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The potential of industry by-products as supplementary feeds for dairy cows in the Hawkes Bay region.

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ABSTRACT

The potential of by-products from fruit and vegetable growers and processors to serve as supplementary feeds for dairy cows in the Hawkes Bay region, which traditionally experiences poor summer pasture growth, was assessed. A total of 75000 tonnes (wet matter) of by-products were produced by the six growers and processors surveyed, mainly between January and June. Peak by-product output occurred in April when an estimated 15000 tonnes of wet matter was produced. Industry disposal costs ranged from $10 to $33/tonne wet matter. The metabolisable energy values (MJ ME/kg DM) of by-products were at least equivalent to those of high quality spring pasture (e.g. carrot 11.3, apple pomace 13.7), but nitrogen levels (% in DM) were low compared to those recorded in pasture (e.g. corn 1.0%, apple pomace 1.9%). A linear programming analysis of a Hawkes Bay dairy farm indicated that farmers could afford to pay up to 15.5 cents/kg DM for additional feed from May to October and 26.7 cent/s kg DM during the remainder of the year if milkfat prices were $6/kg. These shadow values indicate the maximum price that could be paid for transport and feeding costs for by-products on the model farm.

Keywords: horticultural by-products, dairy cows, farm model, nutritive value.

INTRODUCTION

The flat topography and relatively fertile free-draining soils of central and eastern Hawkes Bay provide considerable potential for the expansion of dairying in this region. However, a common problem on seasonal supply dairy farms in this locality is the low availability of pasture for milking cows during the traditionally dry summer months of January and February (Radcliffe, 1975). To maintain cow energy intakes, supplementation with hay, silage, or maize (or other feeds) is necessary during this period in most years. Fruit and vegetable industry by-products generated by Hawkes Bay juice extraction, food processing and grading facilities are a potential source of supplementary feed for dairy cows. Offering these to dairy cows in late pregnancy, the first 10-15 weeks of lactation and at the end of lactation could be an economic method of increasing milk production and would assist horticultural industries in dealing with an increasing waste disposal problem (Sietje, G. 1992 pers. comm.). In addition, by-products may enable the "grass" flavour of milk to be reduced. This is particularly a problem in milk produced from pasture during the spring (Badings and Neeter, 1980) and is an impediment to the development of markets for some dairy products in South East Asia.

The feeding of plant residues, food processing by-products and animal wastes to animals provides a valuable source of protein and energy in many overseas countries (Bath, 1980). In contrast by-products have had limited use as livestock feeds in New Zealand due to adequate supplies of low cost pasture-based feeds and the small tonnages of suitable by-products available, at least until the relatively recent expansion of horticultural industries. The limited amount of local research that has been carried out to define the feeding value, methods of storage and practical mechanisms of feeding by-products to livestock has also contributed to the low usage of by-products by New Zealand livestock farmers. There has, however, been localised use of by-products from the dairy industry (e.g. whey) and the brewing industry (e.g. brewers grain) on dairy farms. This paper describes a preliminary investigation into the availability, nutritive value and potential role of industry by-products as feed supplements on Hawkes Bay dairy farms.

MATERIALS AND METHODS

The investigation into the potential use of by-products on dairy farms involved three stages. First, data describing the seasonality of fruit and vegetable by-product production, monthly tonnages produced, product characteristics and methods and costs of disposal were obtained through an interview survey of selected growers and processors in the Hawkes Bay. Large processing industries were targeted because these were expected to be the dominant producers of by-products.

Second, samples of by-products, some of which were collected during the survey, were analysed for their nutritive value. The analysis included *in vitro* digestibility (by the method of Roughan and Holland, 1978), cellulose, hemicellulose and lignin content, Kjeldhald nitrogen, fat per-

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cent and gross calorific value (Bramwell, 1992). Metabolisable energy content was estimated by multiplying the *in vitro* digestible organic matter in the dry matter (DOMD) by 16.3 (Geenty and Rattray, 1987).

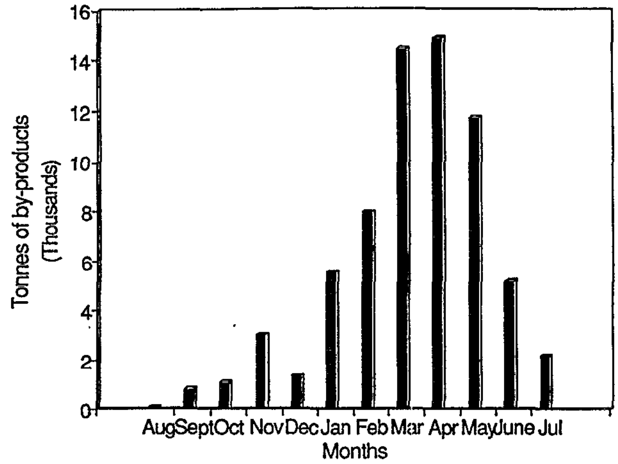
Third, a whole farm feed and financial budgeting analysis was undertaken to identify the pattern of pasture supply and demand on a representative central Hawkes Bay dairy farm, and estimate the cost of alternative supplementary feeds that could be used to overcome pasture deficits. A representative dairy farm was developed from milk production data supplied by the Tui Dairy Company and pasture growth rate data for central Hawkes Bay (Radcliffe, 1975). The farm was modelled on a spreadsheet feed budgeting programme and then in a linear programming (LP) format to identify the maximum price that could be paid for supplements in each month. The base farm of 79 ha milked 139 cows producing 162 kg milkfat/cow/season at a stocking rate (SR) of 1.76 cows/ha. Feed requirements for cows were derived by a dairy cow simulation model (Brookes *et al.*, 1992). Pasture surplus to herd requirements was made into silage and fed at 33% and 50%, respectively, of the daily herd requirements to overcome pasture deficits in summer-autumn and winter. Initially the LP model (Mendizabal, 1991) was constrained to a pasture and pasture/silage feeding system only. Later analyses allowed supplementary feeds to be selected from nitrogen-boosted pasture (10 kg DM : 1 kg N applied), pasture silage, maize silage (25 tonne DM/ha yield, $1753/ha) or barley meal ($269/tonne). The shadow prices for additional feed in each month provided an indication of whether by-products could be profitably introduced as an alternative feed supplement.

RESULTS AND DISCUSSION

Tonnages and seasonality of by-product production

A total of 75000 tonnes (wet matter) of by-products were produced by the growers and processors surveyed (Table 1). The majority (68500 tonnes) was produced by three large fruit and vegetable processors. Production of by-products occurred mainly between January and June with peak output occurring in April when an estimated 15000 tonnes of wet matter was generated (Fig. 1).

FIGURE 1: Seasonality and tonnages of by-products produced by a sample of Hawkes Bay fruit and vegetable growers and processors.



Fruit and vegetable canning by-products included peelings, poor quality produce, seeds, cores, stones, and corn cobs and their outer sheath. A private livestock food distributor is paid a fee to take vegetable wastes; the balance are disposed of at landfill dumps. Apple by-products (pomace, pips, bucher) are mainly disposed of at landfill dumps, but apple pomace has been used to supplement cattle especially during drought years. Fruit with defects is sold to juicing companies, consumers (through gate sales) or dumped at landfill sites.

The average disposal cost for by-products was $21.50/tonne wet matter (range $10 to $33/tonne) or around $0.5 m per annum for the surveyed group. Costs were mainly associated with cartage both because of the wet weight of the material and the need for watertight containers for transport. Disposal costs are expected to increase in the near future because seepage from by-products dumped at landfill sites is polluting water aquifers (Sietje, G., 1992 pers. comm.). More expensive methods of disposal, such as dehydration of by-products or large scale composting will be required to comply

TABLE 1: A summary of the types and tonnages (net weight) of produce and by-products and the main methods of disposal, by a sample of Hawkes Bay horticulture growers and processors.

Industry	Type of produce	Annual production (tonnes/y)	By-product disposed of (tonnes/y)	Methods of disposal
1.	Apple and kiwifruit	80,000	16,000	Sold to farmers for landfill
2.	Tomato, corn, apple, pear, peach, beetroot	83,546	25,240	Sold to private buyer
3.	Tomato, corn, apple, pear, beetroot, peach	–	27,260	Sold to private buyer
4.	Apple	11,100	2,775	Sold to juicing processors;
	Squash	15,000	3,000	squash to farmers
5.	Apples	3,600	407	Sold to juicing processors
6.	Apples	10,971	3,291	Juicing
	Kiwifruit	260	40	Juicing
	Stonefruit	250	63	40% gate sales, 60% dumped

with the Resource Management Act (New, 1991). Alternatively, the amounts of by-products fed to livestock could be substantially increased or new products could be developed from residue materials (e.g. apple pomace).

Nutritive value of by-products

The nutritive characteristics of the by-products assayed are shown in Table 2. All the by-products were low in nitrogen compared to spring and summer pasture, but the energy density was equal to or higher than that of spring pasture for all the products tested except kiwifruit. Sweet corn cobs, which were low in ash and high in fibre, contrasted with carrot peelings and tops which were low in fibre. The apple by-products were highly digestible and had an energy density of around 13.00 MJ ME/kg DM which is comparable to most of the meal concentrates fed to dairy cows (Holmes, and Wilson, 1987). The energy content of the apple by-products used in the current study were higher than those reported by researchers in the United States (Farrell et al., 1977; Table 3), but the kiwifruit nutritive parameters are similar to those reported by O'Reilly (1992). Whole kiwifruit has been fed to dairy cows at levels of up to 30 kg of fresh fruit per day (Simmonds, 1992).

The assay results confirm the potential of horticultural by-products to supplement the diet of dairy cows grazing pasture. However, they would need to be offered with other feeds to provide a palatable balanced livestock ration. For example, the by-products with high carbohydrate and low fibre would complement pasture during the during the summer-autumn when pasture is relatively high in protein but low in energy (Satter *et al.* 1992). The largest quantities of by-products are available at this time (Figure 1). However, some caution should be exercised when interpreting the *in vitro* digestibility assay results which are derived from *in vivo* pasture standards obtained from indoor feeding trials with sheep. The digestibility of by-products may be different if they were fed in combination with pasture, but ultimately this can only be determined by conducting *in vivo* feeding trials.

TABLE 2: Nutritive parameters of horticulture and vegetable by-products. Values for spring and summer dairy pastures are included for comparative purposes (Source : Holmes and Wilson, 1987).

	DMD[a] (%)	Cellulose (% DM)	N (% DM)	Ash (%)	Fat (% DM)	Energy (MJ ME/kg DM)
By-product:						
Carrot	95.7	9.90	1.22	7.7	1.96	11.34[b]
Corn	70.4	26.58	1.02	1.9	2.89	11.07
Apple pomace	74.4	14.90	1.94	2.1	9.93	13.72
Apple bucher	86.1	15.96	0.90	1.8	3.27	13.17
Apple pulp[c]	74.0	28.63	1.48	2.5	7.55	12.96
Kiwifruit pulp[c]	44.5	51.13	1.26	2.9	9.17	8.65
Kiwifruit slices	90.8	6.43	1.12	5.0	3.85	12.96
Corn silage	64.5	35.72	0.87	2.15	4.87	11.15
Pasture:						
Spring	79.0	16.0	4.2	9.9	-	11.8
Summer	62.0	26.0	3.8	9.9	-	9.9

[a] Dry matter digestibility.

[b] Metabolisable energy = (Gross energy value x DOMD x 0.82).

[c] Sourced from the Bay of Plenty.

TABLE 3: Summary of the nutritive value of by-products fruit and vegetable processing industries as reported by other authors. Figures are percentages, except for energy which is estimated MJ ME/kg DM.

Sample	DM[c]	CP	CF	ADF	Fat	Energy (ME)
Apple pressings[d]	89.0	4.7	23.1		3.7	
Apple pomace	69.9	6.1				
Apple pulp[a]	25.0	6.0	18.4			8.4
Apple pulp[bd]	89.0	3.3	22.0	41.0		9.5
Grape pulp[a]	91.0	12.7	30.0	54.0		4.8
Winery pomace[d]	93.5	11.2				7.3
Grape pressings[c]	80.5	14.2	21.2		6.0	
Citrus pulp	83.0-96.5	6.0-9.6	6.4-16.8	23-25.5		9.6- 11.9
Kiwifruit silage	16.2	10.6	25.7	76.0		
Potato offal[d]	94.0	11.7	24.8			
Raw potato	20.7	10.4	2.4			11.12

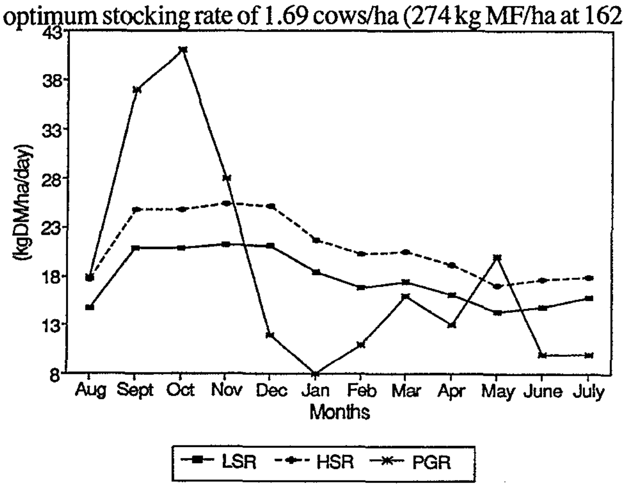
[a] Lowe 1984, [b] Farrel et al. 1977, [c] Boda 1990, [d] dried.

[c]DM = Dry matter, CP = Crude protein, CF = Crude fibre, ADF = Acid detergent fibre, ME = Metabolisable energy (MJ/kg DM).

Feed and financial budget analysis

The relationships between pasture growth and dairy livestock requirements for the representative farm at two stocking rates are presented in Figure 2. This shows a large deficit in pasture supply during the summer months and a surplus of pasture in September and October.

FIGURE 2: Feed demand (low stocking rate = LSR = 1.76 cows/ha; high stocking rate = HSR = 2.09 cows/ha) versus feed supply (pasture growth rate = PGR) on a simulated Hawkes Bay dairy farm.



The LP model for a dairy farm system based on pasture and pasture silage as the only sources of feed indicated an optimum stocking rate of 1.69 cows/ha (274 kg MF/ha at 162 kg MF/cow). This compares favourably with the average stocking rate of 1.76 cows/ha for Tui Milk Company suppliers in the study region during the 1991/2 season (Watters, A., 1992 pers. comm.). A total of 521 kg silage DM/ha would be made in October and this could be most profitably utilised by the herd during June and July. The maximum prices that could be paid for additional feed were 11.3 cents/kg DM from August to November and 25.6 cents/kg DM during the remainder of the year.

If the model constraints on the use of nitrogen, maize, silage and meal were removed the optimum stocking rate increased to 2.15 cows/ha (344 kg MF/ha). This was achieved by increasing the feed supply through the application of an equivalent of 25 kg N over the entire farm in July and establishing 9.6% of the farm area in maize during October. Planting maize precluded the harvest of pasture silage by reducing the farm grazing area at a time when surplus pasture is normally accumulating. The maximum prices that could be paid for additional supplements in this dairying system were 15.5 cents/kg DM from May to October and 26.7 cents/kg DM during the remainder of the year.

The cost of nitrogen-boosted pasture is around 10 cents/kg DM for urea at $450 tonne applied at a 10:1 response (kg DM/kg N applied), and barley meal at $269 per tonne costs 30c/kg DM if the DM content of the meal is 88%. Thus, a dairy farmer could profitably apply nitrogen to increase feed supplies during the spring months but milkfat prices would need to increase to around $6.50/kg before barley feeding was profitable. These supplementary feed costs can be compared to the estimated average disposal cost of by-products of $21.50/tonne of wet matter, which equates to a cost of 10.7 c/kg DM for a product with a 20% DM content. The horticultural industries would be no worse off if the disposal cost was paid directly to farmers, or a feed merchant. Providing transport and feeding costs for the farmer were less than the shadow prices identified for additional feed and, depending on the nutritive value of the by-product, it would be profitable for farmers in the Hawkes Bay to utilise residual products from the horticultural industry as dairy cow cow supplements. By-products could be transported to farms 100 km from their source (i.e. to include all the dairy farms in the Central Hawkes Bay and Tauraua districts) for about $40/tonne in 1992. If the industry paid $20/tonne of the transport cost and the DM content of apple pomace was 20%, the on-farm cost for a high quality feed would be 10 c/kg DM. In the medium-term the industry transport payment would be eliminated as demand for the livestock feed increased.

CONCLUSION

It can be concluded from this preliminary investigation that horticultural by-products are available in significant tonnages, and at an acceptable cost, to supplement the pasture supply on Hawkes Bay dairy farms. The nutritive parameters of the by-products tested indicate that they could help to balance the nutrients in complement the daily intake of fresh pasture by cows. Further research on by-products is now required to establish methods for feeding these materials to lactating dairy cows on a mainly pasture diet and to improve the storage life of by-products so that they can be used at times when fresh material is not available.

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