# The Effects of Shelterbelts on Adjacent Pastures and Soils in a Temperate Climate

A G. Gillingham
*AgResearch, Palmerston North*

M F. Hawke
*Forest Research Institute, New Zealand*

# THE EFFECTS OF SHELTERBELTS ON ADJACENT PASTURES AND SOILS IN A TEMPERATE CLIMATE

A.G.Gillingham [(1)] and M. F. Hawke [(2)]

[(1)] AgResearch,Private Bag 11008, Palmerston North

[(2)] AgResearch, c/- Forest Research Institute, Private Bag 3020, Rotorua, New Zealand.

## ABSTRACT

Two trials were conducted to differentiate the direct (exposure) from the indirect (modified soil fertility due to nutrient transfer by grazing animals) effects of farm shelterbelts on associated pasture growth.Soil from close to "unmanaged"shelterbelts with dense shelter to ground level had relatively high potassium (K) levels and, in a glasshouse situation, provided more pasture growth than soil from further distances, or from adjacent to "managed" shelterbelts. Pasture grown in boxes of a common soil implanted at increasing distances from a shelterbelt also produced highest growth rates close to shelter. These results generally explain the pattern of resident pasture growth, except for the closest (5 metre) distance which had the lowest pasture growth.This appears related to relatively low soil moisture levels at these sites, due either to rain shelter or tree root competition effects.

## KEYWORDS

Shelterbelt, pasture production, exposure, nutrient transfer, soil potassium.

## INTRODUCTION

In New Zealand the provision of planted tree shelterbelts on farmland is generally regarded as beneficial in providing protection to domestic animals from cold winds in particular, although the associated shade can also be sought by animals during hot, sunny weather. The reduction of stock losses , especially lambs , in times of extreme climatic events, such as snowstorms, has also been attributed to the presence of appropriate shelter. However ,as pointed out by Gregory (1995) in an excellent review of the role of shelterbelts on livestock, of 143 farms surveyed in Canterbury ( Scales,1994), a snow prone area of New Zealand, only 23% had one or more shelterbelts.The reluctance of farmers to establish more shelterbelts on farms, despite known benefits to animals, may relate to the extra fencing and planting costs and the cost of the loss of land from farm production as well as an inadequate appreciation of the potential value of the timber. It may also relate to the inadequate understanding of the total impact of shelterbelts on farmland and especially on associated pasture growth.

Measurements of pasture growth adjacent to shelter (Hawke and Tombleson 1993) provide a measure of the net direct and indirect influences which may vary from site to site.This paper reports on experiments designed to clarify the direct(exposure) from the indirect(nutrient transfer by sheltering animals) effects of shelter on adjacent soil and grazed pasture.

## METHODS

**Trial 1: Assessment of nutrient transfer induced soil fertility effects on pasture growth.** Soil to a depth of 80 mm was collected from distances ranging from 5 to 200 metres distance from 6 *Pinus radiata* shelterbelts of 9 to 25 years age and in either managed ie pruned and allowing some wind flow through (2 shelterbelts), or unmanaged ie unpruned with dense branching to ground level (4 shelterbelts) condition. The soil from each distance was dried,sieved , analysed for potassium (K), content (as an index of nutrient transfer) and reconstituted in 4 replicate pots, initially located within a glasshouse and later transferred outdoors. Each pot was sown in Yatsyn ryegrass and watered regularly. Six production harvests were made between September 1993 and April 1994.After each harvest nitrogen was added uniformly to each pot in order to maintain plant vigour. Pasture from each pot was dried and weighed.

**Trial 2: Measurement of shelter effects on pasture growth in a uniform soil**. At distances ranging from 5 to 200 metres distance on both sides of a 17 metre high unmanaged shelterbelt at Matea near Lake Taupo, 4 boxes (435 mm by 250mm by 200 mm deep) of a uniform soil with nutrients added to provide non-limiting growth conditions, were implanted to ground surface level in the surrounding pasture. Each box had previously been sown in Yatsyn ryegrass and grown under glasshouse conditions until plants were about 10 cm high before transferring to the field. The trial was conducted over the spring/summer seasons.in 1994/95 and 1995/96. In 1994/95 six harvests were made and in 1995/96 four harvests were made. Pasture cut from each box was dried and weighed and results expressed as relative production. Results are compared with resident pasture production measured by a trim and regrowth technique from 4 cages at each of the same distance locations as used above and over the 1993/94 to 1995/96 seasons. The 3 year mean soil K test value at each distance is also presented.

## RESULTS AND DISCUSSION

**Trial 1:** The pattern of pasture growth was closely related to the pattern of soil K test adjacent to both managed and unmanaged shelterbelts ( Table 1 ). At only one site was there a relative low correlation between the two factors. The pattern of adjacent soil K test level however differed considerably between managed shelterbelts and unmanaged shelterbelts.This has been supported by subsequent surveys of other shelterbelts. This indicates that grazing stock spent considerable time resting close to unmanaged shelterbelts and deposited relatively large quantities of potassium in dung and urine at these sites during these times. Conversely the soil in the 20 to 80 metre distance from unmanaged shelterbelts had relatively low K levels compared with the rest of the pasture, suggesting that animals spent relatively little time resting there, resulting in some nutrient transfer away from those zones. This coincides with the zone of wind turbulence in the lee of impermeable barriers ie at about twice the tree height distance (Sturrock 1969). By contrast soil K levels close to managed shelterbelts were relatively low indicating that stock preferred to rest out in the open pasture when wind was able to pass through the shelterbelt.

**Trial 2:** Pasture growth in 1994/95 was 81% greater at 5 metres distance on the windward side of shelter than at distances of from 40 to 200 metres from the shelterbelt (Table 2). In 1995/96 total pasture growth was again 53% greater at the 5 metre distance from the shelter.Overall pasture growth was higher on the leeward aspect with the pattern of growth similar to, but not as accentuated, as on the windward side.ie only 27% higher at the 5 metre distance from the shelterbelt.

By comparison the average pattern of production from 4 years of measurement,of the resident pasture was for lowest growth to occur close to the shelterbelt. At the 5 metre distance growth was only 75% and 78% on the windward and leeward sides respectively, of the growth measured at 200 metres distance. However pasture growth at the 10 metre distance was higher than in any other situation on either windward or leeward sides of the shelter.The pattern of growth at other distances, on both aspects, was similar to, but slightly lower than that measured at the 200 metres distance. This depression could be related to the similar depression in the soil K test values at the intermediate distances as measured over the 1992-95 period (Table 2) and associated with lower pasture growth rates as measured in Trial 1.

The depression in resident pasture growth rates at the 5 metre distance was likely to be related to the generally lower soil moisture levels there than measured at further distances from the shelterbelt (data not presented) due to either rain interception or root competition effects.

**ACKNOWLEDGEMENTS**
Landcare Farming Ltd for use of their land at Matea, and R. Fletcher for statistical analysis.

**REFERENCES**
**Gregory,N.G.** 1995. The role of shelterbelts in protecting livestock: a review. NZ J of Agricultural Research **38:** 423-450.

**Hawke, M.F. and Tombleson, J.D.** 1993. Production and interaction of pastures and shelterbelts in the central North Island. Proc. NZ Grassland Assoc. **55:** 193-197.

**Scales, G.H.** 1994. Snowfall risk management; 1992 snows. A survey of management practices used by Canterbury farmers to minimise the impact of snow. MAF Policy technical paper 94/11.

**Sturrock, J.W.** 1969. The control of wind: the roles of research and farm forestry. NZ agric. Science. **3:** 148-151.

**Table 1**
Mean actual and relative ( in brackets) K test and associated pasture growth levels on soil collected from a range of distances from either managed or unmanaged shelterbelts and grown in a common environment. Overall and individual site correlations between soil K test and pasture growth are shown for managed and unmanaged shelterbelts.

| | Distance from shelterbelt (metres) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5 | 10 | 20 | 40 | 80 | 120 | 160 | 200 |
| Soil K test | | | | | | | | |
| Managed | 5 | 5 | 7 | 7 | 12 | 14 | 8* | 12* |
| | (41) | (41) | (58) | (58) | (100) | (117) | (67) | (100) |
| Unmanaged | 25 | 14 | 8 | 6 | 8 | 10 | 10 | 10 |
| | (250) | (140) | (80) | (60) | (80) | (100) | (100) | (100) |
| Pasture growth (kg DM/ha ) | | | | | | | | |
| Managed | 3924 | 3689 | 3861 | 4822 | 5752 | 5457 | 5498 | 5037 |
| | (78) | (73) | (77) | (96) | (114) | (108) | (109) | (100) |
| Unmanaged | 5737 | 3915 | 3255 | 3145 | 3454 | 3766 | 3896 | NA |
| | (147) | (100) | (84) | (81) | (87) | (97) | (100) | |

Overall 'Managed'Correlation R = 0.747. Individual site correlations = 0.880 and 0.736= 0.967, 0.576, 0.843, and 0.823.
Overall 'Unmanaged' Correlation R = 0.623
* = One sample only

**Table 2**
Mean actual and relative (in brackets) levels of pasture production in a uniform soil at a range of distances from a shelterbelt at Matea and compared with associated mean resident pasture growth and soil potassium levels (1993-96).

| | Distance from shelterbelt (metres) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 5 | 10 | 20 | 40 | 80 | 120 | 160 | 200 | SED |
| Pasture Growth(kg DM/ha) | | | | | | | | | |
| 1994/95 | | | | | | | | | |
| Windward side | 4009 | 2855 | 2628 | 2143 | 2200 | 2253 | 1982 | 2221 | 322 |
| | (181) | (129) | (118) | (96) | (99) | (101) | (89) | (100 ) | |
| 1995/96 | | | | | | | | | |
| Windward side | 8183 | 5650 | 5591 | 5120 | 5944 | 5349 | 5693 | 5338 | 376 |
| | (153) | (106) | (105) | (96) | (111) | (100) | (107) | (100) | |
| Leeward side | 7007 | 6596 | 5815 | 5852 | 5903 | 6513 | 5747 | 6100 | 392 |
| | (115) | (108) | ( 95) | (96) | (97) | (107) | (94) | (100) | |
| Resident Pasture Growth(Matea) | | | | | | | | | |
| Four year mean | | | | | | | | | |
| Windward side | 5800 | 8446 | 6752 | 6321 | 7281 | 6810 | 7042 | 7772 | 484 |
| | (75) | (109) | (87) | (81) | (94) | (88) | (91) | (100) | |
| Leeward side | 6422 | 7980 | 7485 | 7171 | 8064 | 7267 | 7894 | 8247 | |
| | (78) | (97) | (91) | (87) | (98) | (88) | (96) | (100) | |
| Soil K Test(Matea) | | | | | | | | | |
| Three year mean | | | | | | | | | |
| Windward side | 8 | 6 | 4 | 4 | 4 | 4 | 5 | 5 | 1.0 |
| Leeward side | 10 | 6 | 5 | 4 | 4 | 4 | 5 | 5 | |