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Shade and shelter for farmed deer in New Zealand: Results from a survey of farmers

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Abstract A questionnaire on shade and shelter was distributed among deer farmers throughout New Zealand, and 89 were completed. Respondents were possibly mainly people with a particular interest in the topic. Most respondents felt that shelter improved deer health and growth (92 and 68% of respondents, respectively), and 79% thought that shade was beneficial to deer health. Ninety-five percent felt that vegetative cover for hiding improved neonatal calf survival, and 80% thought that pacing along fencelines was reduced by shelter. Questions on other aspects of productivity drew mixed responses. Storms were rated as the most likely condition to induce sheltering, followed by wind, sun, cold then rain, for most age classes of deer. An exception to this was adult deer in summer, for which sun rated next highest after storms. Farmers provided opinions on siting for shade and shelter, techniques for protecting trees, and suitable species to plant. Improvements in deer welfare and productivity are likely to result from disseminating this and related information to the deer-farming community.

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INTRODUCTION

Red deer (*Cervus elaphus*) and red × wapiti (*Cervus elaphus* spp.) hybrids have been part of the pastoral farming scene in New Zealand since the early 1970s (Hardie Boys 2000). There are approximately 2 million deer farmed in New Zealand, on over 4000 farms (Hardie Boys 2000). Although deer naturally use a wide range of vegetation for food, cover and shelter from the weather (Darling 1937; Staines 1969), the modern average deer farm provides pasture of predominantly ryegrass and white clover (Moore et al. 1985) or specialised crops (Stevens 2000) and is often relatively devoid of other vegetation.

Red deer at pasture frequently exhibit repetitive pacing along fencelines (Moore et al. 1985; Pearse & Drew 1998), indicating that this environment is sub-optimal (Hediger 1964; Fraser & Broom 1990; Mason 1991). A more natural environment, in which dietary variety and vegetative cover were provided, might improve welfare and possibly enhance productivity.

To initiate study of the effects of additional (non-pasture) vegetation on deer farms, a postal survey of farmers was carried out. Farmers were asked for their opinions on the effects of shade, shelter, and cover on aspects of deer productivity and behaviour, as well as effective techniques for providing this additional vegetation.

METHODS

Copies of a 22-page questionnaire with a reply-paid envelope were distributed to delegates at the 25th Annual Deer Farmers Association (DFA) Conference, and sent to local branches of the DFA throughout New Zealand. Advertisements were also placed in the deer industry press ("Stagline"

newsletter), asking interested farmers to contact the authors, and word-of-mouth contacts were encouraged. One DFA branch copied the questionnaire into its monthly newsletter. Overall approximately 350 copies were distributed.

The questionnaire sought information firstly on each farm's locality, management, and production strategy. The next section asked farmers about the effects of vegetation (shade and shelter, fenceline screening between paddocks, and cover for deer to hide in) on a range of production factors (animal health, food intake, animal growth, pasture growth, and velvet antler growth) as well as effects on fence pacing (walking up and down fencelines) and wallowing (rolling and playing in muddy areas). Farmers were asked to rate the effects by ticking one of four possible responses: reduced productivity/behaviour, no effect, increased productivity/behaviour, or don't know. The questions on health, food intake, and growth were asked for different age classes of deer (newborn calves, calves aged 3 weeks to 3 months, calves aged 3 months to 1 year, and older deer). The questions on fence pacing distinguished between different critical periods (newly weaned calves, new stock brought onto the farm, pre-parturient hinds, and rutting stags), and questions on wallowing distinguished between rutting stags and deer in general. The section on vegetative cover for hiding included some additional possible effects (the survival of newborn calves, ease of mustering, and tameness of stock).

Farmers were then asked to rate the likelihood of different age classes (juvenile classes as above, plus adult stags and hinds separately) seeking shelter from different weather conditions (wind, cold, rain, storm (wind + cold + rain) and sun), for both winter and summer separately. Ratings were on a scale from 0 (never seek shelter) to 4 (always seek shelter).

Opinions were then sought on appropriate siting and methods for providing shelter for newborn calves and older deer. In the final section, farmers were asked to list plant species they had used on their farms and to rate their effectiveness in providing shade and shelter, along with their palatability to deer and ease of establishment.

The number of farmers in each response category for each productivity assessment concerning the benefits of shade and shelter were analysed as a χ^2 contingency table classified by response and age group. The percentage of farmers who believed that fenceline pacing and wallowing were reduced by the presence of various types of vegetation was analysed as a binomial generalised linear model (McCullagh & Nelder 1989), fitting stock type. Scores for shelter-seeking in various weather conditions were analysed by analysis of variance, with age class crossed with weather type nested within farm as the block structure, and age class crossed with weather type as the treatment structure.

RESULTS

Number and locality of respondents

Eighty-nine completed questionnaires were received, representing an approximate return rate of 25% (including the questionnaires distributed through the "Stagline" newsletter). The mid-lower South Island was represented strongly with 25 returns from Southland, 13 returns from Otago, and 24 returns from Canterbury. Ten returns were from the southern North Island, and 17 were from the northern North Island.

Farm location and management

Most of the respondents' farms were located inland (67%), one-quarter were coastal (26%) and the remainder were in mountainous areas. One-third of

Table 1 Mean percentage of respondents that considered shelter to have no effect, or increased or decreased measures of productivity (pooled results for all stock ages, with the significance of the χ^2 test for response by age class interaction indicated NS, not significant; **, $P < 0.01$).

Type of productivity	Mean percentage of respondents				
	Decreased	No effect	Increased	Don't know	Significance
Health	0	5	92	4	NS
Food intake	47	13	13	28	NS
Animal growth	0	10	68	23	**
Pasture growth	11	9	73	7	–
Velvet growth	0	7	42	51	–

the farms were on flat topography, one-third were rolling hills plus steep slopes, and one-third were flat plus rolling topography.

Most of the farms were large, with 37% having more than 400 breeding hinds, and a further 30% having between 200 and 400 hinds. The average farm area was 167 ha, with a stocking density of 9 stock units (s.u.)/ha, and 400 breeding hinds. Southland farms were stocked at a higher density, with a mean of 11 s.u./ha.

The predominant genotype farmed was red deer (72% of farms) followed by red-wapiti crossbreds (29%), most of which were found on Southland farms. Breeding and venison production was the predominant production system (44%) followed by venison and velvet production (24%) and breeding and velvet production (20%). Young venison finishing stags were the least common type of production system. Weaning was mainly carried out before mating in the autumn (66% of farms), or after mating (38%) with very few farms not weaning at all (6%). Most of the post-mating weaning was on Otago and Southland farms, where 50% of the respondents weaned at this time.

Effects of vegetation on productivity and behaviour

Answers to questions on the effects of shelter on aspects of productivity are summarised in Table 1. Over 90% of respondents considered that deer health was increased when shelter was provided. About half of the farmers felt that feed intake was reduced when shelter was provided (many of the rest ticked the "don't know" option). Most (68%) felt there was a positive effect of shelter on animal growth, and 73% felt that shelter improved pasture growth. Forty-one percent thought that shelter also improved velvet antler growth, with the remainder not knowing whether it had an effect. Similar percentages were obtained, for all ages of stock, for each productivity measure ($P > 0.05$) except that the percentage of respondents ticking "increased" for effects of shelter on growth of stock was relatively high for stock aged 3–12 months (78%) and lower for stock aged over 12 months (58%) ($P < 0.01$ for χ^2 test).

Respondents' answers to questions on the effects of shade on productivity are summarised in Table 2. There were no significant differences in patterns of response with age of stock. More than three-quarters of farmers thought that deer health increased when shade was provided. About half of the farmers ticked the "don't know" option when asked about the effect of shade on feed intake, and the remaining replies were spread evenly over "no effects", "increased", and "decreased". When asked whether shade affected animal growth, most replies were split between "don't know" and "increased". One-quarter of respondents felt that shade increased velvet growth but 60% didn't know whether it had an effect. Pasture growth was thought by some to be reduced by shade (37%), while others thought it was increased (28%), and most of the rest ticked the "don't know" option.

Eighty percent of farmers felt that shelter reduced fenceline pacing by "deer in general" (Table 3). There was also belief in decreases in fenceline pacing by "deer in general" when they were provided with shade (67% of respondents), concealing cover (69%) or fenceline screening (66%). Farmers had stronger beliefs ($P < 0.01$) in these effects when asked about "deer in general" than when asked about particular stock types (newly weaned stock, bought-in stock, hinds pre-birth, and rutting stags), for which "don't know" and "no effect" were more prevalent responses. Nevertheless a relatively strong belief that cover reduced pacing in pre-parturient hinds, in particular, was evident (Table 3).

Relatively low numbers of respondents felt that

Table 2 Mean percentage of respondents that considered shade to have no effect, or increased or decreased measures of productivity (pooled results for all stock ages with the significance of the χ^2 test for response by age class interaction indicated NS, not significant).

Type of productivity	Mean percentage of respondents				
	Decreased	No effect	Increased	Don't know	Significance
Health	0	8	79	13	NS
Food intake	20	18	18	45	NS
Animal growth	0	10	50	40	NS
Pasture growth	37	10	28	24	–
Velvet growth	5	11	24	60	_

wallowing was reduced in the presence of vegetation. Twenty-seven percent of farmers felt that wallowing by "deer in general" was reduced by shade or cover, and 17% felt it was reduced by providing shelter (Table 4). Less than a quarter of respondents felt that wallowing by rutting stags was reduced in the presence of vegetation (Table 4).

Concealing cover was thought by most (95% of respondents) to aid the survival of newborn calves. Cover reduced the ease of gathering stock from paddocks ("mustering") according to 69% of respondents, but farmers were in less agreement about the effects of cover on stock tameness, with answers evenly spread across the response categories "tamer", "less tame", "no effect", and "don't know".

Likelihood of seeking shelter/shade

Highly significant differences ($P < 0.001$) were found between weather conditions leading to sheltering behaviour, with storms rated highest for all types of stock. Wind, then cold, then rain, were given successively lower ratings ($P < 0.01$), consistently across age groups. Seeking shelter from the sun rated next highest after sheltering from storms for adult stags and hinds in summer, but after wind for all other age classes ($P < 0.001$ for weather condition by age class interaction).

Location of shade and shelter

For shelter, 82% of respondents felt that the edges of paddocks were an appropriate location. About half of the respondents felt that shelter should be spread throughout the paddock, and in valleys and woodlots. One-third felt that it should be where there was already topographical shelter, and one-quarter felt that it should be located on high areas. Only 16% felt it should be in low areas.

Shade was best placed along the edges of the paddocks, according to 72% of respondents. Sixty percent felt that shade should be throughout the paddock. Forty percent thought that shade should be in valleys and woodlots, and 23% felt that shade should be on high areas. As with shelter, only a few respondents (14%) considered that shade should be in low areas.

For newborn deer, the majority of farmers (86%) felt that cover should be located throughout the paddock. Half of the farmers felt that cover for newborns should be provided around the paddock edges.

Types of shade and shelter

Suggestions for providing shelter/cover for newborn calves included leaving long or weedy areas of pasture, rough terrain, scrub, tussocks (e.g., *Carex comans* and *Chionochloa rubra*), providing access to tree lanes beneath fences, and supplying cut branches or large hay bales. Experiences with providing artificial shade or shelter emphasised the destructive nature of deer, and temporary nature of windbreak cloth, but wooden frames with manuka (*Leptospermum scoparium*) branch canopies had been successful on two farms.

Protection of planted trees and shrubs needed to be strongly constructed (electric fences could not be relied upon) and designed to allow for the growth of the plants. Deer were considered to relish most types of vegetation and some farmers regularly used trees such as willows (*Salix* spp.) and poplars (*Populus* spp.) as a feed source, by either providing

Table 3 Mean percentage of respondents who believed that fenceline pacing decreased when shelter, shade, cover or fenceline screening was provided, for different types of stock. The significance of the effect of stock type is indicated **, $P < 0.01$; ***, $P < 0.001$.

	Mean percentage of respondents			
Stock type	Shelter	Shade	Cover	Fenceline screening
Newly weaned calves	52	42	48	57
Pre-parturient hinds	57	49	62	49
New stock	46	38	47	41
Rutting stags	47	35	35	42
Deer in general	80	67	69	66
Significance	***	***	***	**

cut branches or allowing the plants to grow through fences. Two farmers commented on possible anthelmintic properties of vegetation (flax [*Phormium* spp.] and pine [*Pinus radiata*]), and many commented on the superiority of pampas grass (*Cortaderia selloana*) as an effective shelter species that also provided some forage. However, some felt that dense shelter such as pampas harboured pests such as ferrets (*Mustela furo*).

Pine trees (*Pinus radiata*), *Eucalyptus nitens*, and Douglas fir (*Pseudotsuga menziesii*) all emerged as being easy to establish, and effective in providing both shade and shelter, but having a fairly low palatability. A plant with good ratings for all categories (including palatability) was tree lucerne (*Chamaecytisus palmensis*).

DISCUSSION

When interpreting the results of the study it must be recognised that respondents were possibly not representative of deer farmers in general (with those most interested in shade and shelter being the most likely to respond). The return rate was low, probably because the survey was very detailed and required at least 30 min to complete. Nevertheless, information on many aspects of providing vegetation for deer was obtained.

In general, respondents felt that shelter had positive effects on productivity. This result was expected as shelter reduces heat losses of animals, thereby allowing energy to be used for production rather than keeping warm (Webster 1997). Many aspects of livestock productivity have been shown to be negatively affected by cold (Gregory 1995). It is noteworthy that farmers believed that there was both decreased food intake and increased growth when shelter was present. The belief of 78% of respondents that growth of deer calves aged 3–12 months was enhanced by shelter was consistent with observations that young deer calves are susceptible to chilling, because of the relatively poor insulation of the coat, skin, and subcutaneous fat in relation to other types of livestock (Moen 1985; Webster 1997). Many deer calves of this age have been weaned (on 66% of farms in the present study), leaving them reliant on pasture and shelter to maintain their energy balance during the winter. The strong belief in positive effects of shelter on productivity in this stock class could also reflect the relatively high visibility of productive gains in young stock compared with older stock.

As with shelter, shade was generally thought to have positive effects on productivity and this was consistent with literature on thermoregulation. In hot conditions, an animal that is unable to find shade to reduce its heat gain needs to use energy-dependent physiological responses as well as a decrease in feed intake to maintain homeothermy (Webster 1997). Effects of heat on livestock have included decreases in many components of productivity (Gregory 1995; Silanikove 2000).

Fenceline pacing in farmed deer is undesirable as it not only indicates that welfare is sub-optimal (Hediger 1964; Fraser & Broom 1990), but also contributes to soil erosion (Malcom 1996; Pearse & Drew 1998; Scott 2000). There are many possible factors contributing to pacing as the deer farm environment is physically and socially very different to that of free-ranging wild deer. The present study supported the possibility that the lack of non-pasture vegetation is a factor underlying pacing behaviour, as 80% of deer farmers felt that shelter reduced this behaviour, and the majority felt that shade, cover, and fenceline screening also reduced pacing.

In the light of the importance of vegetation to wild deer, farmers' support for the idea that it reduced

Table 4 Mean percentage of respondents who believed that wallowing decreased when shelter, shade or fenceline screening was provided, for rutting stags and stock in general. The significance of the effect of stock type is indicated NS, not significant.

	Mean percentage of respondents			
Stock type	Shelter	Shade	Cover	Fenceline screening
Rutting stags	11	23	19	5
Deer in general	17	27	27	11
Significance	NS	NS	NS	NS

pacing in farmed deer was not surprising. The presence of vegetation for food, cover, and shelter was observed to be one of the major determinants of the distribution of wild red deer (Darling 1937; Challies 1990; Langbein 1998). Wild red deer use trees for rubbing, and browse from a range of trees, fallen leaves, and shrubs as well as eating a range of herbs and grasses (Darling 1937; Challies 1990; Nugent et al. 2001). They readily seek shelter from chilling conditions (Staines 1976), wind (Clutton-Brock et al. 1982) temperature change, and sun (Darling 1937), and seek cover when disturbed (Langbein 1998). Cover is particularly important at calving time, when hinds are found in areas of weedy or scrubby vegetation (Darling 1937; Birtles et al. 1998), and during the early post-parturient period when the calves remain hidden except when suckling (Darling 1937; Clutton-Brock et al. 1982). Together these observations emphasise that one means of reducing pacing and presumably increasing stock welfare would be to provide additional vegetation on deer farms.

Wallowing behaviour on deer farms is seen as undesirable as it destroys pasture, as well as waterways if the deer have access to them (Malcom 1996). Unlike fenceline pacing, the present study did not lend strong support to the possibility that wallowing was reduced by vegetation. Wallowing is part of the repertoire of rutting stags, but other deer also wallow (Darling 1937). The reasons for wallowing are unknown but may include control of external parasites (Darling 1937).

Very strong support for providing cover for newborn calves was evident, with 95% of respondents feeling that this improved calf survival. The need to provide vegetation for farmed deer to allow normal behaviour during the periparturient period has long been recognised (Kelly & Drew 1976; Cowie et al. 1985). Nevertheless, calving paddocks with no cover are still common and may contribute to calf mortality during the early post-natal period (Harboard 1996, 1999). Possible reasons why cover is not always provided include difficulties with mustering and identifying calves, and problems with subsequent weed control if areas of long pasture are set aside for calves.

Storms were rated highly as a weather condition likely to cause sheltering behaviour in deer. This is consistent with studies that have shown that the lower critical temperature of animals (the temperature at which the animal needs to increase heat production to maintain homeothermy) is raised considerably in wet, windy weather (Webster 1997). For most stock types, wind was rated second highest for causing sheltering behaviour, and was consistent with the observation that the location of wild red deer on any day was strongly influenced by wind strength and direction (Clutton-Brock et al. 1982). However, for adult stags and hinds in the summer, sun ranked second below storms, indicating the importance of providing shade for adult deer. While rain consistently rated as the least likely weather condition to cause sheltering, deer that have been accustomed to housing in covered yards readily return to cover even in light rain (pers. obs.). Therefore, motivation to seek shelter may compete with that to maintain vigilance against disturbance, which has been reported to be a major factor influencing behaviour in wild deer (Darling 1937; Birtles et al. 1998).

Approximately half of the farmers felt that valleys were an appropriate place in which to provide shade and shelter. However, one respondent commented that attracting deer to valleys, especially during rain, was unwise as it would encourage erosion of these areas. The undesirability of allowing stock on steep slopes has long been recognised (Leopold 1949).

Many farmers felt that trees and shrubs provided valuable forage, which was eaten very readily. There may be productivity and welfare benefits from providing alternatives to ryegrass/clover pasture or single crops on deer farms. Firstly, the natural diet of deer includes browse (between 20–80% of the diet of wild deer in New Zealand, depending on their habitat (Challies 1990)). Secondly, for many types of animals, intake is enhanced by variety (McCrory et al. 2000) and thirdly, foraging is an effective antidote to boredom in intensive production systems (Marsden & Wood-Gush 1986; Beattie et al. 1995). An effective means of providing tree forage is to grow the trees behind netting fences so that the deer can browse the branches as they grow through (Brook 1995).

In conclusion, the opinions of the respondents in general supported the provision of additional non-pasture vegetation on deer farms to allow natural behaviour including sheltering from weather, seeking cover at calving, and browsing. It was believed that benefits from such vegetation included improved health, animal growth, and calf survival, as well as decreased fenceline pacing. A decrease in pacing would reduce the associated soil erosion and may reflect improved welfare. Deer farmer experience has identified ways of establishing plants for shade and shelter and providing these plants as an alternative source of forage. Improvements in

deer welfare and productivity are likely to result from disseminating this and related information to the deer-farming community.

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