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The impact of turnips on dairy production as evaluated by component trials, modelling and farm systems research.

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ABSTRACT

A comparison of different methods (component trials, systems modelling and whole farm trials) for evaluating dairy farm inputs is made using the example of turnips grown on-farm as a summer forage. Component studies conducted at the Taranaki Agricultural Research Station and at DRC showed respectively increased (P<0.01) milksolids production of 36 and 66 g milksolids(MS)/ kg turnip DM. Modelling the use of turnips using a farm management model (UDDER) has shown the practice to be profitable in a dry year if the crop exceeds 8.0 tonne DM/ha and in a normal year, 10.0 tonne DM/ha. A programme designed to demonstrate the value of turnips on summer milksolids production (More Summer Milk) showed on 3 farms over 2 years a decrease of 16 kg MS/ha. The sowing of 7-9% of the farm into turnips (DM yields varied from 6.5 - 11.5 tonne DM/ha) resulted in less pasture conserved (180 kg DM/ha) and, by the commencement of feeding turnips; reduced milksolids production (0.2 kg/ha/day), lower average pasture cover (360 kg DM/ ha) and lower cow condition score (0.2 units/cow). Feeding turnips resulted in a small increase in milksolids production, insufficient to compensate for the initial production loss. UDDER simulated the farm situation prior to feeding turnips reasonably well but the response to turnip feeding was higher than occurred on-farm. The results highlight that the impact of a forage crop on dairy production cannot be predicted from short-term feeding trials or currently available farm systems models.

Keywords: Summer forage crop; turnips; milksolids production; component trials; computer models; UDDER; farm systems trials.

INTRODUCTION

The growth of pasture over summer has been identified as a major limiting factor to dairy production in the larger dairying regions of New Zealand (Scott, 1978; Roberts and Thomson, 1984: Penno *et al.,* 1995). Survey and field trials conducted in Victoria, Australia by Notman (1992) and Notman and Mulvaney (1994) suggested that feed production during summer could be increased considerably by the use of turnips (Barkant) as a summer forage. Average yields in excess of 9.5 tonne DM/ha within 90 days of sowing were reported. A growth rate of approximately 110 kg DM/ha/day over the November-January period when pasture production averages between 40 to 50 kg DM/ha/day. The estimated ME of turnips is 12.5 MJME/kg DM while summer pasture has a ME of 9-10 MJME/kg DM. From this information it was assumed that turnips would ideally supplement summer pasture. To determine if turnips will be of benefit to dairying a review of studies on turnips (covering short-term feeding trials, computer modelling exercises and farm systems trials, conducted in recent years) is presented.

METHOD

Short term feeding trials:

Two such trials have been conducted in New Zealand (Penno, *et al.,* 1996; Clark, *et al.,* 1996). The basis of such studies is to have animal and pasture conditions equal at the commencement of the study to minimise bias. For the trials reported, treatments were balanced before the experiment started for milk yield, milk composition, liveweight, body condition score. Pasture allowance was equalised for all treatments. The primary objective of trial management was to ensure the allowance of crop was the only variable between treatments.

Computer modelling:

Modelling has been seen as a means of integrating the complex components of the farm into a useful tool for examining whole farm systems (McCall and Sheath, 1993). However, for dairying only one farm system model, i.e. UDDER has been commercially developed into an easily usable management tool. UDDER has been effectively used (McLean, 1993) for long-term planning on dairy systems where aspects such as stocking rate, calving date, calving pattern, concentrate feeds, nitrogen fertiliser and crops require a general evaluation.

Clark (1995) used UDDER to determine the economic “break even” point using three turnip yields (4, 8 and 12 t DM/ha) and three summer pasture situations (normal, dry and drought). The information from the work of Clark (1995) will be discussed in context with other trial results.

More Summer Milk:

The design and objectives of the project have been reported elsewhere (Exton, *et al.,* 1996) but in brief they

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were: To demonstrate various means of increasing feed supply to increase milk production over the summer/ autumn period and reduce the decline in milk production from peak milk in October to 7 %/month. One of the four feed inputs was turnips. The area of the farm sown into turnips varied from 7 to 9% and was governed by the requirement to increase cow intake by 4 kg DM/cow/day for 60 days over summer. The conclusion arrived at by Exton, *et al.*, (1996) was that the sowing of turnips as determined on-farm did not increase milksolids production and the practice was not recommended. The reason why this result was obtained when a more positive effect was indicated from component and modelling studies will be examined.

Three farms (A, B and C) covering a range of environments in the Waikato were selected to evaluate the impact of turnips on milksolids production. Farms A and B were in drier areas and farm C was in a wetter area. Two farms (A and B) remained in the programme for two seasons, 1994/95 and 1995/96, farm C only participated for the first season. The management of the farms and the measurements made has been described by Exton, *et al.*, (1996). In the first season the three farms ran the splits through until all cows were dried off. In the second season the treatment herds were brought together at the end of feeding turnips. Farms A and B was used to simulate farm performance using UDDER. To run the simulations actual pasture production data and farm management strategies from the control farmlets were used. UDDER was calibrated to the actual performance of each control farmlet. The simulations then were re-run using the actual areas sown in turnips, crop yields and feeding periods to assess the impact of turnips on milksolids production.

RESULTS

Notman (1992) calculated from theoretical energy requirements for milk production that supplementing summer pasture with turnips would increase milksolids production by 80 g MS/kg DM from turnips fed. Results from short-term grazing trials Penno, *et al.*, (1996) and Clark, *et al.*, (1996) showed that cows on a restricted pasture allowance, increased milksolids production by 66 g MS/kg DM and 36 g MS/kg DM of turnips fed respectively. Clark (1995) concluded from running UDDER simulations that the financial “break even” occurred in a dry and drought year at a crop yield of 8 t of DM/ha and in a normal year at 10 t DM/ha.

More Summer Milk:

The 1994/95 season was very dry with little rain falling on farms A and B from November to March. Farm C was situated at a higher altitude and had regular summer rainfall. The 1995/96 season was wetter and this is reflected in higher production from both pasture and turnips (Table 1). The inclusion of the turnip crop into the system resulted in 180 kg DM/ha less silage conserved. By the time turnip feeding commenced in early to mid January, the average farm cover on the turnip farmlets was less (-360 kg DM/ha), cow condition was slightly poorer (-0.2 condition score/cow) and daily milksolids production lower (-0.2 kg MS/ha/day). This negative effect of turnips on farm performance was reflected in a loss (growing to end of feeding) of 8 kg MS/ha to growing turnips (Table 2).

Over the period of feeding turnips, little effect on milksolids production was recorded. In 1994/95 a positive effect to feeding turnips was recorded in only one of the three farms. In 1995/96 a positive effect on both farms, although very small (5 kg MS/ha), was recorded. When the rate of feeding turnips is taken into account the average response was less than 3 g MS/kg of turnip DM fed.

TABLE 1: Actual farm performance, at (early January) and up to the point of feeding turnips, during the feeding of turnips (early January to early March) and post-feeding for control and turnip farmlets over two seasons.

	Season	1994/95			1995/96	
	Farm	A	B	C	A	B
Feed production Tonne DM/ha	Pasture (P) - (Oct-June)	5.5	4.4	10.5	9.1	7.5
	Turnip (T)	5.5	6.8	11.1	10.4	11.5
	Difference (T=P -T)	0	2.4	0.6	1.3	4.0
kg DM/ha	Advantage to turnips over whole farm (T)	0	180	50	130	360
Silage made (kg DM/ha)	Control (C)	160	200	0	270	480
	Turnip (T)	30	140	0	80	130
	Difference (S=T-C)	-130	-60	0	-190	-350
Net DM (kg /ha)	T-S	-130	120	50	-60	10
At commencement of feeding turnips						
Farm cover (kg DM/ha)	Control	3700	2950	2980	2690	2520
	Turnip	3260	2530	2670	2520	2310
	Difference	-440	-420	-310	-170	-210
Condition score	Control	4.7	4.0	4.2	4.5	4.5
	Turnip	4.7	4.0	3.9	4.2	4.3
	Difference	0	0	-0.3	-0.3	-0.2
Milksolids (kg MS/ha/day)	Control	2.2	2.3	4.0	3.0	3.3
	Turnip	2.2	2.1	3.9	2.6	3.2
	Difference	0	-0.2	-0.1	-0.4	-0.1

TABLE 2: Milksolids production (kg/ha) recorded on the three farms during the key periods of managing turnips as a summer forage crop for 1994/95 and 1995/96.

Farm	Year	Period of turnip management	Milksolids (kg/ha) Control (C)	Turnips (T)	Difference (T-C)
A	1994/95	Growing	199	200	1
		Feeding	107	117	10
		Post-feeding	59	50	-9
		Total	365	367	2
B	1994/95	Growing	292	276	-16
		Feeding	125	116	-9
		Post-feeding	119	99	-20
		Total	536	491	-45
C	1994/95	Growing	331	338	7
		Feeding	202	188	-14
		Post-feeding	119	108	-11
		Total	652	634	-18
A	1995/96	Growing	307	293	-14
		Feeding	125	130	5
		Total*	432	423	-9
B	1995/96	Growing	406	390	-16
		Feeding	160	164	4
		Total*	566	554	-11

* Herds were combined at end of turnip feeding and no assessment of production post-feeding.

UDDER simulations:

Up to the time of feeding turnips UDDER simulations were similar to what was recorded on farms A and B: lower average farm cover, lower condition score and in the 1994/95 season, lower daily milksolids production (Table 3). When turnips were fed the predicted milksolids response was greater than actually occurred. Overall the effect of turnips on total milksolids production (planting turnips to immediately post-feeding) differed with an average increase of 11 kg MS/ha from UDDER simulations compared with an actual loss of 14 kg MS/ha.

DISCUSSION

From the reports of Notman (1992) and Notman and Mulvany (1994) it could be assumed that the average yield from Barkant turnips of 9.5 t DM/ha could be further increased by 20-30% with the application of 45 kg /ha of phosphate fertiliser and 60 kg/ha of nitrogen fertiliser. However from the survey results reported by Clark (1995) the average yield of turnips in the major dairying areas of New Zealand for 1994/95 was 7.4 t DM/ha. This was below the economic "break even" for a drought situation (Clark, 1995). These results suggest that the initial assumptions on what Barkant turnips could yield in New Zealand were over-estimated.

From Table 1, a close relationship between summer pasture production and turnip production was noted. Regression analyses confirmed a significant ($P<0.05$) association between the growth of pasture and turnips ($R^2=0.82$) over the period, 4 October to 22 March. From the association it can be calculated that turnips will produce, on average, 23% more DM/ha than pasture. However with only 7-9% of the farm sown into turnips the increase in DM from turnips for the whole farm will be in the order of only 2%. This then brings into doubt the relationships established from UDDER by Clark (1995), that for a normal year the economic break-even yield for turnips is 10 t DM/ha. As there is an association between the yield of turnips and pasture then when modelling farm systems, turnip yield should not be varied independent of pasture growth.

The inference made from the component trial results of Penno *et al.*, (1996) and cited by Clark *et al.*, (1996) is that the feeding of turnips will result in an increase in production of 36 to 66 g MS/kg of turnip DM consumed. This however was not achieved in the MSM programme. The results for the MSM project for the 1994/95 season were considered abnormal because of the very dry early summer period resulting in low crop yields on farms A and B. However on the wetter farm, farm C, crop yield exceeded 10 t DM/ha but milksolids production was again

TABLE 3: UDDER simulations of performance for farms A and B over the 1994/95 and 1995/96 seasons.

Farm	Treatment	Farm situation at start of turnip feeding: Farm cover (kg DM/ha)	Condition score	Milksolids (kg/ha/day)	Milksoilids (kg/ha): Pre feeding	Feeding	Post feeding	Total*
A 1994/95	Control (C)	1850	3.7	2.45	304	104	66	474
	Turnip (T)	1650	3.5	2.33	289	114	58	461
Difference	(C -T)	-200	-0.2	-0.12	-15	10	-8	-13
B 1994/95	Control	2180	4.0	3.16	375	138	68	580
	Turnip	1940	3.9	3.08	367	137	55	559
Difference	(C -T)	-240	-0.1	-0.08	-8	-1	-13	-21
A 1995/96	Control	2300	4.3	3.52	413	181	97	691
	Turnip	1880	4.1	3.58	403	196	88	687
Difference	(C -T)	-420	-0.2	0.06	-10	15	-9	-4
B 1995/96	Control	2870	4.2	3.87	407	189	78	674
	Turnip	2800	4.3	4.08	414	201	79	694
Difference	(C -T)	-70	0.1	0.21	7	11	1	19

* Total kg MS/ha from cultivation for turnips to drying off.

less from the turnip than the control farmlets (Table 2). The following season (1995/96) was considered a more normal climate and turnip yields on farms A and B exceeded 10 t DM/ha. However the good crop yields resulted in no increase in total milksolids production. From a break-down of farm performance (Table 1), the reason for the lack of a response to turnips becomes clear. Less silage was made and by the commencement of turnip feeding; farm cover, cow body condition and daily milksolids production was lower. The net result being less total feed and less milksolids produced on four of the five turnip farmlets. From these results it would appear that the differential increase in DM yield from turnips was not sufficient to overcome the penalty effects of the crop on pasture and animal performance.

These results highlight a problem with short-term feeding trials designed to examine the effect of a forage crop on animal performance. The feeding trial approach is to have the animal and pasture situation equal at the commencement of feeding whereas in the actual situation these are not equal (Table 1). The outcome will then overestimate in comparison with the farm system, the benefit of the forage crop in terms of animal performance.

UDDER simulations using the actual data recorded on farms A and B over two years (Table 3) shows a different response to what actually occurred. The negative effect of the crop on average farm cover and condition score prior to turnip feeding was similar to that recorded on-farm whereas the comparative effect on daily and total milksolids production prior to feeding was more variable. Overall UDDER predicted a positive effect of turnips on milksolids production (sowing to end of feeding) whereas in the actual farm situation, a loss in milksolids occurred.

CONCLUSION

Turnips do not have the growth potential to provide sufficient feed over summer to overcome the loss in pasture and dairy cow performance resulting from the inclusion of the crop into the dairying system. When assessing the impact of a forage crop on dairying, the results of short-term feeding trial results and partial budgeting approaches are not recommended. At present the available farm production computer models, although better than partial budgets, also tend to overestimate the impact of a summer forage crop on dairy production. The experience with turnips has shown that the farm systems trial is the only approach that will determine the true impact of a forage crop on dairy performance.

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REFERENCES

Clark, D.A. 1995. Summer milk - Pasture and crops. *Proceedings of the Ruakura Farmers' Conference* **47:** 10-16.

Clark, D.A., Howse, S.W., Johnson, R.J., Peasrson, A., Penno, J.W., Thomson, N. A. 1996. Turnips for summer milk production. *Proceedings of the New Zealand Grassland Association* **57:** 145-150.

Exton, P.R.; Dawson, J.E.; Thomson, N.A.; Moloney, S. 1996. More Summer Milk - Progress to date. *Proceedings of the Ruakura Farmers' Conference* **48:** 34-41.

McCall, D.G.; Sheath, G.W., 1993. Development of intensive grassland systems: from science to practice. *Proceedings of the XVII International Grassland Congress* **1993:** 1257-1265.

McLean, N.R., 1993. Applying management strategies to increase profit. *Dairyfarming Annual* **45:** 142-150.

Notman, P. 1992. Survey of turnip yields in Victoria, Australia. ADRDC Report.

Notman, P., Mulvaney, J. 1994. Turnip crop fertilisers requirements and herbicide usage trial report. ADRDC Report.

Penno, J.W.; Thomson, N.A.; Bryant, A.M., 1995. Summer milk - Supplementary Feeding. *Proceedings of the Ruakura Farmers' Conference* **48:**17-24.

Penno, J.W.; Bryant, A.M.; Napper, A.R.; Copeman, P.J.A. 1996. Effect of feeding turnips to dairy cows grazing limited amounts of pasture in mid to late lactation on milksolids production. *Proceedings of the New Zealand Society of Animal Production* **56:** 242-244.

Roberts, A.H.C.; Thomson, N.A., 1984. Seasonal distribution of pasture production in New Zealand XVII. South Taranaki. *New Zealand Journal of Experimental Agriculture* **12:** 83-92.

Scott, J.D.J., 1978. Dairy Cattle. Increased stocking rates for higher milk production. *Proceedings of the Ruakura Farmers' Conference* **30:** Aglink Fpp161.