Quality pastures for improved profitability

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Abstract

Dry matter production per hectare has been the traditional 'yardstick' by which plant breeders have selected and developed new forage cultivars. An association between greater dry matter production and enhanced farm profitability has often been assumed. However, recent developments indicate that this relationship cannot be presumed under all situations. Enhanced knowledge and understanding of the nutritional requirements of grazing ruminants in recent years has resulted in refocusing by plant breeders to encompass quality characteristics as key selection criteria for new forages.

Grazing studies that assess animal productivity, not dry matter production per hectare, clearly indicate potential for new forage cultivars to produce significantly greater yields of animal products. While reasons for these associations are not clear, improved digestibility through the summer months and different endophyte alkaloid profiles associated with different high endophyte perennial ryegrass cultivars may, in part, explain significantly different animal performance across ryegrass cultivars

Introduction

Plant breeders have achieved significant advances in pasture and forage developments during the last decade. Key issues faced by plant breeders include decisions regarding selection criteria for new forage lines. Traditionally, selection objectives have focused on readily identifiable cultivar characteristics, including total dry matter (DM) production per hectare, disease resistance and insect tolerance. While these characteristics are central to the development of productive and sustainable cultivars, traditional methods have frequently failed to consider nutritional requirements and forage preferences of grazing ruminants. While a newly selected cultivar may grow more DM per hectare, this does not under all circumstances relate directly to the production of more meat, fibre, milk or velvet per hectare.

Farmers and veterinarians are developing a greater understanding of the importance of both quantity and quality of feed on offer. While quantity of feed on offer is the more likely constraint to production of venison and velvet under most pasture based New Zealand systems, our understanding of the importance of feed quality has increased over recent years. Management systems that address profitable and sustainable year round feed supply are discussed elsewhere in this volume. This objective of this paper is to identify aspects of pasture quality that may restrict productivity from year round pasture based deer units in New Zealand. We investigate ways by which pasture quality may be optimised while maintaining a low cost pasture-based system with emphasis on the summer quality problem.

Seasonal changes in pasture quality

Assessment of DM cover is a traditional and relatively simple method by which animal productivity from a property may be predicted. However, our understanding of nutritional requirements of deer has increased dramatically in recent years. We know that DM on offer to animals varies markedly with season and pasture management. Differences in quality, including protein, digestibility and anti-nutritional factors can greatly influence productivity. A direct, positive association between dry matter and animal productivity cannot, therefore, be presumed under all circumstances

Characteristics of spring pastures

The flush of spring growth associated with warmer temperatures precedes slightly the increase in voluntary feed intake associated with change in day length. Quantity of feed can therefore frequently exceed demand with development of rank, low quality pastures. Management issues facing producers include the requirement for conservation of excess growth as silage or grazing by other stock classes. Further, particular care must be taken to prevent overconditioning of hinds and potential dystocias associated with increased quantities of relatively high quality feed.

While quality of spring pastures is typically superior to that of summer pastures, there are a number of issues that may prevent attainment of optimum productivity from spring pastures:

- *Predominance of perennial ryegrass* Given free choice, deer select species other than ryegrass, but ryegrasses tend to predominate in a mixed sward during spring months.
- *Low dry matter* Dry matter content of spring pastures is low and water content is high. Each mouthful of feed ingested may contain 85% or more water, therefore grazing is less efficient than from forages with higher dry matter percentages.
- *High concentrations of rumen degradable protein* Crude protein (CP) concentrations can be very high in spring pastures, frequently exceeding an animal's protein requirements. Protein requirements range from less than 10% CP for maintenance of non-lactating, older stock through to 18 - 20% CP for young growing weaners. Spring pastures may contain CP concentrations of 30% or more, particularly following application of nitrogenous fertilisers. Further, the rumen 'bypass' component of CP in spring pastures may be less than 10%, with the balance rumen degradable. Pasture proteins are often wasted, being excreted by the animal as urea in the urine.
- *Metabolisable energy (ME) content* The metabolisable energy (Megajoules of ME / kg of DM) content of spring pastures is typically high, frequently exceeding 12 MJME / kg DM. This reflects the high protein, highly digestible characteristics of spring pastures. The ME figure does not, however, indicate availability of energy from fermentable energy sources needed to fuel rumen fermentation processes. Rumen fermentation and utilisation of pasture proteins may be inefficient from spring pastures, particularly when conditions are dull and overcast, reducing photosynthesis and sugar production by plants.

Characteristics of summer pastures

Increased animal requirements for high quality feeds through the summer months coincide not only with reduced pasture growth rates, but also deterioration of ryegrass quality. Onset of late spring/early summer is associated with reproductive changes in the ryegrass plant. Stem and seedhead development occurs at the expense of leaf growth, leading to a greater proportion of cell wall relative to cell contents. Greater concentrations of cell wall

components, cellulose, hemicellulose and lignin are reflected by increased neutral detergent fibre (NDF), acid detergent fibre (ADF) and crude fibre (CF) values, while digestibility, ME and crude protein values decline. Digestibility values of greater than 80% (> 12 MJME / kg DM) are found for well managed spring and autumn pastures. Values can decline to less than 65% (or less than 9.5 MJME / kg DM) for poorly managed grass dominant-pastures during summer.

Reproductive development by white clovers is not associated with the same decline in quality, because leaf development continues from the growing point in the presence of flower development

Controlling quality of summer pastures

Strategic management of pastures can, to some degree, control changes in pasture quality across the seasons. While digestibility of pastures during winter and spring months remains relatively unchanged by different grazing management strategies, pasture quality during summer months can be significantly altered by different grazing plans. Often small adjustments to grazing practices can impact substantially on animal productivity, particularly through control of seedhead and stem development.

Stocking rate Low stocking rate and reduced utilisation of pasture during late spring can result in high DM covers. However, feed quality declines rapidly through an increased ratio of stem and seedhead relative to leaf. Shading of clovers by taller grasses reduces clover percentage, indirectly reducing total sward quality because animal productivity is positively associated with proportion of white clover present in the sward.

Higher stocking rates result in improved utilisation of pasture grown, and potentially more clover in the sward. Very high stocking rates and continued selection and removal of green leaf material to low grazing residuals can result in insufficient leaf area for effective harvest of light for photosynthesis. Recovery and growth of the plant is reduced.

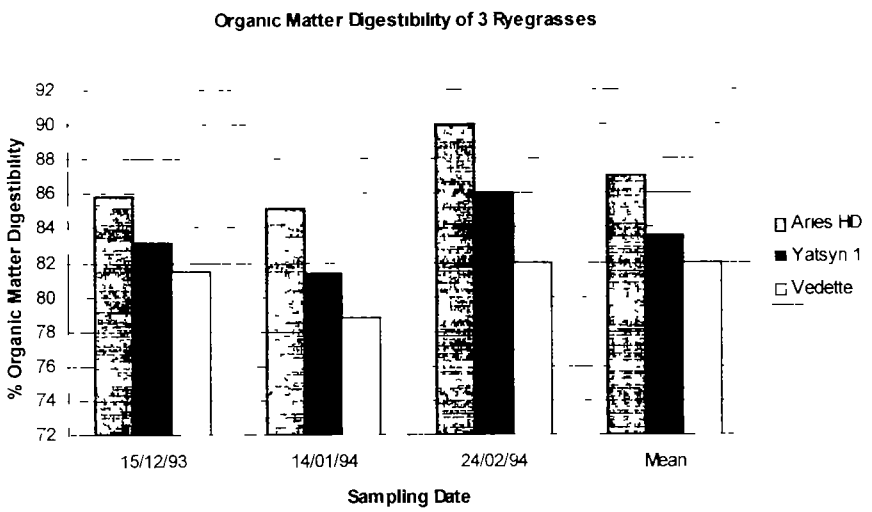
Mechanical topping of pastures for silage or hay conservation will contribute significantly to maintaining pasture quality when stocking rates are not sufficiently high to maintain grazing pressure

Decline in quality of ryegrasses in a mixed sward is offset to some degree by a greater predominance of white clover. Clovers are readily accepted by grazing deer, further, clovers are highly digestible, provide consistent concentrations of CP and higher concentrations of trace elements and minerals relative to poorly managed ryegrasses. Grazing management and fertiliser strategies should be implemented to ensure ratio of ryegrass to white clover remains at less than 70:30.

Pasture cultivars Importantly, not all grass cultivars experience the same loss of quality over the summer period. Selection of cultivars for differing levels of "aftermath heading" can contribute significantly to enhanced quality of summer pastures. Aftermath heading describes reproductive growth following the initial reproductive development during late spring and early summer. While all grasses require some degree of reproductive development to ensure cultivar survival, extent of aftermath heading varies considerably between cultivars

Traditional grass cultivars will continue to 'go reproductive' after removal of initial seedhead and stem development through grazing or topping. Wrightson Research plant breeders have been aware of summer quality problems on New Zealand pastures for more than 10 years New cultivars from the Wrightson breeding program have been selected for reduced aftermath heading and higher digestibility Maintaining summer quality on these cultivars is simplified through a reduced requirement for heavy grazing pressure or topping to keep seedhead development down during the summer month. Figure 1 shows differences in organic matter digestibility for different ryegrass cultivars managed under the same grazing regime.

Figure 1 *Organic matter digestibility of three perennial ryegrasses managed under the same grazing system*



Based on the different digestibility values for each cultivar, and converting digestibility to ME figures by multiplying by a factor of 0 15, we can predict likely differences in performance of, for example, a 90 kg Red deer hind during mid summer (see Table 1)

Table 1. Potential benefits associated with improved digestibility of ryegrasses during the summer period

	Anes HD	Vedette
Feed Intake (Kg DM / day)	3 0	3 0
Feed Quality (MJME / kg DM)	13 0	12 3
ME Intake (MJME / Day)	39	36 9
Maintenance requirement	25	25
ME left for production (lactation and liveweight gain)	14	11 9

Tetraploid versus diploid perennial ryegrasses Tetraploidy results from the treatment of a diploid ryegrass line with a chemical that doubles the number of chromosomes per cell. Cell size is increased proportionately, so each plant contains fewer cells and tillers, but cell and tiller size is increased. Larger cells result in a higher ratio of cell contents to cell wall Because cell contents contain the readily digestible sugars and proteins, this part is increased, while the relatively indigestible cell wall components are reduced Higher sugars can lead to enhanced acceptability and palatability by stock, therefore care is required with grazing management to ensure that tetraploid ryegrasses are not overgrazed Tetraploids are more suited to a rotational grazing system where plants are not continuously exposed to selection and repeated grazing

Past attempts to introduce perennial tetraploid ryegrasses from the Northern Hemisphere to New Zealand have been relatively unsuccessful. Previous tetraploid lines were nil endophyte. High endophyte ryegrasses produce an alkaloid, peramine, a natural insecticide which offers some degree of protection against damage by the Argentine Stem Weevil. When introduced to New Zealand, these lines did not persist, and this was wrongly attributed to their tetraploid nature rather than lack of endophyte.

Recent advances in the Wrightson Research breeding program have lead to the commercial release of a persistent perennial tetraploid cultivar, Quartet, bred specifically for New Zealand conditions. Trialling under sheep grazing conditions show significant animal production advantages compared with Nui perennial ryegrass, as described later in this paper.

Alternative summer forages. The importance of alternative forages in the nutrition of deer, particularly through the summer period has been investigated elsewhere in this volume, therefore will not be discussed here. We cannot overemphasise the value of highly digestible, high protein alternative summer forages, including legumes (white and red clovers, lucerne), brassicas and Grasslands Puna chicory.

Anti-nutritional factors and animal performance from summer pastures

Anti-nutritional factors associated with pastures can further impact on animal performance during the summer period. Mycotoxins associated with pasture fungi, including sporidesmin (facial eczema) associated with *Pithomyces chartarum* can impact significantly on the productivity and profitability of deer units across warmer regions of New Zealand. Further, where Argentine Stem Weevil damage requires use of high endophyte perennial ryegrass, animal health problems and lost productivity associated with endophyte alkaloids can impact substantially on profitability. Effects of high endophyte associated alkaloids lolitrem B (ryegrass staggers) and ergovaline (heat stress) on grazing ruminants in New Zealand are well reported. It appears that Elk are particularly susceptible to the effects of ryegrass staggers. Clinical signs associated with endophyte alkaloid toxins are particularly evident when feed supply is short and animals are forced to graze into the base of the sward with little opportunity for selective grazing.

Strategies to minimise loss of productivity associated with facial eczema through grazing management and prophylactic zinc supplementation are well reported. Similar grazing management strategies may be employed to control some negative effects of endophyte associated toxins. Avoidance of hard grazing to the base of the sward, good management to encourage leafy growth at the expense of stem and seed head development and removal of stock from ryegrass predominant pastures are strategies commonly used to reduce endophyte associated health problems.

During the past two decades, scientists have discovered that concentrations of endophyte associated alkaloid toxins are not the same across all cultivars of ryegrass. For example, Aries HD perennial ryegrass contains only half the level of the heat stress toxin, ergovaline, compared with Yatsyn 1 (Bluett et al., 1997) However, peramine was present in sufficient quantities to ensure ryegrass persistency. Ergovaline has been positively associated with heat stress (Fletcher, 1993) and negatively associated with plasma prolactin concentrations (Fletcher et al., 1997) in animals. Consideration of the potential for endophyte toxicity from different ryegrass cultivars when resowing perennial ryegrass pastures is a management tool that can impact significantly on animal performance.

New directions from plant breeders to build animal productivity

Earlier we discussed the traditional approach to breeding of new forage cultivars. Total DM production, insect and disease resistance have remained the key objectives by which plant breeders have selected new cultivars. The New Zealand industry will always require cultivars that persist and produce maximum quantities of dry matter. However, our enhanced understanding of nutritional requirements of animals has changed the selection criteria taken by Wrightson Research plant breeders. The focus is now on incorporation of agronomic breeding objectives, together with animal factors that influence efficiency of animal production from forage based feeding systems.

Persistency. Cultivars are exposed to the effects of grazing, trampling and high stocking pressure early in the selection process to ensure new breeding lines are well suited for animal grazing situations, and not just pressures under a lawn mower

Palatability: During the selection process, some breeding lines may show promise as being nutritionally superior based on physical appearance, visual characteristics and even laboratory testing. If the animal won't eat the new cultivar, top animal performance on commercial properties is less likely. A recent example involved a new agronomically superior brassica line that demonstrated considerable potential for top animal performance. Well before market release, potential animal performance was assessed, during which time Wrightson Researchers discovered that animals found the cultivar to be extremely unpalatable. The cultivar was never released commercially.

Quality: Examples of plant breeders' strategies to address quality problems with New Zealand pastures, particularly over the summer period, have been discussed. Cultivars selected for reduced aftermath heading, including Aries HD and Maverick Gold are performing well under animals in New Zealand, Australia and South America, demonstrating a profitable end result to more than 10 years of breeding and selection.

Quantifying the benefits of new forage cultivars

New Zealand farmers are paid for animal products produced per hectare. It makes sense, therefore, that we look at the potential for new forage cultivars to produce animal products per hectare, and not simply bulk of dry matter production per hectare. Wrightson Research is currently pioneering the use of animal grazing trials to investigate benefits to farmers associated with new types of forages.
Some examples of these studies are as follows:

High endophyte perennial ryegrass evaluation, lamb liveweight gain study: *First year results*

An improved understanding of nutritional requirements of grazing animals has resulted in the development of cultivars bred specifically for improved forage quality and altered endophyte alkaloid profiles. Aries HD perennial ryegrass was bred for increased digestibility, while the perennial tetraploid Quartet is late flowering. The objective of this study was to compare liveweight gains by lambs grazing 5 new high endophyte perennial ryegrass cultivars, including Aries HD and Quartet, using Grasslands Nui as a control. The results reported below summarises results for the first year of a 3-year study.

Materials and Methods

Pasture establishment and management: Three replicates of 6 commercially available high endophyte perennial ryegrass cultivars were sown in Canterbury during February 1997. Replicates 1 and 2 were located at Lincoln; the third replicate was at Winchmore Research Station. Plot sizes were 0.425 ha, 0.325 ha and 0.450 ha for replicates 1, 2 and 3, respectively. Treatments were *Lolium perenne* cultivars Quartet, Aries HD, Embassy, Vedette, Bronsyn, and Grasslands Nui (control). Sowing rates were 25kg/ha (tetraploid), and 18kg/ha (diploid). *Trifolium repens* cv Grasslands Challenge was sown with all cultivars at 3 kg/ha. Irrigation was by overhead sprinklers for replicates 1 and 2, while replicate 3 received water by border dike (flood) irrigation.

Study animals Cultivars were stocked at a base rate of approximately 30 Coopworth ewe lambs/ha.

Grazing management· Grazing periods were as follows: Winter: 15/5/97-22/8/97; Spring: 23/8/97-31/10/97; Summer: 1/11/97-3/2/98; and Autumn: 4/2/98-6/5/98. Base animals were randomly allocated to each cultivar at the start of each grazing period. For each replicate, base stocking-rate was determined by the cultivar with the lowest herbage mass. Plots were then managed to a common residual herbage mass by addition of extra lambs following monthly assessment of pasture mass. Extra grazing days were recorded However, additional lambs were not weighed. Animals were set stocked in spring, with a 3-paddock rotation in summer and autumn, and a 2-day shift in winter. The trial was independently managed, with test cultivars coded to avoid bias.

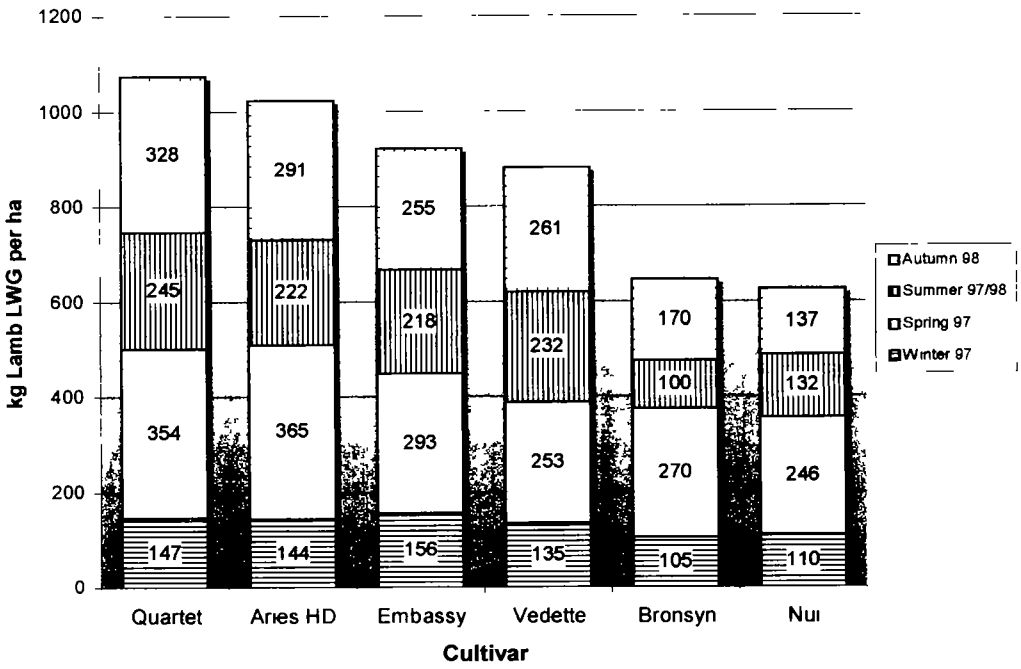
Table 2. Total lamb liveweight gain by lambs grazing different high endophyte perennial ryegrass cultivars during year one of the study (includes extra grazing days)

	Total liveweight gain / lamb (kg) by season and total for year one						
Cultivars	Winter 97[1,a]	Spring 97[2,b]	Summer 97/98[2,c]	Autumn 1998 [2,d]	*Total*	*Carcase weight / ha*[3]	*Relative Gross Revenue (NZ $)*[4]
Quartet	147	354	245	328	1074	537	1343
Aries HD	144	364	222	291	1020	510	1275
Embassy	156	293	218	255	922	461	1153
Vedette	135	253	232	261	881	441	1101
Bronsyn	105	270	100	170	645	323	806
Nui	110	246	132	137	625	313	781

a 15/5/97 – 22/8/97
b 23/8/97 – 31/10/97
c 1/11/97 – 3/2/98
d 4/2/98 – 6/5/98

[1] Mean of 2 site replicates, with Lincoln replicate receiving twice the weighting of the Winchmore replicate
[2] Mean of 3 site replicates
[3] Assuming a 50% dressing out percentage
[4] Based on $2 50/kg schedule

Figure 2 Total lamb liveweight gain by lambs grazing different high endophyte perennial ryegrass cultivars during year one of the study (includes extra grazing days)



Results and discussion

Results from the first year of this study demonstrate significant differences in liveweight gains by lambs grazing a range of perennial ryegrass cultivars (Table 2 and Figure 2). Annual dry matter production by cultivars in this study differ by less than 15 % (Norriss, 1998, unpublished data), with Quartet the lowest yielding, and Bronsyn often the highest. Lack of association between dry matter yield and lamb liveweight gain clearly illustrates the potential for cultivar characteristics, other than herbage production, to significantly modify performance of grazing animals. Improved digestibility characteristics associated with particular new cultivars may explain, in part, improved performance by these cultivars. Small but consistent improvements in digestibility have been demonstrated for both Aries HD and Quartet compared with cultivars selected for dry matter yield alone (Norriss, 1998, unpublished data). Further, changed endophyte alkaloid profiles may improve animal performance because concentrations of ergovaline concentration are reduced for Aries HD (Bluett et al., 1997) and 'Quartet' (Norriss, 1998; unpublished data) compared with Yatsyn 1.

White clover (*Trifolium repens)* content of mixed swards can significantly impact on performance of grazing animals (Poppi et al., 1987). Averaged over spring, summer and autumn, clover content ranged from 4.2% for the cultivar with the lowest clover content, to 6.3% for the highest. There was no clover present in winter (data not reported). These small differences in clover content are unlikely to explain the live weight gain differences.

The small and inconsistent differences in extra grazing days between treatments, suggests that each cultivar was managed to near potential. We found a comparatively high number of extra grazing days for Bronsyn in summer. This observation combined with low live weight gains, may indicate animal rejection of Bronsyn during this season.

The large and significant live weight gain differences between cultivars are unlikely to be explained by differences in dry matter production, clover content, or grazing management interactions. Live weight gain differences probably reflect variation in endophyte toxicity, forage quality, and other unknown factors. The study is ongoing, with second year results due for release during late 1999.

An investigation of dairy cow performance for cows grazing Aries HD or Yatsyn 1 high endophyte perennial ryegrass cultivars

Results from the lamb liveweight gain study indicate that the development of cultivars bred specifically for improved forage quality and altered endophyte alkaloid profiles will translate to improved per hectare profitability. While the previous study results provide valuable information to the lamb industry, Wrightson Research sought to identify similar associations within the dairy industry. The objectives of this study were to investigate the performance of lactating dairy cows grazing a new cultivar, Aries HD, compared with a dairy industry standard cultivar, Yatsyn 1. Both lactational performance and reproductive outcomes were investigated.

Materials and methods

Pasture establishment and management Two commercially available high endophyte perennial cultivars were sown on a commercial dairy farm in Central Hawkes Bay during autumn 1997. A total of 63 hectares was sown with Lolium perenne cultivars Aries HD (31.5 ha) and Yatsyn 1 (31.5 ha). Trifolium repens cv Grasslands Challenge and cv Grasslands Kopu were sown with each cultivar. Cultivars were managed in an identical manner with regards to grazing, irrigation and fertiliser management.

Study animals Cultivars were grazed by crossbred Jersey – Friesian dairy cows. 359 dairy cows were split into two herds (179 Aries HD and 180 Yatsyn 1) at the end of September 1997. Cows in the Aries HD herd accessed Aries HD only; the Yatsyn 1 herd grazed Yatsyn 1 on each grazing rotation. Cows remained in the split herds until the end of May 1998.

Grazing management The herds were rotationally grazed through each cultivar as appropriate, with each herd remaining on each cultivar for up to 10 consecutive days of each grazing rotation. Time spent on each cultivar was dictated by grazing round length. For the remainder of each grazing rotation, cows remained in split herds, grazing the balance of the farm, sown down in a Maverick Gold hybrid ryegrass / Banks perennial ryegrass mixture.

Data collection. Milk volume produced by each herd was quantified using a flow meter installed in the milk line. Volumes were collected from the morning and afternoon milkings from each herd while the herds grazed the study cultivars. Milk volume data were not collected for the first 48 hours of commencement of grazing the study cultivars. Representative milk samples were collected for milk solids (MS) analysis (fat + protein) at each milking while the herds grazed the study cultivars.

Statistical analyses An ANOVA was performed (Genstat Version 5.0) to investigate the difference in MS production between each herds over the 7 sampling periods. Autocorrelation within and between sampling periods was assessed as less than 10%. Means were adjusted for missing values. This method of analysis assumes paddock to paddock and animal to animal variation was minimal. Differences in time from mating to predicted calving date for each cow, controlling for the effects of time from calving to start of mating

were assessed using survival analysis, Cox's proportional hazards model (BMDP Dynamic, 2L).

Results and discussion

Results from the first year of this ongoing study show significant differences in milk solids production from the herds grazing Aries HD and Yatsyn 1 (Figure 3; P = 0.012). Across all sampling periods, 11% more MS were produced by cows grazing Aries HD herd compared with those grazing Yatsyn 1. Further, cows grazing Aries HD tended to have shorter intervals from start of mating to conception than cows grazing Yatsyn 1 (P=0.06). Aries HD cows averaged 36 days from start of mating to predicted conception (using Livestock Improvement Corporation records) compared with 42 days for the Yatsyn 1 herd (Figure 4). Interestingly, this fertility response was associated with cows grazing Aries HD for only part of each grazing rotation.

Figure 3 Average daily milk solids yield by Aries HD and Yatsyn 1 herds during each sampling period (P = 0.012)

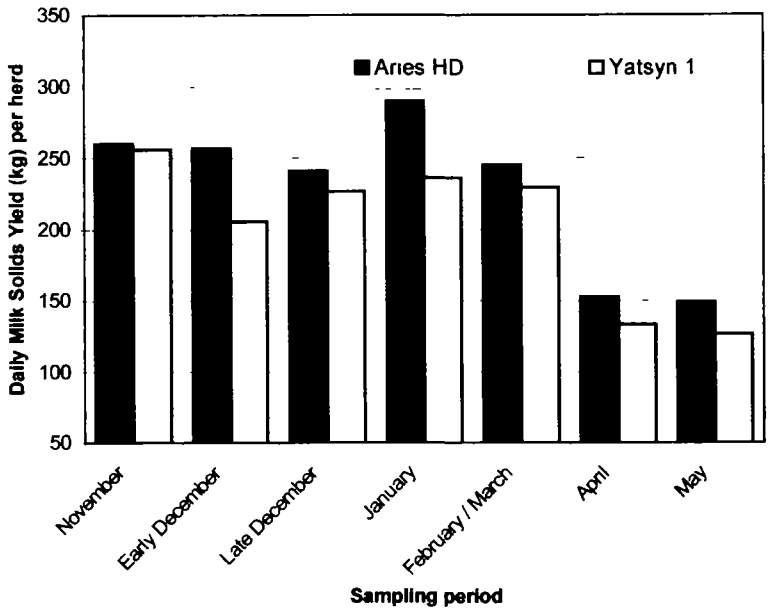
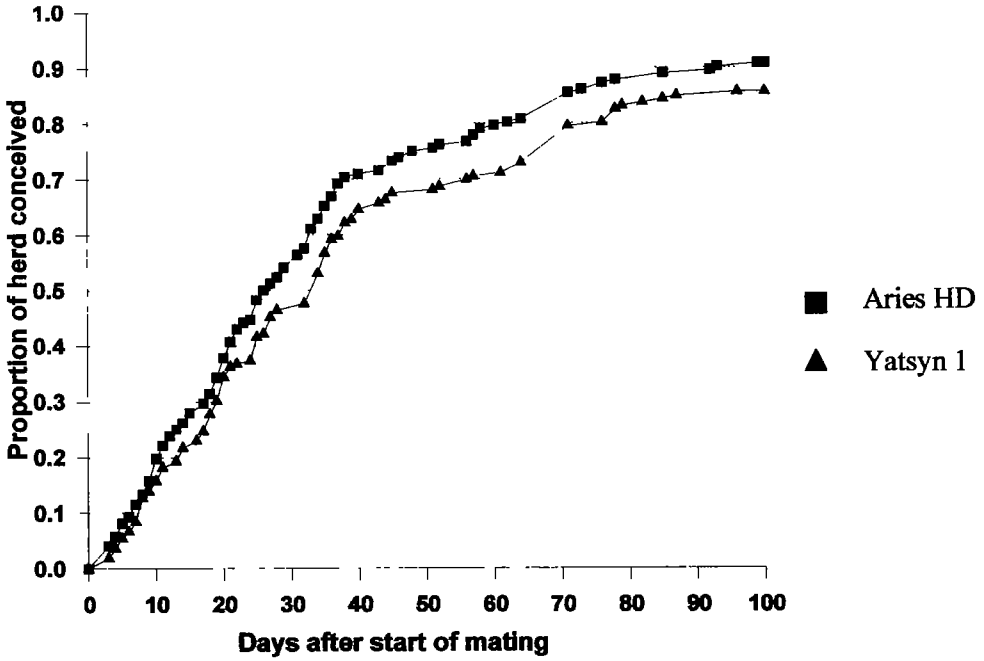


Figure 4. Cumulative proportion of cows conceiving for herds grazing Aries HD or Yatsyn 1 cultivars (P = 0.06)



Annual dry matter production by Aries HD and Yatsyn 1 differ by less than 5% (Norriss, 1998, unpublished data). Lack of association between DM yield and dairy cow performance in the first of this two year study supports findings from the lamb liveweight study in which DM yield was not strongly associated with animal performance. Improved digestibility characteristics of Aries HD may again, in part, explain the significantly greater MS production from Aries HD compared with Yatsyn 1. Further, significantly different endophyte alkaloid profiles have been shown previously to alter animal performance. The different pattern of change in time to predicted conception for the Aries HD and Yatsyn 1 herds may reflect different nutrient intakes, endophyte alkaloid intakes or other unidentified characteristics associated with the cultivars in this study. The second year results from this study are due for release in 1999.

Conclusions

Animal grazing studies are part of Wrightson Research's commitment to the selection of forages to improve profitability from pasture based systems. Findings from preliminary sheep and cattle grazing studies indicate that the use of DM as an indicator of animal profitability from pasture is not appropriate under all circumstances. These outcomes suggest that cultivars performing well in these studies are likely to deliver similar benefits to the deer industry.

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