SEASONAL PASTURE SUPPLY AND MANIPULATIONS TO MATCH DEMAND

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Introduction

One of the central tenet(s) of New Zealand's philosophy of a pastoral based animal industry is the seasonal matching of pasture supply and animal feed demand It is this reliance on pasture grazed *in situ* as the basis of all phases of our ruminant livestock production systems which distinguishes New Zealand systems from those of most other highly developed livestock systems This aimed synchrony of feed demand and supply is often taken as read but there is a need to revisit the subject occasionally to ensure the concept is not neglected

Seasonal feed demand can be markedly influenced by decisions and actions made within and between deer production systems The scope for manipulating feed demand will be outlined It seems more logical to discuss the demand factors first, otherwise there may be an over-estimate of the importance or need for feed supply manipulation Finally, some guidelines for calculating the financial costs and benefits of manipulating feed demand and supply will be introduced

1. Manipulating the feed demand of deer

There are many factors which influence the seasonal demand of deer but they can conveniently be divided into three groups, those pertaining to

- the individual animal
- the timing of events
- the production system(s)

The objective of this section is to consider how these variables can be used to minimise feed demand in periods of low pasture growth and maximise demand in periods of rapid pasture growth

1.1 Individual animal factors

Individual animal factors which influence feed demand include

- liveweight and liveweight gain
- pregnancy and lactation
- seasonal intake pattern

(i) *Liveweight and liveweight gain*

It is well known that heavier animals have higher energy requirements than lighter animals because of their greater maintenance requirement (as liveweight doubles maintenance requirements increase by 67%) For example, replacement of a 110 kg 15 month stag with a 50 kg weaner stag in autumn reduces feed demand by 35% In other words three weaners can be carried for every two 15-month stags or a weaner can be carried for 3 days on the feed required by a 15-month stag for 2 days

It is equally well recognised that increasing growth rate increases energy requirements For example, a 60 kg weaner stag gaining 300 g/day in has an energy requirement 50% higher than one of the same weight growing at 50g/d

So in theory, significant shifts in feed demand can be made by utilising small, slower growing animals in winter and large, fast growing animals in spring However, in practice (see Table 1), unless winter liveweight gain is very low, seasonal changes in liveweight and liveweight gain in young deer do not show a large increase from winter to spring compared for example to a three fold increase for a breeding ewe with twin lambs

Table 1: Percentage increase over a range of winter (100 days) liveweight gains needed to give a spring liveweight gain of 300 g/d (for 100 days)

Initial liveweight (kg)	Winter liveweight gain (g/d)			
	0	50	100	150
	% increase in requirement (winter to spring)			
50	57	43	32	24
65	41	31	23	16

Compensatory (or catch-up) growth has been shown to further assist in shifting feed demand from winter to spring (Table 2) and should be utilised where possible

[NOTE Individual ME requirements for various growth rates are presented in the paper *Deer feed requirements* by K R Drew, elsewhere in these Proceedings - Ed]

Table 2: Effect of two combinations of winter and spring liveweight gain of stags on the difference between winter and spring feed demand. (Source: M Cornwall-Smith, pers com).

Group	Winter liveweight gain (g/d)	Resulting spring liveweight gain (g/d)	Winter (MJ ME/d)	Spring (MJME/d)	% increase winter-spring
High winter gain	145	195	23	32	40
Moderate winter gain	45	250	17	32	88

(ii) Pregnancy and lactation

Pregnant and lactating hinds have higher feed requirements than non-breeding hinds During lactation the feed requirement of the hind (plus the grass intake of the suckling fawn) doubles the feed demand of the non-lactating hind This is the greatest % change in feed requirements of any productive deer Unfortunately, in only the hill and high country is lactation of hinds synchronised with the peak of spring growth In much of New Zealand, the highest feed demand of hinds is after the peak of pasture growth

(iii) Seasonal intake

During the rut, the feed intake (not the feed requirements) of mature stags declines to about 33% of its summer value The potential advantage of saving autumn pasture due to this reduced feed intake is partially offset by the need to "spread-out" stags during the rut and by their high winter requirements to replace some of the weight loss

There is scope to seasonally manipulate feed demand of various classes of deer Breeding hinds show the greatest seasonal change in requirements, but the change is not well synchronised Marked seasonal change in the feed demand of young growing deer implies low winter target growth rate

1.2 Timing of events and number of animals

Theoretically, altering the timing of events such as calving date, weaning date, buying and selling can be altered to help match feed demand with supply There is less opportunity for changing calving date with deer than is with cattle or sheep because of their fairly fixed seasonal breeding season Weaning date can be altered For example, if fawns are left suckling hinds over the rut, their combined feed demand is about 25%

higher than if they were fed alone (no milk production) and twice that of the hind alone (eg if weaners are sold) Time of weaning can have a large effect on the ability to save autumn growth into the winter (see later section)

An example of the use of stock sales to reduce feed demand (Table 3) shows that to match the decline in pasture growth from January to March, the number of yearling finishing stags carried should drop by 42% Where feasible, culling of velveting stags and hinds should also be scheduled to coincide with a period of declining pasture growth

Table 3: The reduction in stocking rate of stags required to match the decline in pasture growth over summer.

	January	February	March
Pasture growth (kg DM/ha/day)	30	20	20
Stag liveweight (kg)*	100	106	112
DM requirement (kg DM/head/day)	3 4	3 5	3 6
Stags /ha	9 5	6 0	5 8

* assumes stags growing at 200 g/head/day

There is a general reluctance by farmers to use purchase and sale as a method for changing feed demand, but this is by far the most effective of the animal based options Whether the economics of production encourage reducing stock number at times of declining pasture growth (and vice versa) will be commented on later (see Section III)

1.3 The production system(s)

There are major differences between the 3 basic deer production systems (breeding hinds, velvet stags and finishing for venison) in their seasonal feed demand They are clearly, on their own, suitable for very different feed supplies Breeding hinds are most suited to parts of the country with long winters, a late spring but a good summer, characteristics of the hill and high country Velvet stags have a more even feed demand with relatively higher winter and spring demand, more suited to the warmer, irrigated districts on the plains Finishing on its own has perhaps the most natural fit to the average pattern of pasture growth although winter demand is high and spring demand not quite high enough to match the peak of spring growth

There is of course the possibility of combining two, (Table 4) or three deer production systems or indeed other species production systems so that their combined feed demand fits pasture growth better than any one separately For example, breeding ewes or cattle can be incorporated to increase the spring feed demand

Table 4: Relative (to winter) seasonal feed demand of combinations of deer production systems

	Autumn	Winter	Spring	Summer
Hinds alone	104	100	108	185
Hinds + 50% venison	104	100	142	138
Hinds + 50% velvet	80	100	114	146
Velvet alone	54	100	120	108
Velvet + 50% venison	80	100	150	100
Venison alone	105	100	180	90*

* assume 50% killed before summer

It is not impossible (see Nicol, 1987) to design an animal production system which very closely matches pasture growth However, in most cases, even though the system is designed to minimise animal demand in seasons of low pasture growth and maximise demand during spring and summer, deficits in winter and surpluses in late spring/summer do still occur It is difficult to design animal feed demand profiles which show a ratio of spring winter feed demand of >3 1 unless animal numbers are manipulated, whereas the spring winter ratio for pasture growth rate is more like 5-10 1

The second section of this paper considers ways in which feed supply can be manipulated

2. Manipulating pasture (feed) supply

There are five major strategies for manipulating the pattern of pasture growth into a deer feed supply These are

- choice of pasture species
- hay and silage production
- growing of winter/summer crops
- changing pasture cover
- use of nitrogen
- buying in feed or grazing off stock

2.1 Choice of pasture species

There is considerable interest in incorporating a wide variety of alternative species into deer farming systems because of their specific

- nutritional qualities
- seasonality of supply

Legumes such as lucerne and red clover together with chicory promote high levels of deer performance, but only significantly so over summer and autumn, particularly over summer, when the nutritional value of grass based pastures is often limited by build up of dead material and stem Although these species have strategic value, their overall contribution to altering the total farm feed supply is limited because

- unless they are incorporated as a high % of the farm area (>40%), their presence does little to increase the total late-spring/summer feed supply
- if they are present as a high proportion of the farm area they, by virtue of their high spring, lower winter productivity, accentuate a winter feed deficit

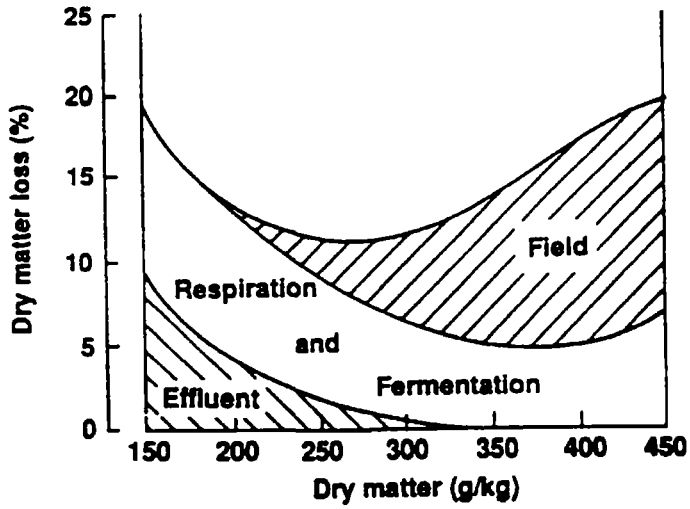
Most cool season growing grass species have a short persistency which limits their use to situations where regular renewal (every 2-3 years) of pastures is required or where they can be used in-between cash crops

Without being dismissive of alternate pasture species, no individual species or combination of pasture species can sufficiently reduce the ratio of spring winter production to match the ratio of spring winter demand

2.2 Hay and silage production

Conservation of pasture as hay and silage are age-old methods of transferring pasture from season to season There are many good reviews which discuss the advantages and disadvantages of these two alternatives (see Barry *et al.* 1980) The main advantage of silage is the opportunity to conserve earlier in the season and therefore less need for settled drying weather Early conservation gives potential for a higher quality food and importantly allows the conserved area to come back into grazing earlier in the season Later conservation as silage or hay gives a higher yield per area, a lower feeding value and grazing after conservation The importance of the quality of the conservation depends on its ultimate use High quality is needed where the conserved feed is a high proportion of the diet of productive animals (weaner deer) but is less significant when such feed is a small proportion of the diet (<25%) or is for non-productive stock (breeding hinds, stags in winter)

Figure 1: The losses associated with conservation of pasture



Of major importance in the transfer of pasture from season to season as hay or silage are the losses associated with the processes of conserving, storing and feeding out Good hay and silage pastures may contain 4000-6000 kg DM/ha but what proportion of this ends up consumed by animals as hay or silage? Losses associated with harvesting are greater for hay, those of storage potentially more important with silage (Figure 1) On average, there should be an expectation that these losses will be in the range of 20-30% so that for every 1 tonne DM cut for hay or silage only 700kg will end up being fed out to the animal At least a further 5 to 10% may be wasted during feeding These losses must be taken into account when calculating the costs of conservation (see Section 3)

2.3 Winter/summer crops

Feed can be transferred by sacrificing late spring/summer pasture growth through cultivation to conserve moisture and growing a crop such as rape, turnips, turnips + short rotation ryegrass which will grow at rates (30-40 kg DM/ha/d) greater than pasture in late summer/autumn These crops are grazed off in "breaks" in winter allowing pastures to be "spelled" from grazing The yield (kg DM/ha) of winter/summer crops depend on the soil moisture level and the length of time since sowing Consequently the yield can vary from 2000 kg DM, 60 to 80d after sowing to 5000 to 6000 kg DM/ha after 120-150 days of growth Some crops will regrow (rape, forage brassicas, cereals and ryegrasses) for a smaller subsequent grazing whereas others, turnips and kale, are used in a single grazing

These feeds are generally of high feed value but if high levels of utilisation (kg DM consumed/kg DM grown) are desired they will only support modest levels of stock performance For more detailed discussion on the use of winter feed crops refer to Nicol and Barry (1980)

Again when calculating the real costs of transferring feed through forage crops, the costs of the pasture growth sacrificed must be included When these crops are grown as part of a pasture renewal programme the "lost" production from pasture will be less important Furthermore, if these crops are complementary to other cropping eg between cereal crops, there may be lower "opportunity" costs of reduced pasture production

2.4 Changing pasture cover

Mean pasture cover is defined as the average pasture mass (kg DM/ha) over the whole grazing area Increasing the mean pasture cover essentially stores pasture *in situ* where it can be used by decreasing the average pasture cover in periods when pasture growth rate falls This is a very effective way of transferring autumn growth to winter and winter to early spring and late spring into summer and is often referred to as a "feed wedge"

For example, carrying an extra 1000 kg DM/ha (2500 kg DM/ha as opposed to 1500 kg DM/ha) into June gives and increase of 300% in the pasture available on that area for winter (assuming a residual of 1000 kg DM/ha) The potential for moving feed around by increases and decreases in pasture cover must not be underestimated

The advantage of *in situ* transfer of pasture in this way is that no harvesting or storage costs or losses are incurred Care must be taken though, that the quality of the pasture carried over does not significantly deteriorate or that pasture density is significantly reduced This is only likely to be a problem when very high masses close to ceiling yield are transferred Deterioration in quality is much less of a problem in pasture carried forward from March/April to June/July than it is from October/November through to January/February

By way of comparison of the above methods of conservation, approximately the same DM can be transferred into feed available for the winter by

- 10% farm area as hay (not grazed for 80 days in spring)
- 12 5% as turnips (not grazed for 200 days from November through to June)
- 25% of as saved pasture not grazed for 50 days in March/April

2.5 Use of nitrogen

Nitrogen fertiliser can be used very effectively to increase grass growth in autumn and/or early spring where soil temperatures are too low for mineralisation or N-fixation (<10°C) but still high enough (>4°C) for grass growth The pastures being topdressed should have enough mass (1200 kg DM/ha) and be left ungrazed for at least 6 weeks before grazing Responses of up to 10-15 kg DM/kg N applied can be anticipated and this can be costed (see later) as a source of winter feed More detail on the strategic use of nitrogen has been given elsewhere (Smetham, 1993)

2.6 Buying in feed or grazing-off stock

Deficits in feed supply can be met by the purchase of feed or by grazing-off of animals By definition, systems which use either of these options are not "self-contained" in their balance of feed demand and supply but none-the-less such options can make sensible economic options

Purchase of feed, mainly in the form of grain and proprietary feeds has been common on deer farms, particularly when animal values are high relative to feed costs

Off-farm grazing is not as common in the deer industry as for example in the dairy industry The principle involved is that if pasture can be converted by a very productive animal then it is often possible to find a cheaper off-farm source of feed for less productive animals For example, it might be feasible to winter weaner stags from hill country properties on plains farms and then returning them to the hills in spring, if this resulted in their slaughter before the second winter

The next section considers the costs of manipulating feed supply

3. Assessing the cost of manipulating feed supply and demand

It is not possible here to do full justice to the economic implications of manipulating feed demand and supply Also economic analyses are always subject to debate about the economic criteria used and quickly become out of date However, some attempt to place financial costs and benefits of matching feed supply and demand is desirable if the implications of matching supply and demand are to be seen clearly

Elsewhere (Nicol, 1993) an attempt was made to calculate the cost of providing feed at various times of the year and in various forms This involved calculating the cost of growing pasture actually eaten by livestock which, independent of class of farm, appeared to average 5 c/kg DM on a yearly basis

Table 5 shows estimated costs (including the cost of the grass) of moving pasture around as hay, silage, greenfeeds and "saved" pasture These costs are based on both the actual costs involved plus an opportunity cost of the pasture

Table 5: Costs (per km DM and per MJME) of transferring pasture

	c/kg DM	c/MJ ME
Silage - grown	15 0	1 7
- bought	16 0	1 8
Hay - grown	15 3	1 8
- bought	19 3	2 3
Turnips	12 3	1 0
Purchased grazing	7-12 0	0 8-1 2
Autumn "saved" pasture	6 5	0 62
Nitrogen "boosted" pasture	10 3	0 98

These "costs" of feed can be used to compare the returns to various feed planning alternatives For example the returns to 1 kg carcass gain will be very much greater if the gain is made on spring pasture costing 5 c/kg DM than on winter feeds with a higher cost (Table 6)

Table 6: The effect of carcass weight gain in winter or spring on returns

	Winter	Spring
Feed	50% barley 50% silage	Pasture
Cost c/kg* DM	17 0	3
Feed cost required for 1 kg carcass gain**	$4 74	$0 90
Margin over $7 00 kg net venison schedule	$2 26	$6 10

* assumes costs of 22, 15 and 3 c/kg DM for barley, silage and spring grass respectively

** assumes 30 MJME/day for 80 kg stag gaining 200 g/day, and 12 5, 9 0 and 10 5 MJME/kg DM for barley, silage and spring grass respectively

The above may be a rather extreme example, because it can be argued that a stag has to be fed over the winter to be able to benefit from the reduced costs and therefore greater returns in the spring Returning to the data illustrating the effects of moderate and high winter liveweight gain in weaner stags (Table 2) and adding costs to the winter and spring/summer feed (Table 7) gives a more

"systems" approach to the question of feed costs Table 7 shows a reduction in *total* feed costs of $13 per head for the moderate winter gain scenario

Table 7: Costs ($ per head) of moderate and high levels of winter feeding of weaner stags

	Diet	Winter (100d)	Spring (100d)	Total
High	grass + hay+ 0 6 kg barley	$31	9 0	$40
Moderate	grass + hay	$18	9 0	$27

Assumes - autumn saved grass at 6 5 c/kg DM, hay 16 c and barley 22 c/kg DM

This $13 difference in winter feed costs equates to (a) being able to accept 1 8 kg lower carcass weight in the moderate winter group if they are sold at the same time as the high winter group The difference in carcass weight between the two groups in the research work was about 3 0 kg, giving a level of an extra $8 00 per head return to the high winter feeding or (b) accepting a 30 c/kg drop (from $7 00 to $6 70) in the schedule over the 4-6 weeks it takes the moderate winter group to catch up to the high winter group So for early slaughter the extra winter feed costs are worth it For later slaughter, unless the schedule drop is greater than 30 c/kg carcass weight, moderate winter feeding level pays

[NOTE These calculations do not account for venison price differences above and below 50 kg carcass weight, and the percentage of deer achieving premium carcass weight under different feeding scenarios - Ed]

There are many other examples which could be worked through in a similar way For example, is the pay-off in extra velvet worth extra winter feed costs or better spring feeding?

These examples are not given as necessarily "right" answers but to illustrate the exercises which can be done There is not necessarily a single right answer as each individual's situation is different

4 Conclusions

There are a few principles which emerge from this discussion of ways and costs of manipulating feed demand and supply which should be considered in planning the feeding of deer These are

- Seasonal animal feed demand can be manipulated quite markedly by changing numbers of animals, liveweight and liveweight gain, and physiological status
- Pasture is a cheap feed source Therefore, maximise use of spring pasture and use the limited available winter grass sparingly to productive stock
- The most cost efficient way to move pasture from one season to another is through transfer of pasture mass Eg reduce feed demand in autumn, wean early, sell weaners, kill stags before rut (and before too fat), cull hinds at weaning Control intake of remaining stock in autumn
- Growing winter crops can be an effective way of transferring feed, particularly as part of a pasture renewal programme
- Conservation as hay and silage is an expensive feed option Buying-in feed can be a competitive option
- Consider carefully whether seasonal premiums for products justify out of season production

References

Barry, T N, Marsh, R, Reardon, T F and A South (1980) Conservation and utilisation of silage and hay IN Supplementary Feeding (Editors, K R Drew & P F Fennessy) Occ Pub No 7, NZ Society of Animal Production, pp 107-135

Nicol, A M & Barry, T N (1980) The Feeding of Forage crops IN Supplementary Feeding (editors, K R Drew & P F Fennessy) Occ Pub No 7, NZ Society of Animal Production, pp 107-135

Nicol, A M (1987) a simple dryland beef production system Proc NZ Grassland Association 52 129-132

NZMWBES (1992) New Zealand Meat and Wool Boards Economic Service, Publication No 2052 Sheep and Beef Farm Survey, 1990-91

Smetham, M S (1993) The pattern of feed supply and its manipulation IN Introductory feed planning for deer farmers (Ed A M Nicol) Lincoln University Animal Industries Workshop 1993, pp 21-35

Nicol A M (1993) Principles of manipulating feed demand and supply IN Introductory feed planning for deer farmers (Ed A M Nicol) Lincoln University Animal Industries Workshop 1993, pp 41-51