. By pruning a tree each day this way during a drought, the livestock are maintained in good condition when there is little pasture feed growing. Any larger logs remaining are cut later and used for firewood, which burns as well as any other in a good wood burner.

Neil Faulknor, land management officer with Hawke's Bay Regional Council, covered tree management in the region, and researcher Ian McIvor, based at HortResearch in Palmerston North, reported his recent findings on the best methods of killing large trees by herbicide injection. Well-known farm forester Mike Halliday explained rural perspectives regarding the current debate on carbon credits and Peter Cameron, who has managed the Akura Tree Nursery for the Greater Wellington Regional Council near Masterton, emphasised the importance of selecting the right tree types when planting a new land area.

John Stantiall, a farm consultant with Wilson & Keeling Ltd. and based in Feilding, summarised his analyses of using poplars and willows for supplementary fodder and their cost-effectiveness. Professor Tom Barry reported the trial results from Massey University's Riverside Farm near Masterton, where they looked at livestock health and reproduction while feeding poplar-willow fodder to livestock.

Alec Olsen demonstrates

Finally, the project's communications manager Deric Charlton outlined content of the guidelines booklet he has prepared and edited on managing poplars and willows. These reports are featured in other articles in this newsletter.

Managing Poplars for Drought Fodder

From Barrie Wills, Central Environmental Services, Alexandra; John Prebble, Mount Blue, Palmerston and Murray Harris, Land & Forest Consultants Ltd, Dunedin

The 'Flevo' poplar forage trial at John and Heather Prebble's dryland farm near Palmerston has now been completed. These trees were originally planted as a fodder bank for livestock during drought. The trial aimed to determine the effect of practical pruning on tree fodder production and on leaf retention. The trees were planted at 5 x 5 m spacings and were originally cut for forage in March 2002. They were pruned in November 2004 and again in mid-March 2005. As tree height approached 6-7 m and a large quantity of bulk was present, growth on half these trees was harvested in March 2006. The remaining trees were harvested in March 2007.

Conclusions and Recommendations:
Autumn pruning produced greater biomass within the relatively short two-growing season period from pruning until harvest. The spring pruning did not produce as much biomass even after a longer growing period. Eliminating the smaller branches during pruning initially improved the overall biomass yield, presumably by reducing competition for nutrient and light resources, but was eventually offset by a decrease in edible fodder content.

Edible stem dry matter (DM) content varied from 37 - 48 % and leaf content from 35 - 42 %. There were clear disadvantages in allowing tree fodder material to mature too much. In retrospect it would be advisable to thin much earlier in the re-growth period, ideally at the end of the first growing season after cutting, to feed most of the fodder and leaves from larger branches. Regrowth on these trees was five years old by harvesting time, which made branches very cumbersome to handle.

A representative tree that had been harvested in March 06 was cut and weighed again in March 07 to estimate how much DM and growth had occurred. This measurement was indicative of a year's growth with most branches being less than 20 mm in basal diameter and under 2 m long, with a total wet weight of 14.4 kg. At 400 poplars/ha, this equates to 1,814 kg DM/ha based on a 35% DM content.

The treatments applied to the trees had a negligible effect on leaf retention at the end of the growing season. Using different poplar species and/or clones would probably be the most effective way to prolong fodder supply. 'Flevo' begins spring growth earlier than 'Kawa', but also ceases growth earlier in autumn, so a combination of these clones could extend the tree fodder season by 3-6 weeks, taking some pressure off conserved winter feed.

Avoid horizontal cuts when trimming larger trees for the first time, as this restricts wound healing and meristem development from which new branches arise. Two or three cuts angled at 30-40° are recommended. Consider seasonal impacts in relation to harvesting time. More DM is produced during wetter seasons, necessitating an earlier harvest – two years would probably be the maximum growth requirement.

Why tree fodder in Otago?
It is a good land use for infertile, wet, rough or less accessible sites on a farm. Planting is usually simple, but good weed and animal control is essential during establishment. Several small fodder blocks are preferable to a few large ones. Well-placed fencing allows maximum animal control during grazing

Tree and shrub leaves offer nutritious variation to livestock diets, and can improve stock health and welfare. Adverse climatic effects like drought are usually delayed with trees and the foliage is a valuable supplementary fodder. Appropriate fodder tree planting can ease pressure on winter-feed crops or processed feed like hay and silage.

Deep root systems mobilise and cycle moisture and nutrients inaccessible to most pasture plants. Shelter provided by these trees is a bonus during lambing or calving, as is the accumulated pasture under them.

Managing dairy effluent – conclusions from the Otago trial

From Murray Harris, Land & Forest Consultants Ltd, Dunedin and Malcolm Deverson, Clutha Agricultural Development Board, Balclutha

Some conclusions were evident after three years of monitoring the effluent management trial involving 6,000 'Kinuyanagi' willow trees in a half-hectare coppice block at the Sharpin Brothers' property at Wharetoa near Balclutha.

Effluent management
There have been limited opportunities to monitor water quality in the Washpool stream below the trial area. However the results in general have proved the value of willows and the K-Line effluent irrigation method as an effective management system.

Murray Harris

In particular:

- Measurements of stream water quality above and below the site immediately after effluent application indicate acceptable levels of nitrate in the runoff. Water quality does not appear to be compromised.
- A willow block like this can absorb excess effluent at peak times when sumps and storage ponds are full and spraying on paddocks may cause harmful runoff.
- There are clear advantages for this system on mole- and tile-drained land where even moderate soil moisture capacity may at times lead to harmful runoff.
- Applying effluent at low rates has greatly benefited the stream water quality.
- A willow block beside/below a dairy shed and effluent ponds could be used as an emergency soakage system.
- More than one willow block would be needed for a farm the area of Sharpins.
- John Stantiall's economic model indicated an economic advantage in willows as an effluent "mop-up" crop.

Value as tree fodder
The willows had generally recovered well after grazing in early January 2007 and further growth was evident by early March. It was decided to let cows harvest *in situ* again, and this was done over 4 or 5 days in late March using approximately 60 dry cows. It was intended to leave a small 10 m x 10 m section through all grazings to check the season's growth rate, but this block did not survive the grazings. Apparently the foliage was too palatable!

Conclusions:

- In the South Otago and similar 'drought-rare' climates, the feed stored in willows and rough pasture below is not as valuable as in lower summer-growth areas.
- The only practical way for farmers to harvest the tree fodder is by grazing on site.
- Such harvesting will inevitably be done by lame or dry cows and these are often (and desirably) only available in low numbers.
- Harvesting can be undertaken 2 or 3 times between late spring and early autumn, depending on seasonal moisture levels and tree growth rates.
- Willows need to be established carefully on sprayed lines to ensure good first year growth. A satisfactory spacing would be 1 m apart within rows that are 1.5 m apart.
- The first-year growth should be cut to approx 0.4 m so that growth in the following year does not have to compete with the pasture understorey.

Feeding poplar and willow to grazing sheep

From Professor Tom Barry, Massey University, Palmerston North

The research on supplementary feeding grazing sheep with poplar and willow has been conducted on Massey University's Riverside Farm, near Masterton in Wairarapa. The work began in summer 2000 following meetings with Greater Wellington Regional Council (GWRC) staff in Masterton.

Tom Barry at Riverside Farm

The first achievement of this programme has been the collaboration developed between the staff of GWRC and Massey University, and without the GWRC support this programme would not have been possible. In particular we are grateful to the Manager, Land Management, David Cameron, and to Peter Cameron, Manager of the Akura Nursery, for support they have given to this work and our post-graduate students based in Masterton while studying at Riverside Farm.

The first study, conducted over three years, looked at the effect of supplementing ewes grazing low-quality drought pasture with willow or poplar over 10 weeks in late summer/autumn, which included mating during the last six weeks. The short drought pasture had a low metabolisable energy (ME) value, as would be expected.

The ewes consumed willow or poplar leaves and stems 3-5 mm thick, and this edible willow/poplar had a higher ME value than drought pasture and contained appreciable levels of condensed tannin (CT) that was only present in traces in the drought pasture. Averaged over the three-year period, supplementation with willow/poplar before and during mating increased the reproductive rate of the ewes by about 20%. There was no effect on lamb birth weights or lamb weaning weight.

	Drought Pasture	Drought pasture + poplar or willow supplementation
Diet composition:		
ME (MJ/kg DM)	7.7	9.5 – 10.5
Condensed Tannin (g/kg DM)	2	15 - 50
Reproductive Rate (% ewes mated):		
Scanning	127	146
Lambing	125	143
Weaning	102	122

Farmers feeding supplementary willow/poplar during drought conditions can therefore expect to wean more lambs than if no supplement was used. This is the second major achievement of the programme and is one that can now be confidently recommended to farmers in dry East Coast hill country. Edible supplementary willow/poplar is of approximately the same nutritive value as good quality leafy forage of the legume birdsfoot trefoil (*Lotus corniculatus*). The responses in reproductive rate from supplementing with willow and poplar are probably due to its higher ME and CT concentrations than present in droughted pasture.

Our third achievement has been the development of willow browse blocks on rush-infested wet areas of Riverside Farm that were undeveloped and had little if any productivity. Willow stakes were planted at 6,000 stems/ha and after two years the wetland dried and volunteer pasture developed under the growing trees. Compared with ewes grazing control droughted pasture, grazing mixed-age ewes on the willow browse blocks before and during mating also increased the ewe reproductive rate by approximately 20%. A grazing plan has since been developed for willow browse blocks involving three grazings over the seven-month growing period. After six years the survival of the browsed willows is approximately 85%. In our most recent experiment, mating hoggets on willow browse blocks has also increased reproductive rate, compared with control hoggets mated on dryland pastures.

Our last achievement is the use of willow browse blocks for the sustainable management of internal parasite burdens in sheep. Relative to undrenched lambs grazing dryland pastures, grazing willow browse blocks for 14 weeks reduced their parasite burdens at slaughter of some economically important parasite types and reduced dag score in regularly drenched and undrenched lambs. Liveweight gain and dag score were similar in undrenched lambs grazing the willow browse blocks and lambs regularly drenched while grazing dryland pasture (the conventional farming system).

	Control Pasture		Willow Browse	
	Drenched	Undrenched	Drenched	Undrenched
Liveweight gain (g/d)	158	111	182	154
Final dag score (units)	1.48	1.72	1.12	1.37
Worm burden:				
Nematodirus spathiger		2,891		273
Nematodirus fillicollis		97		41
Trichostrongylus vitrinus		3,965		609
Trichostrongylus colubriformis		975		289
Cooperia		436		295

It has been a pleasure to work in this SFF-funded project. Peter Gawith has given excellent project leadership and has helped us greatly at Riverside Farm with his suggestions and advice. Grant Douglas has been a most efficient and thorough Project Manager and Deric Charlton has effectively managed our communications. All of these have contributed to the success of the project.

Peter Cameron – a lifetime of cloning

From Deric Charlton, Greenfields Communications, Palmerston North

Peter Cameron has now retired after 44 years of managing the cloning of poplar and willow trees at Greater Wellington Regional Council's Akura Tree Nursery near Masterton. Akura is now New Zealand's largest poplar and willow nursery. Peter Cameron began his career at tree nurseries owned by the former Wairarapa Catchment Board. He took over at Akura in 1985 when planting first began there, and since then he has seen well over a million poles and stakes go out for planting.

Peter Cameron at Akura

Over four months each winter Akura Nursery sells as many as 500,000 poplar and willow trees, poles, stakes and seedlings to the district and regional councils, farmers and lifestyle block owners. Over the years the results of Peter Cameron's efforts have greatly influenced the farm landscape throughout the southern North Island. Nearly all the poplars and willows growing on erosion-prone land in this part of the country have been propagated at Akura under his supervision.

A three-year rotation system is used to propagate the most suitable poplar and willow clones that were developed at the former National Water and Soil Conservation Centre at Aokautere near Palmerston North. The trees are mostly cloned as poles and these are grown as spaced plants in the Akura plantations and cut at 2 m lengths for planting in fenced-off areas, 2.5 m for planting in paddocks grazed by sheep, and 3 m for planting on cattle-grazed land.

Peter Cameron finds poplars and willows are ideal for soil conservation. Given good weather conditions the poles grow as much as 25 mm a day and up to 1 m a month, from October through to March. The growing season for these trees may only extend over six months so their growth depends on sunshine and warmth, but it is boosted by irrigation and fertiliser application.

"Once established and growing well in the correct situations, these poles maintain soil stability on steep gullies and faces," explains Peter, "though they take about three or four years before becoming effective enough to play a major role during heavy rain and adverse climatic events. They can also help to control wind erosion on arable land, and willows are used for riverbank protection, helping to prevent soil loss from surrounding grassland. We also know that these trees are valuable in providing shelter and shade for livestock, supplementary stock fodder during summer droughts and they give the countryside four seasons, adding to its beauty and supporting bird life."

Akura supplies nine poplar clones for different farm sites, depending on whether a situation is wet or dry and windy or sheltered. The land management officers allot each tree clone according to the site and undertake on-farm evaluation trials with new poplar and willow clones, to determine their suitability. These trials last up to eight years to determine whether a new clone will perform as expected. Peter also checks its growth in the nursery and its reproductive capability. One major advantage of poplar and willow poles is that they can be planted when livestock are grazing a paddock. In Wairarapa, each pole is covered with a Dynex plastic sleeve to deter animals from chewing the bark.

Thirty years ago two-thirds of poles planted were willows, but now about 70 percent are poplar as more slopes are being planted.

Because they own it, Greater Wellington Regional Council is Akura Nursery's main customer. In recent years Peter has seen increasing numbers of lifestyle block owners visiting Akura to purchase poplar and willow clones. He finds that they are seeking technical advice about the trees and their management needs and seem to be very committed to their responsibilities on the land.

Peter has derived great satisfaction seeing the trees performing to expectation on the farm. He is impressed how farmers have planted their land and how this has altered the rural landscape during his career. He is delighted that farmer attitude towards soil conservation has changed over recent decades and feels that today's landowners are much more aware of the need for tree planting and thus maintaining the land.

In recent years climate change effects and the unpredictability of weather patterns have influenced tree-planting strategies. Peter knows that sudden rain events can create havoc in his region, pointing to the February 2004 storm that devastated the lower North Island. Further storms hit Wairarapa in August 2004, February 2005 and in July 2006. Over 200 mm rain fell on large areas of hill country in only 48 hours - the worst downpour exceeding 300 mm! There was little early indication of these events.

Peter says Akura Nursery was established along the right lines in 1985. It only comprised a building and a grass area, but during the first season he tried different propagating systems and management methods. The first poles were sold in 1988 and since then the Akura team has grown from selling poles and seedlings to dealing with the public and lifestyle block owners. He has also developed an effective advisory service, so that Akura is now a "one-stop shop" for poles, seedlings, suitable chemicals, tree protection equipment and management information.

Guidelines book now available

From Deric Charlton, Greenfields Communications, Palmerston North

The book that provides comprehensive details on establishing and managing poplars and willows is now available following a lengthy preparation and editing process. Copies can be obtained through Project Manager Dr Grant Douglas at AgResearch in Palmerston North (Ph. (06) 356 8019; email grant.douglas@agresearch.co.nz) at $12.00 (incl. GST) a copy or at a discounted rate for bulk orders. *Growing Poplar and Willow Trees on Farms* is a 72-page publication in full colour that covers the major topics essential for any farmer or landowner planting these trees on their land for any or all of the purposes they serve – soil conservation, shelter and shade, supplementary fodder or landscape enhancement.

The main chapters cover the different species and clones that are available in New Zealand, planting and establishment methods, tree management including pollarding, using them in browse blocks and shelterbelts, and also as coppiced plantations to effectively resolve farm effluent nutrient dispersal. Risk management aspects covered include safety equipment and procedures when pruning these trees, diseases and pests that affect them, such as poplar rust, willow sawfly and possums. Finally there is a section on cost-benefit analysis of tree fodder.

A broad range of farmers, land management staff, researchers and consultants has provided the relevant information for the book, based on practical experiences with growing these trees on the land. Some of the most experienced contacts have also read and amended the text more than once, so that it has emerged as being a compendium of practical guidelines.

This publication is a valuable reference book for those growing poplar and willow trees on the land and should be a lasting memento of this particular SFF project.

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