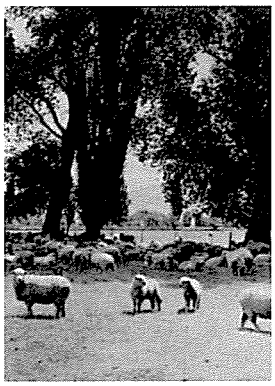
5. SHADE AND SHELTER

Shade



Sheep gather in the shade during the heat of the day.

The value of shade for livestock has frequently been discussed by most members, with the general belief that farm animals are content and less stressed when they can spend the hot part of the day lying in shade under trees.

Unfortunately, little has ever been done to quantify the effect of shade, although Presidents Alexander, Pottinger, and Owen Smith have all called for research on the subject. Niall Alexander, third President of the Association, wrote in *FF 4/4*. He felt strongly about animals without shade but could find no research on the subject in New Zealand. However, Bill Jolliffe (NZ Forest Service) sent him a report by Hosaka (1958) with observations on work done in Hawaii, the United States, Australia, and New Zealand dealing with the effect of heat on production of beef cattle. He had discovered that cattle spent 5–7 hours per day grazing, 9–11 hours lying down, and 5–7 hours loafing.

In an experiment in Missouri, United States, for a period of 50 days during two successive summers, a mob of steers was divided into two lots. The grazing and the area were the same for each, with the only difference being that one lot had shade available, and the other did not. Over the 2 years, the steers without shade gained on average 0.47 kg in weight daily. The steers with shade gained 0.68 kg, and so the provision of shade produced an improvement of 43% in the live weight increase.

Niall Alexander found information in the Ruakura Library in papers by Hancock (1954) and Payne and Hancock (1957) relating to the effect of heat on dairy cows. This showed that the amount of heat generated as a by-product of digestion is beyond the control of the cow. Some breeds of cattle evolved in the tropics tolerate high temperatures better than cattle from temperate climates, but they do not have the ability to sweat as a means of dissipating heat.

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

To quote from Hancock "The multiple stomach and peculiar digestive system of ruminants was evolved, presumably, to allow grazing in the cool of the day, and rumination and resting *in shade* during the heat of the day. In these conditions, the system has no need of any arrangement for rapidly dissipating heat.

"So we see the poor cow, deprived of the shade that is her natural refuge from high air temperatures, is unable to cope with the hot sun. Her pathetic attempts to dissipate heat by such physical processes as increasing her respiration rate, vaporisation from the respiratory tract, and vasodilation—the typical symptoms of heat distress—avail her little, and under the impulse of reflex action she checks the generation of heat within her body by a progressive restriction of food intake and/or rumination."

Production from Dairy Cows

Studies of Jersey cows showed milk production slowly decreases with rising air temperatures above 16°C and more rapidly when temperatures reach 21°–27°C, all temperatures that are quite common during the summer months on New Zealand dairy farms.

Niall Alexander went on to discuss suitable types of shade trees, suggesting that poplars may be among the best as a desirable shape can be easily achieved by pruning, and the resultant log will have a timber value.

Niall also told of the tree planting of Colin Brook of Te Kuiti (*FF 9/1*) who planted plane trees at wide spacing, all pruned to 6 m and later (by 1967) topped to form rows of large living beach umbrellas. Pruning ensured light and grass grew to the base of the tree, and that the shade moved with the sun. On a hot day, stock could be seen lying in little lots all over the paddock, just ruminating or drowsing in dreamy contentment.

Well-known Ruakura scientist, Clive Dalton, writing in *TG 11/3* August 1990, traced the history of dairy farmers wanting to get rid of trees, partly from pioneering days, and more recently from experiences of poor plantings of some eucalypts and macrocarpa which blew over in old age, and cost a lot to clean up.

Clive Dalton mentioned the change from Jersey to Friesian, or yellow to black cows, saying that black cows suffer more from heat stress in sunny weather. He said that cattle would alter their grazing habits in hot weather and graze more at night, but they did need shade during the day to reduce stress. "Stress on a lactating dairy cow can be measured in the bucket, and with $6/kg of milkfat it is a real issue. Cows under heat stress will dry off earlier and farmers will miss out on those last kilograms of income."

With the publicity about climate change and the hole in the ozone layer, dairy farmers can see the need for trees and need help in the selection of species and tree establishment. Clive Dalton thinks the Association has a role to play here, and that many more dairy farmers should be joining.

In 1975, the Association made a donation of $500 to Dr C.W.Holmes of Massey University to further his research into shade and shelter. In a paper to the National Shelter Working Party, 1984, C.W.Holmes and A.R.Sykes said that in New Zealand heat stress is unlikely to occur throughout a 24-hour period, offering the opportunity for compensatory grazing to occur during the cooler periods of the day or night. Consequently, the main effects of climatic stress on grazed pasture intake can be expected to occur over cold rather than hot periods.

It is probably fair to summarise the attitude of most modern scientists and farming leaders on the subject of shade, as considering that grazing lost in the heat of the day is compensated for at night, and that the area of pasture lost in the provision of shade trees, together with the quality of pasture due to lack of light, make recommendations for widespread planting of shade trees unlikely.

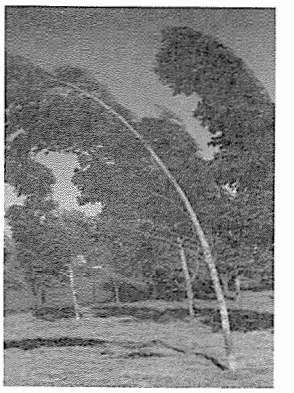
Most farm foresters would, however, continue to get pleasure from seeing their stock "ruminating or drowsing in dreamy contentment", under the shade of a tree with timber-producing potential.

Shelter

The need for shelter on farms has been a driving force in the establishment of many branches of the Association, and for many members a more important reason for their

membership than woodlots, although obviously the two go together in many cases.

The original Lower Northland branch had shelter planting as one of its main objectives; Taranaki incorporated shelter into its branch name of the Taranaki Farm Shelter and Forestry Association, while branches such as Wairarapa, and those on the eastern side of the Southern Alps exposed to frequent strong north-west winds, have probably all devoted more field days to the establishment and management of shelter than any other topic.



Exposure to wind puts great pressure on the log.

Dr J.S.Yeates, Massey Agricultural College lecturer in agricultural botany, was one of the first New Zealanders to promote farm shelter with his widely read "Farm Trees and Hedges", first published in 1942. Dr Yeates was an early enthusiast for farm forestry, being active in the establishment of the Middle Districts branch, and presenting a paper to the 1958 Conference on "Farm Shelter Problems in the Manawatu Plains Area", this paper appearing in *FF 1/2*. In the same issue an article on shelter in Otago by NZ Forest Service forester C.H.Brown gave advice on siting shelterbelts to avoid shading, and he was well advanced in his thinking.

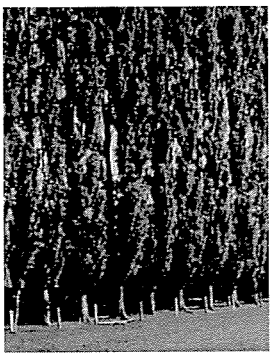
Much of Dr Yeates' work would now be considered outdated because the species suggested have been found to be unsuitable, and the whole theory behind the provision of good shelter has undergone a major shift.

Jack Stronge in *FF 1/3* outlined arguments for and against shelter, deciding that there was a very real need for research on the subject, a theme often repeated in the following years.

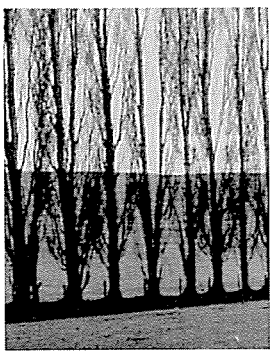
Some 76 notes and articles on shelter have appeared in *Farm Forestry* and *Tree Grower*, with 46 of these between 1966 and 1982, the period when good establishment techniques were worked out and the best management practices discovered to provide ideal shelter for differing farm situations.

Need for Height and Permeability

J.M.Caborn of the Department of Forestry and Natural Resources, University of Edinburgh, wrote "Shelterbelts



This Lombardy poplar shelter, photographed in summer (*above*) and winter (*below*), illustrates porosity and allows good grazing up to the fence line.



and Windbreaks" in 1965, a book widely read by people interested in establishing good farm shelter, and reviewed by Jack Stronge in *FF 8/4*.

Earlier papers by Caborn had been published in 1957. His main contribution was to describe the benefits of allowing some wind to pass through a shelterbelt, showing that permeable (up to 50% open) belts led to a slowing of wind without the turbulence caused by dense belts. He also showed the benefits of an irregular, saw-tooth, upper margin to the belt which could further break up wind flow, and of the need for long unbroken belts to prevent wind acceleration through the gaps. He showed the effect of height of the belt in determining what distance out from the trees received a significant drop in wind speed.

Log Production from Shelter

D.S.Jackson, NZ Forest Service Napier, in an address to the 1963 annual Conference, brought the work of Caborn, Yeates, Brown, and Neil Barr together with Branch field-day reports, to give an excellent summary of where research had now led good shelter practice. He listed the problems of shelterbelts as transference of fertility (stock camping beside the belt) and the strip of bare ground with associated loss of productivity of pasture, of stock (through diseases like blood poisoning and footrot), and of wool (through degrade and barley grass infestation), and finally losses due to shelter maintenance, renewal, and disposal.

Jackson showed how these problems could be largely overcome by correct distances between fences and trees, and by not topping as this encourages large lateral branches. Instead trees should be pruned to provide good saleable logs at the end of the rotation as well as allowing sunlight into the fencelines. He also wrote of using lower-growing, complementary species to increase density near the ground while trying to keep permeability higher up.

Dick Thevenard, also writing in *FF 5/2*, gave perhaps the first account of yield from pine sawlogs cut from a shelterbelt with *Chamaecyparis lawsoniana* as a complementary species. The pines had been pruned to 5 m

and were cut at age 13 when the largest tree was over 40 cm dbh. The 34 trees yielded 106 posts and 2230 bd ft (5.3 m^3).

The planning of production from fast-grown trees on a fertile site was outlined by Neil Barr in *FF 10/4*, with emphasis on early pruning to produce clearwood, and suggestions for complementary species to fill in the base of the shelterbelt, including *Acacia melanoxylon*, *Thuja plicata*, and *Cryptomeria japonica*.

Neil Barr had previously, in *FF 2/1*, referred to the financial value of shelter in increased dairy production. Where a belt was removed at Whenuapai to allow for aeroplane runway extension, the dairy farmer reported a drop of 16 1/4% in production compared to his previous year's returns, and allowing for price changes. He considered his shelter only 50% efficient.

The farm forestry movement was really beginning to attract farmers' attention with these articles, showing how well-managed shelter planting could both increase production and earn income when mature, but of course these isolated examples were just a beginning.

Early Research on Shelter in New Zealand

Members felt that Government Departments were against the establishment of shelter, with very few Advisory Officers encouraging farmers to plant trees. Jack Stronge wrote in 1966 that the current advice of many of the "experts", Government and otherwise, could be summed up "Grass is the only crop that it really pays the farmer to grow—cut down your trees and root out your hedges. Stock should be grazing, not sheltering—kind thoughts for your stock don't pay dividends. They don't feel cold, they don't mind the wind, so they don't need protection."

The first research on shelter for New Zealand conditions came in the form of a report from Dr J.W.(Hamish) Sturrock, Crop Research Division, DSIR Lincoln, printed in *FF 9/3* and *9/4*. Artificial shelters were set up to protect crops of rape and turnips, with considerable gains in the weight of foliage of both crops and of the root growth of turnips being measured.

Measurements of wind speed, duration from different quarters, and soil moisture, together with observations on the growth of edge plants on the border of sheltered plots, added to the value of the experiment.

Hamish Sturrock followed up this initial crop work with measurements of the effects of shelterbelts on farms reported in *FF 12/3* 1970. A table showed the reduction of wind speed achieved at varying distances from the belt, measured at a number of sites using different tree species. The reduction in evaporation was also measured. The article concluded by showing how much further research was required to cover the many different types of farming, with and without irrigation, and the production of timber from shelterbelts.

Perhaps the first person to combine the research of earlier years with large-scale practical farm planting was Peter Smail, current Association Patron, who farmed an exposed dry property at Hororata for 40 years from 1953. As well as fierce nor'westerlies, the property was high enough to receive the odd blanketing of snow and so, as Peter cultivated the largely undeveloped land, he planted the very necessary shelter, some 15 km in 11 years. The shelter was so successful that he was able to go from blade shearing in October to pre-lamb shearing in August with no losses due to storms and a lambing increase of 10%.

Two-row, two-tier shelter, with slow-growing *Cedrus deodara* and *Pinus radiata*.

Peter Smail developed a highly efficient shelter system, using *P. radiata* 2 m from the fence, then 3 m on the windward side to a row of *Cedrus deodara*, then 3 m to the other fence. Every second pine was pruned to 6 m to allow permeability and the production of quality timber. Great attention was given to good tree establishment, with cultivation or ripping to allow easy root penetration, deep planting of seedlings, and the use of herbicides to prevent grass and weeds robbing the young trees of moisture. With this system, the combination of pine and deodar root spread formed a root plate, preventing windthrow in extreme gales. With mechanical trimming of branches to the fence line in later years, sunlight kept grass growing to the fence with none of the problems mentioned earlier.

To complement these shelterbelts, Peter planted four-row plantations of *P. radiata*, with the three windward rows

pruned to 6 m and the fourth row side-trimmed. The snow driven in among the pruned trees was filtered by the unpruned fourth row creating a snow-free area on the lee side.

Numerous field days, two national farm forestry conferences, and frequent groups of students from Forestry School and Lincoln College, as well as researchers, have visited this Hororata property, with Peter's lively commentary ensuring that the benefits of shelter are driven home.

Trials with Leyland Cypress

In the early 1970s, the Leyland cypress, *Cupressocyparis leylandii*, a cross between *Chamaecyparis nootkatensis* of the north-western United States, Canada, and Alaska, and *Cupressus macrocarpa* from Monterey in California, became widely established in New Zealand. This intergeneric cross had originated in Wales in 1888, with a number of clones being added to the original over the years, but it had remained little known. Pat Bates, working at the Ruakura Research Station, had grown a few, and sent cuttings of four clones to Peter Smail who found them able to grow well in his difficult environment.

A decision was made to establish a series of trials in the South Island, with Peter finding farm foresters in different areas to plant the trees, and Hamish Sturrock of DSIR, who had also seen Pat Bates' work, measuring the growth and form. Neil Barr produced the first 500 trees for the South Island trial, and in subsequent years, Peter Smail's trusty Toyota Crown did many thousands of kilometres taking Hamish around the trials for measurements.

Joll Hosking grew trees for the North Island and, together with Dick Thevenard, found farmers throughout the North Island to repeat the exercise a year or two later. Progress on the growth of the trees was reported in *FF 15/3*, *15/4*, *18/1*, *19/2*, and *20/3* and *TG 3/4* and *7/4*.

Further clones of Leyland cypress were added to the trials in 1983, together with some other cypress crosses.

The very successful growth of this tree, with the extensive publicity, encouraged some nurseries to grow very large

Leyland cypress Haggerston Grey, age 12, on a dry site.

numbers. One South Island nursery that made rather a killing thought that Peter Smail should be referred to as Lord Leyland! The tree is now a common sight throughout the country. The advent of the kiwifruit planting boom also produced a ready market for large numbers of Leylands, and high machine side-pruning has resulted in many kilometres of narrow trimmed belts. This development has led to over-dense shelter for many purposes, and severe side-trimming inside the branches' green foliage has led to unsightly die-back in a number of such belts.

The Leyland cypress exercise has shown how farm forestry can have a big impact on research, and it is perhaps a pity that the same type of effort has not been put into a number of other species, to provide options for farmers and variation to the landscape.

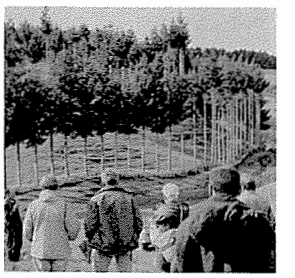
A number of Branches have established their own shelter trials, including one with nine species by the Whangarei Branch (*FF 15/1*) and a well-reported trial of a number of species on a difficult Otago site reported by John Edmonds for the Mid Otago Association in *FF 17/3*.

Agroforestry and Timberlines

The increasing interest in agroforestry or two-tier farming as a means of growing timber and ameliorating the climate for pasture and stock has been discussed by Leith Knowles (FRI) in *FF 17/3*, and Mark Farnsworth in *FF 18/1*. While this is now widely practised, it is much more a means of

growing quality forest trees than of sheltering pasture, which soon loses productivity after the trees reach the age of 8 or 10 years.

A modification is the timberline method of growing pruned trees (mainly *P. radiata*) in lines at 2.5–3.0 m spacing, with lines say 40 m apart or to suit existing fencelines. This method does not shade out the pasture too much and can be modified by fan pruning alternate trees to maintain shelter, or by planting complementary species in a row alongside the pines. This system was discussed by Jeff Tombleson (FRI) in *TG 6/3*, and widely put into practice by Ian and Robbie Moore on their "Te Rakau" dairy farm near Tauranga, visited by the National Conference in 1995.



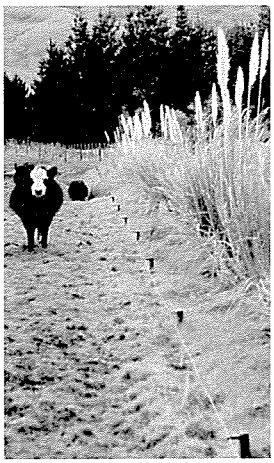
Agroforestry on Robbie Moore's dairy farm

The boom in kiwifruit planting brought a need for horticultural shelter in a very big way, emphasised by Horticultural Advisory Officers of MAF as a means of getting vines into production at the earliest time. In retrospect, this was often overdone, with very large trees such as eucalypts, pines, and poplars causing shading problems, and a drain on soil fertility and moisture for the first row of vines alongside the shelter. Many of these larger trees were subsequently removed, as were some of the internal rows of shelter where orchardists had planted more than proved necessary.

One benefit of this development was the advent of contractors to side prune, top, and mulch the shelterbelts every year or two. There are many excellent examples of Leyland cypress, *Cryptomeria japonica*, willow, alder, *Casuarina* spp., and other trees that have been well maintained, and the contractors have proved useful to nearby farmers in managing their shelter.

Use of Electric Fences

It is not possible to cover the many innovative ideas practised by many farm foresters in their approach to shelter, but such a topic is not complete without mention of Jim and Airini Pottinger's "Anerley" property at Tinui, Masterton. Both Life Members of the Association, Jim and Airini farmed a steep extremely exposed property with the ever-



Shelterbelt protected by a one-wire electric fence.

increasing use of trees to shelter and subdivide the farm as well as producing a considerable timber resource. Their contribution to good tree establishment in such difficult conditions was made possible with extensive and ingenious use of electric fences, many of just one wire about 25 cm above the ground. The long grass inside the wire provided a visual barrier stock would not cross, and where it was possible to prepare planting sites with herbicides, and establish many tree species. The changes to the environment, both physical and aesthetic, that one farmer can make in his lifetime are well demonstrated at "Anerley".

National Shelter Working Party

The continued lack of firm quantitative data to convince farmers of the need for shelter led to the formation of the National Shelter Working Party, convened in 1979, with Chairman Harvey Smith and Secretary/Editor Hamish Sturrock, both from Crop Research Division, DSIR, and with members from Forest Research Institute, Soil Bureau DSIR, Research Division MAF, National Plant Materials Centre MWD, NZ Agricultural Engineering Institute, Wairarapa and South Canterbury Catchment Boards, and Agricultural Engineering Advisory Services Division MAF, and with Peter Smail and Joll Hosking representing the Farm Forestry Association.

The final report of this Working Party was published in 1984 as *Water and Soil Publication No. 59* by the National Water and Soil Conservation Organisation. Harvey Smith made the point in the preface to the report, that the greatest deficiency in our knowledge of the role of shelter is in its effect on pasture production and livestock performance.

Dr Joan Radcliffe, in a paper on the effect of shelter on pastures, summarised the literature in New Zealand and overseas, stating that although there had been so little research on shelter for permanent grasslands, reports reviewed had suggested that substantial increases in grass growth might occur with shelter, but there was a need to quantify this response as only then could the economics of providing shelter be assessed.

Joan Radcliffe started trials at Peter Smail's farm from 1980 to 1982, which Peter later reported as showing a 61% greater dry matter yield measured in cages with all the necessary meteorological data from sheltered and unsheltered sites.

Dr C.W.Holmes from Massey, with Professor A.R.Sykes from Lincoln, considered the effects of shelter on livestock. Their most clearcut finding was the effect of exposure on newly born lambs. They showed that the New Zealand mean for pre-weaning lamb mortality was 15%, and that a study at Whatawhata showed that 30% of these lamb deaths were due to starvation/exposure. They suggested a 2% national loss of lambs due to exposure alone, representing an annual wastage of $30m to the nation or $20m to individual farmers (1984 dollars).

Again, the paper emphasised the need for further research in a number of areas to quantify the benefits of shelter, winter feeding levels, and good stock management.

Other papers on shelter for different types of farming and the management of shelter for wood production followed, with a final discussion from the Chairman on the best methods of dissemination of shelter information to land users.

The report of the National Shelter Working Party came down with nine recommendations for further research, three for dissemination of information, and one for the formation

An agroforestry block provides sheltered accommodation for sheep off shears, or for lambing ewes.

of a Shelter Committee to continue co-ordinating the work of different departments.

Unfortunately, the production of this report in 1984 coincided with the arrival of Rogernomics, the end of quangos, and the rapid running down of Government Departments involved in land use.

Few Advisory Services Remain

In summary, it is fair to say that a good deal of knowledge and practical experience exists about the establishment and management of various tree species to provide good farm and horticultural shelter, but that hard evidence on the cost to farmers of not providing shelter (i.e., poor pasture growth, loss of moisture, and poor animal growth) has not been widely demonstrated. The extension services called for have gone, and now it is very much up to individual landowners to seek advice from consultants or other experts.

To most farmers with shelter, there is satisfaction in feeling safe from storms, and watching contented stock among well-tended trees which should contribute substantially to farm income on maturity.

Tree Grower 10/3 and *11/3* outlined the shelter experience of Peter Smail, and secondly the visit of the 1990 National Conference to his Hororata property.

While shelter is still a common topic of discussion at branch field days, the development work seems largely to have been done, with the decision on whether or not to follow being up to each farmer.