Northland Pastoral Extension Research Stocktake

Opportunities for Dairy Production in Northland

Contents

Introduction

The main investigations into increasing milk production and concurrently dairy farmer profit during the 1970s and 80s in Northland included finding ways to fill feed deficits during the dry summer months, avoiding pugging damage on heavy clay and podsolised soils during winter, improving reproductive performance, growing more dry matter per hectare and increasing yield of forage crops. Thirty years later, these are still the main issues facing farmers and we are still some way off having all of the solutions.

This research stocktake examines papers that investigated the identification of pastures that would be sustainable in flood-prone areas, the potential of alternative forage crops including brassicas and sorghum, and experiences with on-off grazing in early lactation. Three other important issues that are relevant today but are not discussed in this research stocktake include the use of nitrogen to promote pasture growth, kikuyu management on dairy pasture and the use of new-type endophyte grasses in dairy pastures. These three topics are covered in detail in other stocktakes in this series.

1.0 Flood Tolerant Pastures for Dairying in Northland

Reference: P.W. Woods, J.N. Couchman, A.O. Taylor
Proceedings of the XVII International Grassland Congress 1993, 1522-1523

Overview

Much flood prone land in Northland consists of fertile alluvial flats which are used for dairy production. Heavy rainfall from subtropical cyclonic disturbances has caused severe pastoral damage to these areas by flooding during late summer and early autumn. A range of pasture species were screened to ascertain plant survival under depleted oxygen levels and warm temperatures which occur in flood water during summer.

Method

To screen plants for flood tolerance a system of controlled immersion was required which reflected conditions arising in the field. Water temperatures of approximately 18°C and dissolved oxygen (DO) levels down to 5% were deemed appropriate for screening purposes. Plants were placed in a bath with the aforementioned conditions and several pots of each line were used in each run. One pot was removed each day as the experiment progressed. DO levels and temperatures were monitored daily. Once withdrawn, plants were allowed to recover and were assessed for survival after one month.

Results

Species survival is indicated in Table 1. *Lolium perenne* and *trifolium repens,* on which most traditional pastures are based, were intolerant of flooding.

Subtropical grasses tended to survive immersion better than temperate species. Subtropical creeping grasses such as *Hemarthria altissima* and *Paspalum distichum* were more tolerant than *Paspalum dilattatum.*

Table 1. Immersion survival in days for each species at 2 bath temperatures

Temperature	18.0°C		25.6°C	
Temperate Grasses				
Lolium perenne Supenui	< 6	(2)	< 2	(3)
Festuca arundinacea Grasslands Roa	< 9	(1)	< 3	(2)
Phleum pratense Grasslands Kahu	< 15	(1)	< 4	(2)
Holcus lanatus Massey Basyn	< 9	(1)	< 2	(2)
Phalaris arundinacea Szarvasi-50	> 18	(1)		
Phalaris arundinacea MN-76	> 18	(1)		
Phalaris arundinacea Rice reed	> 18	(2)		
Phalaris arundinacea Palaton	> 18	(1)	> 9	(2)
Phalaris arundinacea Venture	> 18	(1)		
Phalaris aquatica Grasslands Maru	< 9	(1)	< 2	(2)
Agropyron elongatum Largo	> 15	(1)	< 2	(2)
Agropyron repens ex. DSIR house (Couch)	< 12	(1)	< 6	(2)
Dactylis glomerata Grasslands Kara	< 6	(1)	< 2	(2)

Subtropical Grasses		
Paspalum dilatatum Grasslands Raki	> 15 (1)	< 6 (2)
Paspalum distichum ex. Clint Allen (Mercer grass)	> 15 (1)	> 20 (3)
Hemarthria altissima Bigalta	> 15 (1)	> 17 (2)
Hemarthria altissima Floralta	> 15 (1)	> 17 (2)
Perennial Legumes		
Trifolium repens Grasslands Kopu	< 9 (1)	< 3 (2)
Trifolium repens Grasslands Pitau	< 12 (1)	< 3 (2)
Trifolium fragiferum O'Connors	< 6 (1)	< 3 (1)
Trifolium fragiferum Palestine	< 3 (1)	< 3 (2)
Lotus pedunculatus Grasslands Maku	> 15 (1)	< 6 (2)
Lotus tenuis ex. PMC	< 9 (1)	< 3 (2)
Annual Legumes		
Trifolium subterraneum Trikkala	< 3 (1)	
Trifolium balansae Paradena	< 6 (1)	
Lotus subbiflorus ex. CSIRO (1)	< 12 (1)	
Lotus subbiflorus ex. CSIRO (2)	> 9 (1)	

< less than
> greater than
() number of runs

Of the temperate species, *Phleum pratense* (Grasslands Kahu), *Phalaris arundinacea* (MN-76, Rice Reed, Palaton and Venture), *Agropyron elongatum* (Largo) and *Agropyron repens* (Couch) were the species best able to survive. *Festuca arundinacea* (Grasslands Roa), *Holcus lanatus* (Massey Basyn), and *Phalaris aquatica* (Grasslands Maru) also survived better than the *Lolium perenne* (Supernui).

All legumes screened were intolerant of flooding.

Summary

Plants placed in the bath were immediately subjected to low DO levels. Under field conditions it would take a number of days from the onset of a flood for similar conditions to develop. Hence plants found to be tolerant here would be expected to withstand longer periods of immersion in the field.

Phalaris arundinacea, which is most likely to be the best alternative to the traditional ryegrass/white clover mix, is very summer active and winter dormant, and is also susceptible to frosting. Widespread use on low-lying farms could not be recommended without adequate provision for winter feed supply. Usage of *Phalaris* as a specialist pasture with nitrogen applied during the growing season warrants further evaluation. The difference in survival among white clover lines required further verification.

2.0 Potential of New Summer Grasses in Northland

I. Warm-season yields under dryland and irrigation

Reference: A.O. Taylor and J.A. Rowley
N.Z. Journal of Agricultural Research 1976, 19: 127-33

Overview

The warm-season yield of a range of C_4-photosynthetic pathway summer-growing tropical grasses was measured by mechanical harvesting over three seasons on small plots near Kaitaia. Several of the grasses produced higher yields than the naturalised summer grasses *Paspalum dilatalum* and *Pennisetum clandestinum* (kikuyu). Irrigation sufficient to replace evaporative water loss substantially increased the early summer production of all grasses but usually decreased their early autumn production. Production of all grasses was lowest in late summer.

Method

Yields from a range of perennial C_4 grasses grown in small plots on a sandy coastal Northland site were measured over three years. Representatives of the C_3 temperate genera *Lolium* (ryegrass) and *Phalaris* were included, and *Paspalum dilatatum* and kikuyu, two C_4 grasses currently growing in the area, were used as controls. Grasses were mechanically harvested and were grown under optimal conditions of nutrition, and of weed and insect control to allow full expression of their yield potential. Half of the trial was irrigated to obtain information on both the drought sensitivity of these grasses and their yield under non-limiting water.

Results

Dry Matter Yields

Several of the grasses produced more dry matter than kikuyu, particularly under dryland in the second and third years, but only the *Setaria* and *Digitaria* cultivars were consistently and significantly greater yielding. *Paspalum dilatatum* was one of the lower yielding of the C_4 grasses.

Irrigation and Seasonality of Yields

Irrigation significantly increased total warm-season production of the grasses over the trial period, although there were considerable between-variety differences in the extent of this yield increase. On a seasonal basis, continuous irrigation substantially increased yield during early summer but usually depressed yield in autumn. The only exception to this was ryegrass; its growth rate was always increased by irrigation. Many ryegrass plants died of the effects of drought in the dryland plots and continuous reinfestation with weed kikuyu depressed vigour of the irrigated plots.

The authors’ proposed that the almost universal depression of autumn yields by irrigation could have been caused by over watering and leaching of soil nutrients. They also surmised that it is possible that these grasses have a maximum yield capacity dictated by a ceiling to tiller production rather than by photosynthesis-nutrient limitations, and that high early-summer yields permitted by adequate water cannot be sustained.

Summary

The site used for this summer grass trial had a light sandy soil and exposed aspect, yet *Setaria* spp., the highest yielding of the grasses, produced as much dry matter as a maize crop.

3.0 Modelling the Contribution of Forgage Crops to Production, Profitability and Stability of North Island Dairy Systems

Reference: C.P. Millee
Proceedings of the New Zealand Society of Animal Production 1980, 40:64-67

Overview

A range of forage sources and a range of cow feeding options were modelled using a linear programming tool to synthesise and evaluate alternative north island dairy systems and to develop research priorities. Forage crops significantly increased production in lower producing Northland systems but had a much smaller effect on a Ruakura system. Average profitability was increased only slightly by conservation. It was determined that the most rewarding area for new research would be to increase pasture yield.

Results

Level of Cropping
Cropping resulted in increased production and economic performance. In Northland, the largest relative effect was on minimum income and internal rate of return to farm capital (Table 1). Minimum net income ($/ha), for example, more than doubled between the best all-grass system and the best cropping system.

In Ruakura conditions, an optimal level of cropping was only 10%, and the effects of cropping on the performance parameters of Table 1 generally small. Dry matter yield and milk production both increased by more than 10%, but gross margin by only 2.5% and minimum net income by 24%.

In both environments, increasing the cropping level beyond the optimum point resulted in higher milkfat production and only slight reductions in profitability.

Table 1: Effects of levels of cropping and conservation on average system performance

	Percent of Farm Cropped					
	0		20		40	
	5[1]	12[1]	11[1]	33[1]	11[1]	16[1]
Dry matter (t/ha)	9.5	9.5	12.6	14.4	14.0	14.7
Stocking rate (cows/ha)	2.4	2.2	2.7	3.2	2.9	3.1
Milkfat (kg/cow)	139	155	157	161	162	159
Net income ($/ha)	170	199	253	273	278	292
Minimum net income ($/ha)	26	57	75	150	140	147
Rate of return (%)	1.3	2.2	3.8	4.4	4.6	5.0

[1] *Percent of feed grown that is conserved*
[2] *Average net incomes of Northland dairy farms, 1976-7, estimated at $90.00/ha (N.Z.D.B., 1979)*

Level of Conservation
At any level of cropping, increasing conservation resulted in higher production and profitability (Table 1). In all-grass systems the whole effect resulted from better feeding of (fewer) cows, while in cropping systems greater conservation enabled higher forage yields and higher stocking rates. The effect of conservation was at all times smaller than the effect of cropping. At any cropping level, the model predicted it would be more profitable to grow crop than to conserve more of the existing forage.

Crop and Pasture Yield
Higher pasture yields resulting from three different sources produced similar increases in milkfat production, but even when the cost of extra forage was deducted, economic responses differed quite widely (Table 2), depending on the timing of the additional forage. The change of species in Table 2 refers to the use of a summer-growing grass while change of site refers to exchanging Ruakura pasture yields for those of Northland.

Table 2: System responses to higher pasture yield assuming no extra cost

	Reason for Higher Yield		
	Nitrogen	Species	Site
Pasture DM (kg/ha)	3000	5000	5890
DM/MF (kg/kg)	30.0	29.1	27.8
Gross margin (c/kg DM)	3.7	5.2	5.9

Production responses to increasing maize yield were much the same (29.1 kg DM/kg MF) as for pasture, emphasising that metabolisable energy content is a reasonable basis for comparing the nutritive value of forages, provided that the forage is fitted into an appropriate system.

Summary

Three main conclusions were drawn. First, existing forage crops have a profitable role to play in appropriate Northland dairying systems. Secondly, increased conservation appears to have a limited role in increasing farm profitability, though industry profitability could benefit from a more even product flow. Thirdly, research and development on grazing forages, preferable perennial, pasture-type forages, would bring the highest rewards in the short term.

4.0 Summer Brassica Forages in Northland

Reference: G.J. Piggot, C.A Farrell, G.L. Stebleton, and P.W. Shannon
Proceedings Agronomy Society of New Zealand 1980, 10: 13-15

Overview

Trials in Northland assessed the production of October-sown forage brassica crops – turnips, kale, rape, wairoa brassica and fodder radish. Timing of harvest determined dry matter yield. No significant differences were measured between crops harvested during late February or early March. Turnips yielded significantly more dry matter than kale or wairoa brassica when harvested in early February while kale yielded more than rape or wairoa brassica if harvested in April in two out of four trials.

Results

Timing of harvest had the greatest effect on crop yields in this trial. For crops harvested between mid-February and early March (14^{th} Feb – 9^{th} March), there were no significant differences between crops within each trial. However, turnips produced more dry matter than the other crops in trials 1 and 2 when harvested in early February.

Summary

The yields harvested in this trial were average to low when compared to previous crops such as sorghum and maize grown in the same area. Therefore, brassicas as summer forages appear to have no special advantage for dry matter production when compared with alternative forage crops and even pasture.

There were no significant yield differences between crops when harvested during mid-February to early March. However, the results suggest that if the feed requirement is in January or early February then turnips should be sown. Kale may be a better choice for feeding in March or April. The results also suggest that wairoa brassica may provide better regrowth following a February harvest, and it appears that wairoa brassica is more prone to loss of yield by leaf fall if left unharvested after February compared with kale.

5.0 Sorghums for Conserved Feed in Northland

Reference: A.O. Taylor, J.A. Rowley, M.J. Esson, J.D. Eastin, and R. Wallace Proceedings Agronomy Society of New Zealand 1974, 4: 74-78

Overview

This paper details the yield and potential use that sorghums can have in Northland as warm season forage crops to alleviate pasture deficits. Sorghums show a considerable variation in maturity and size, and hence in potential yield and water use. The best sorghum to use depends on early season soil temperatures, soil moisture availability during summer and minimum night time temperatures in late summer on that site. Sorghum silage is high in energy (43% soluble carbohydrates) and low in protein (6%). Well made, high-protein pasture silage could be an ideal feed to use in conjunction with sorghum silage.

Method

Three major trials were laid down in October 1973 on a range of soil types in the far north. Following preparation of the areas by first grazing and then spraying with paraquot, 1/3 hectare areas were direct drilled with a range of grain sorghums, silage type sorghums and maize. All plots were harvested in March 1974.

Results

On the peat site at Sweetwater, dry matter yield of the early maturing grain hybrids produced better yields than later maturing hybrids (Table 1). Much of this variation in total yield came from the grain component. Dry matter yield of forage hybrids on the peat was roughly proportional to height (Table1).

On sand at Cape View, lack of soil moisture frequently more than halved yields of forage sorghums and maize compared with those on the peat, while grain sorghum yields were reduced much less (Table 1).

Differences in available soil moisture on the sand and on the peat can also be seen to cause major differences in the relative DM yields of the three main forage classes used in these trials, namely grain sorghums, forage sorghums and maize. When adequate or almost adequate moisture is available, as on the Sweetwater peat, then ultimate yield potentials are approached and the tallest forage sorghum yields best and the short grain sorghums yield least. Maize and the tall forage sorghums use more water during vegetative growth than small grain types, so less soil moisture remains for grain filling which is a large and important component of yield.

Table 1: Total warm season silage dry matter (DM) yields (kg/ha) using direct drilling techniques

Plant type	Sweetwater peat[1]	Cape View sand
Hybrid Grain Sorghums		
De Kalb A 25	17,020a	12,070 b
Northrup King 233	17,290a	12,480 b
Northrup King 266	16,500a	14,250 a
Pioneer 842	14,770b	13,180 ab
De Kalb C 42	13,280c	12,750 b
Hybrid Forage Sorghums		
Northrup King 300F	16,490 d (156)[2]	9,840 b
De Kalb FS 1A	24,740 b (182)	8,560 b
De Kalb FS 26	23,940 b (215)	8,560 b
De Kalb FS 4	27,980 a (226)	12,800 a
Open Pollinated sorgho Sugar Drip	20, 480 c (219)	11,800 ab
Hybrid maizes		
De Kalb XL 45	23,050 a	10,670 a
Northrup King PX 610	21,540 a	12,440 a

[1] Grain yields averaged 41% (grain sorghums) and 34% (forage sorghums) of total silage dry matter at Sweetwater
[2] Plant height ion parentheses in cm
Means with letters in common do not differ at the five percent level of significance

Summary

The use of ensiled sorghum in combination with wilted fine-chopped silage made from spring flush pasture (possibly with the addition of non-protein nitrogen in the form of urea) would provide a more balanced ration to fill feed deficits. Many areas of Northland have a good spring flush of pasture and similar machinery can be utilised for the feedout of silage sorghum as for grass silage so additional infrastructure using this feed is not required. Good forage conservation schemes should be infallible and the use of silage from two sources made at different times of the year allows two decision making steps and so better ensures adequate supply.

6.0 The Culture and Yield of Sorghum for Forage and Sugar

Reference: G.J. Piggot and C.A. Farrell
Proceedings Agronomy Society of New Zealand 1984, 14: 105-109

Overview

Sorghum, grown for forage or stalk sugar, was studied in Northland from 1979 to 1983. Trials were conducted on the effect of sowing date, seeding rate, row spacing, harvest regime, weed control, fertilizer requirements and the use of land during winter after sorghum. The main results are summarised here.

Results

Sowing Date
Although early summer has been the recommended sowing period, earlier sowing would be expected to result in higher yields during late summer when the forage is needed most on pastoral farms. Sowing date trials were conducted at three sites in consecutive years using Sudax in 1980-81 and Sugar Drip in 1981-82 at a range of seeding rates. The sowing dates were late October, mid November and early December. At all sites and in both years, the December-sown crops yielded significantly less DM in February. By the April harvest, yield was little affected by sowing date, and there was only a small effect of sowing date on regrowth, in May, of February-harvested plots. Additional weed control was required on October-sown plots.

Seeding Rate
High seeding rates (25 kg/ha) are normally recommended for forage sorghum cropping making seed cost a major factor. Seeding rate comparisons were made (12 vs 32 kg/ha for Sudax and 12 vs 25 kg/ha for Sugar Drip) within the sowing date trials. The higher seeding rate was associated with increased plant and tiller numbers and, to a much lesser degree, dry matter yields for both sorghum types, particularly Sugar Drip. Seeding rate interactions with sowing dates occurred only with plant or tiller counts and were caused by plant establishment at the lower seeding rate being more seriously impaired at unfavorable sowing dates. Therefore, there appears to be little justification for using high seeding rates as with most sowing dates used for this trial the results were not significantly different.

Harvest Regime
Of the cultivars monitored, the regrowth from February cutting matured much later and produced a similar DM yield. This result indicates that sorghum could provide farmers with the option of maximizing forage (and sugar yield) by harvesting the crop in April or they can harvest for forage in February and still obtain a silage harvest in late June yielding up to 2/3 of the single harvested regime.

Winter Land Use
Following the autumn cutting or grazing of sorghum, farmers have the option of regrassing or growing a winter forage crop. Three winter forage trials were conducted to evaluate alternative forage options comparing 7 different forages. On poorly drained alluvial clay, the highest yielding species was fodder radish followed by oats and tama ryegrass while lupin was poorest. However, the lupin yield on well-drained soils was outstanding and out yielded subterranean clover by 4 times on average.

Summary

Sorghum, while well adapted to Northland, will develop and yield variably depending on the cultivar or hybrid chosen, the soil type and the season. Crop management can strongly influence growth and development. The key requirements are the correct sowing date and a weed-free seedbed. Flexible harvesting or grazing regimes can be devised to provide multiple harvests.

7.0 Experiences With On-Off Grazing in Early Lactation On Dairy Farms

Reference: M.B. Blackwell
Proceedings of the New Zealand Society of Animal Production 1993, 53: 37 – 39

Overview

Damage to soils and pastures in early spring is a significant factor reducing pasture growth, feed utilisation, and animal production on New Zealand dairy farms. This is particularly the case in Northland where the predominant soils are of clay texture and have poor drainage characteristics. A solution to this problem is the early removal of dairy cows from pasture, after a period of grazing that is sufficient to meet the dry matter intake needs of the cows. This limits the extent of treading, and reduces damage to soils and pastures, allowing the farm to sustain higher pasture growth rates, maintain a higher average pasture cover, and achieve a longer first rotation.

Discussion

Table 1 shows the variation in milkfat production for the month of October in the Northland region for the three years 1990-1992. The first year 1990 was exceptionally dry in September, while 1991 and 1992 were relatively wet in September and October.

Table 1. Milksolids production for October in Northland region (NZ Dairy Exporter)

	90/91	91/92	92/93
Soil conditions in September	Dry	Wet	Wet
Northland prod. for October (million kgs milkfat)	6.20	5.82	5.80
Variation versus 90/91		-6.1%	-6.5%

Much of the damage occurs from July to October, with most Northland herds commencing calving from 10th July to 1st August. The damage causes reduced pasture growth in spring, reduced feed utilisation, and underfeeding of cows at a critical stage of their lactation. This inability to adequately feed the cows in spring denies farmers the confidence to increase stocking rate and/or calve earlier as a means to increase milksolids production.

The effects of this underfeeding also impacts on the cows reproductive performance and it reduces the size of the spring feed surplus and slows summer pasture growth.

These problems can be reduced by instigating the early removal of lactating cows from pasture each day, after a period of grazing that is sufficient to meet the dry-matter intake needs of the cows. Dairy farmers have found lactating cows can be stood off without special facilities, or the need for supplementary feed.

If no specialist stand-off facilities are available on farm the best place to stand cows from farmers' experience is on the cowsheds concrete yard, with the herringbone area blocked off. Cows are accustomed to standing there, and the concrete is cleaned daily of stones, so the risk of stone bruising to hooves is minimal. While space on the yard is limited, few cows lie down on the concrete. The close contact means they keep each other warm and they may be less exposed to the weather than in the paddock, or in a race.

In the case study presented in this paper, cows were stood off at night over the wettest part of the spring (commencing in August and stopping in October prior to mating) and production figures during these months were similar or higher than those of the previous two years where no standing-off had occurred. This would indicate that there are benefits to minimising the damage to pasture in spring which do not negatively impact on production.

Summary

Contrary to much farmer opinion, there appears to be no detrimental effect on daily per cow production from repeated standing-off, provided certain conditions are met.

These conditions are:

1. on-off grazing of lactating cows is done while feed cover is plentiful, to extend the length of the first (and second) milking rotations, to avoid getting into a feed shortage
2. Pasture being eaten must have good length and density (around 2,500 kg DM/ha) to allow high levels of dry matter intake in a restricted time period
3. Cows must be in good health, with low incidence of mastitis and no sore feet
4. Magnesium supplementation is essential
5. First calving heifers must be well grown and cows must be in good condition.

Negative aspects of the practice can be:

6. The extra time required to take the cows off grazing and wash down the yard
7. Extra loading on the effluent disposal system

Authors Note: More recent Dexcel studies would indicate that there may be detrimental effects on cow welfare if cows are not given sufficient time and space to lie down in a 24 hour period. If unable to lie down during prolonged periods of standing off they will preferentially lie down in a paddock than graze thus affecting feed intake and consequently milk production. Detailed information on this topic can be found in the animal welfare section of the Dexcel website www.dexcel.co.nz

Future Opportunities for Dairying

The lack of comparative advantage in Northland for traditional New Zealand seasonal milk production means its future prosperity in dairy farming must be firmly lodged in building competitive advantage through innovation. This can be achieved through the use of technology, enhanced management capability and alternative production systems for niche products.

Some of the projects currently being investigated by researchers within the dairy industry or which have recently concluded include:

- The Pastures From Space project – The use of satellite imaging technology to determine pasture covers and density on individual farms. Only being studied in the Waikato at present.
- Rapid Pasture Plate Meter – The development of an implement that can be towed around the farm behind the quad bike measuring pasture covers and eliminating the need for manual farm walks with a rising plate meter.
- Automatic Milking – The use of robots in the dairy shed to increase labour productivity and broaden lifestyle opportunities. The Greenfield site in Hamilton operates a fully automated dairy farm presently milking around 180 cows.
- Automatic Heat Detection – Technology to take the guess work out of detecting oestrous in dairy cows.
- Feed Conversion Efficiency – A major project which is currently in the planning stages with the goal of identifying cows with superior feed conversion efficiency genetics and determining the profitability of including this trait in the breeding index.
- Extended Lactation – Extending lactation to 670 days to avoid the problem of getting cows in calf each year.
- Once-a-day-milking – the pros and cons of milking once a day on lifestyle and profit.
- Herd Homes – new age wintering barns that can be used all year round to improve pasture utilisation and effluent use.

While the projects outlined above are not Northland specific, the technology can be applied and tested here and this can only be of benefit to the Northland dairy farmer.