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FACIAL ECZEMA — PROBLEMS AND SUCCESSES IN CONTROL

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ABSTRACT

Facial eczema is the most Important mycotoxin affecting New Zealand livestock. It is a particular problem in the lower lying warmer and moister areas of the northern North Island where conditions are favourable to rapid fungal growth and sporulation during autumn. In severe years animal deaths and depressed production can lead to losses exceeding $60 million, average losses are estimated to exceed $20 million anually. Production losses. especially despressions in ewe fertility, can occur in the absence of clinical symptoms so most farmers grossly underestimate the financial losses Inflicted by this disease. Research has led to a number of control methods including the identification and avoidance of toxic pastures, fungicides, zinc dosing and selection for more resistant stock. However these are not widely accepted by the farming industry because of costs, high labour requirements and a disinclination to disturb normal management practices.

Keywords: facial eczema, control, production losses, resistance, zinc, fungicides.

Facial eczema (FE) is without doubt the single most important pasture associated toxin our livestock are exposed to. It is a particular problem in the lower lying areas of the northern North Island, where autumn brings the warm moist conditions necessary for the rapid growth of the fungus *Pithomyces chartarum* which produces the toxin sporidesmin which, in turn causes the tissue damage leading to the clinical symptoms known as facial eczema. The occurrence and severity of facial eczema outbreaks is dependent on weather conditions, as they affect both fungal growth and feed supplies, and thus varies from year to year.

TABLE 1: National cost of facial eczema in 1981.

		NZ$[1]	NZ$
Sheep	Deaths and condemned	18.6m	
	Weight loss	10.7m	
	Wool loss	24.3m	
	Reproduction	3.2m	35.0m
Beef	Deaths and condemned	0.7m	0.7m
Dairy	Deaths and culls	24.3m	
	Milk production	3 2m	
	Less value culls	-10.4m	17.1m
Deer	Not available		
Total loss			$52.8m
	Control measures	4.6m	
	Research	1.0m	5.6m
Total national cost of FE			$58 4m

'1981 $'s.

INDUSTRY COSTS

In severe years costs are high and Table 1 shows estimated losses incurred in the widespread and severe outbreak of 1981, with average annual losses estimated at about $20-25 million. However many of the losses inflicted by subclinical facial eczema have until recently gone undetected. For example a common feature of trial work with lactating dairy cows has been an immediate drop in milk yield following dosing with sporidesmin. This occurs before any clinical symptoms appear and is evident even if the dose of sporidesmin is too small to cause any subsequent detectable liver damage. This suggests that grazing pastures with spore counts currently considered safe, in that they cause no detectable liver damage and certainly no clinical cases, may well cause significant but transient depressions in milk yield.

Analysis of several nutrition and reproduction trials affected by facial eczema has clearly shown subclinical facial eczema during the breeding season depresses ewe fertility, reducing the number of ewes cycling, the length of the breeding season and the number of multiple ovulations. Table 2 shows data from one such trial in which ewes from a flock with poor reproductive performance in an FE-prone area were protected by weekly Zn drenching or left untreated. Gamma-glutamyltransferase (GGT) levels were measured in blood samples collected from the ewes to identify those suffering liver damage. Mating results were assessed with an ultrasonic scanner in June.

TABLE 2: Effects of FE-induced liver damage on ewe reproductive performance (Jagush, Towers, Maclean and Grey, unpub.)

Liver damage	% Barren	% Single	% Twins	Group size'
Nil	11	52	36	149
Minor	6	56	39	53
Moderate	23	45	31	31
Severe	39	45	16	38

'Number of ewes in each category.

When the animals are grouped on the basis of their GGT levels (Table 2), a very large increase in the percentage of barren ewes and a decrease in multiple pregnancies as the amount of liver damage increases is apparent. Although Zn dosing gave only partial protection against FE reducing the number of animals suffering liver damage by 63%, it increased potential lambing rate by 7% and reduced the number of barren ewes by about 40% (Table 3). The data suggests that complete protection would have increased potential lambing rate by 12% and halved the number of barren ewes,

In assessing the impact of these findings to the industry it should be noted that despite the fact that almost 50% of the ewes suffered liver damage less than 3% displayed any clinical symptoms. In the absence of reliable survey data on the incidence of subclinical facial eczema in the national flock we can only guess at the lambing losses suffered by the industry from this cause. Certainly where any clinical cases are seen we can be sure that subsequent lambing percentages will be measurably lower.

TABLE 3: Effects of prophylactic zinc oxide dosing on the reproductive performances of ewes exposed to facial eczema (Jagusch, Towers, MacLean and Grey, unpub.).

Treatment	% Subclinical'	Foetus/ewe	% Barren
Zn dosed	17	1.21	11.6
Nil	46	1.14	17.0

'Serum GGT levels elevated above the normal range

J. Squire (unpub.) has collated the information on production losses due to facial eczema in sheep flocks i.e. animal deaths, lowered fertility, lowered liveweights, lowered wool weights, increased replacement costs etc, and calculated that in even quite minor outbreaks where few if any clinical cases are seen and no stock losses are recorded, gross margins per stock unit will be depressed by 2-10%. This being the case even hard pressed sheep farmers can profitably afford to spend more on protection than is current practice.

TABLE 4: Facial eczema control methods.

Toxic pasture avoidance
- confine, feed supplements
- selective grazing FE-free slopes etc
  - spore counting
  - crops

Fungicides
- selective spraying
- blanket spraying

Zinc salts
- drenching
- water supply treatments
- pasture spraying

Breeding
- selection for genetic resistance

CONTROL MEASURES

A number of control practices are available (Table 4). The earliest methods were based on the avoidance of toxic pastures initially by confining the animals and feeding supplements during weather conditions associated with danger, and later, particularly in hill country, by preferentially grazing exposed, dryer, or cooler slopes where the microclimate is less favourable to fungal growth. These basically "hit or miss" procedures were immeasurably improved with the introduction of spore counting techniques and have been successful in reducing the impact of FE outbreaks, especially where adequate subdivision allow the stock to be restricted to the safer areas.

The spore counts considered dangerous were originally set to avoid clinical cases and later reduced to a level designed to avoid most visible liver damage. But grazing spore counts lower than the current danger level of 100 000 on a wash count is not necessarily always safe. The farming community has reported facial eczema outbreaks in animals grazing reputedly safe pasture. This question has recently been examined at Ruakura (E. Manns, unpub.) by grazing five groups of lambs on pastures with wash counts always less than 90 000 throughout the 1985 autumn. Despite grazing relatively low spore counts, liver damage was detected in the most susceptible animals whenever the cumulative sum of the daily spore counts exceeded about 200 000 over 7 days. While only minor liver damage was detected, if the aim is to avoid all liver damage then the spore count considered dangerous must be further reduced.

But spore count is only one of the factors determining toxin intake. Dry matter intakes and the toxin content of the spores are also important.

Toxin intake	= spore count	× DM intake	× spore toxin content
(mg/day)	(1000's/kg)	(kg/day)	(mg/1000)

This simple equation is complicated by the fact that spore counts vary both from site to site and throughout the pasture profile, while the toxin content of spores dinishes with age.

Attempts to reduce spore numbers sufficiently to avoid facial eczema by altering pasture management have generally not been effective when applied to prime flat lands, but in hill country with a greater diversity of aspect and of microclimate there are opportunities to alter toxin intake by appropriate management practices. As part of a study on the management of hill country pastures at Whatawhata Hill Country Research Station, data has been collected on spore counts and occurrence of FE that gives a risk rating to various management, aspect and pasture parameter (Table 5), confirming many of the observations on which current advice is based.

Thus animals heavily grazing short leafy well controlled ryegrass or ryegrass/white clover dominant pastures that may have been burnt off over the summer are at greatest risk especially if on north facing slopes. Sheep lightly stocked on southerly slopes grazing uncontrolled rank dead rubbish are at least risk. Clearly there is on occasion conflict between management practices maximising pasture and animal production and those that minimise risk of FE.

High spore counts do not necessarily indicate toxic pasture. From the time the spore is formed the toxin content begins to drop as it is leached from the spore and destroyed on exposure to light and moisture. But how quickly? If spore counts rise and stay high for days or weeks is the pasture safe or toxic?

TABLE 5: Facial eczema risk factors in hill country management (G. Sheath, pers. comm)

Pasture management	Controlled/short	High
	Uncontrolled/rank	LOW
Grazing pressure	Heavy	High
	Light	LOW
Aspect	Steep northerly slopes	High
	Easy	Moderate
	Steep southerly slopes	LOW
Pasture type	Ryegrass dominant	High
	Weeds/white clover	Moderate
	Other grasses	LOW
	Standing dead	LOW

Although we have been able to demonstrate that spore numbers are a good indicator of toxin level as the count rises to a peak, and that toxin content of the pasture falls more rapidly than does the spore count once the peak is passed, present analytical techniques are not sensitive enough to allow a full examination of this important question. Developments which are currently reopening the possibility of developing a vaccine against FE, may have as a spinoff an ELISA analytical technique sensitive enough to allow the measurement of toxin levels in grass samples. This will allow us to examine how the relationship between spore numbers and toxicity changes with time.

Fungicides

The discovery that the benzimidazole anthelmintics, which also have a fungicidal action, would reduce *Pithomyces* growth and thus spore numbers was a major advance in FE control. Correctly used fungicides provide effective control of the disease and remain the most appropriate method where severe facial eczema occurs regularly and where high value stock such as deer are farmed. In recent years fungicides have lost favour because of a relatively high cost particularly in relation to zinc dosing, purported breakdowns in effectiveness, and most importantly, the difficulty in incorporating the use of fungicides into routine farm management practices. Unless blanket spraying of the whole farm is undertaken there is always the problem of deciding when the sprayed pasture should be grazed, whether further areas should be sprayed and when to start grazing unsprayed areas again. Successful use of fungicides requires careful attention to spraying techniques and an understanding of what fungicides can achieve. Most purported breakdowns in effectiveness arise from poor spraying technique, or undue expectations of the reductions in spore numbers that can be achieved when conditions are particularly favourable to fungal growth and sporulation.

Zinc prophylaxis

More recently recommendations for zinc dosing to reduce FE have been published (Table 6). Zinc dosing rarely gives complete protection but can be expected to reduce the incidence and severity of FE by about 50 to 90 percent depending on the dosing strategy, administration method and interval between doses employed.

Zinc dosing can be readily incorporated into the dairy industry either by oral drenching or water supply treatments. On many farms both the farmer and the herd are well schooled in daily drenching for bloat and hypomagnesaemia control — ZnO dosing is just an extension to this routine. Alternatively introducing $ZnSO_4$ into the water supply has proved a very effective control method. Data from the most recent trial conducted at Ruakura (B. Smith, pers. comm.) is summarised in Table 7. Three groups of 10 lactating cows grazed toxic pastures during the autumn of 1985, two of the groups only had access to water containing $ZnSO_4$, the third to untreated water only. As in earlier trials, introducing $ZnSO_4$ into the water supply gave exceptionally good protection against FE.

TABLE 6: Zinc prophylaxis procedures.

Dosing strategy	—	short term "crisis" dosing
	—	long term routine dosing
Dosing method	—	oral drenching
	—	pasture spraying
	—	water supply treatments
	—	flank painting
Dosing interval	—	daily
	—	twice weekly
	—	weekly
	—	fortnighly

TABLE 7: Protection of lactating cows against facial eczema with $ZnSO_4$ treated water (B Smith, pers. comm.).

Treatment	Mean GGT[1] (IU/l)	Number clinical[2]	Milk yield[3] (kg/cow/week)
Control	899	5	46
Zn-CDD[4]	31	0	76
Zn CC[5]	122	0	75

[1]Normal range 10-30 IU/l at 25°.
[2]Ten cows per group.
[3]Yield during week cows first became clinical, pre trial mean 74 kg/cow/week.
[4]Constant daily dose — fixed weight $ZnSO_4$ added to water supply each day, trough concentration varies
[5]Constant concentration — variable weight $ZnSO_4$ added to water supply each day to keep trough concentration constant

The initial recommendations for daily zinc dosing were clearly impracticable for the sheep industry. Recent research has therefore concentrated on extending the period between individual zinc doses. Final recommendations are not yet available, but current results suggest that so long as routine dosing begins before the FE season, then dosing at fortnightly intervals will give reasonable protection.

This obviously still requires a large labour input so alternatives such as subcutaneous depot injections or slow release rumen boluses are under investigation in conjection with commercial interests — unfortunately without great success to date. These technologies are best suited to releasing milligrams of material daily whereas we are trying to stretch them to provide gram amounts per day and this may not be possible.

Selection for resistance

The most recent success in FE control has been the development of programmes breeding sheep with increased resistance to the disease. Ram selection is based on a performance test in which potential flock sires are challenged with small amounts of the toxin either by grazing dangerous pastures or by dosing with sporidesmin. Rams which show no rise in blood GGT levels — and thus have suffered no liver damage are deemed resistant and used as flock sires. Although even a single generation of breeding for FE resistance can markedly reduce the sensitivity to sporidesmin (Table 8) breeding for resistance is still a long term programme. Initial estimates of the likely rate of gain suggest that it will take six generations (18 years) to halve the incidence and severity of liver damage observed in a bad outbreak of FE.

TABLE 8: Incidence of liver damage in selected and unselected Romney sheep following sporidesmin intoxication.

	Percent damaged livers	
	Dose 1[1]	Dose 2[1]
Control	74	100
Fe-resistant[2]	36	73

[1]All animals initially dosed with 0.14 mg sporidesmin/kg LWT, those animals not reacting were then redosed with 0.26 mg/kg.
*Sired by performance tested rams and from ewes sired by performance tested rams.

Published protocols for performance tests using field challenges have been successfully followed by a number of groups for several years. But being dependent on the development of naturally toxic pasture, field challenge performance tests require very careful forward planning to take advantage of suitable conditions whenever they arise and a high labour input to monitor daily spore counts to ensure the rams are not overdosed. Obviously relying on toxic pasture restricts field challenge performance testing to ram breeders in FE prone areas and means that if in some years toxic conditions do not arise, then no selection can be made.

The entry into the market of a commercial company providing a performance testing service based on sporidesmin dosing overcomes these restrictions and, although more expensive than field challenging, will greatly enhance the adoption of selection for resistance by the breeding industry. New Zealand sheep farmers in adopting resistance breeding schemes appear to have scored a world first. Poultry breeders have for many years incorporated resistance to disease in their selection programmes, but despite a lot of research on disease resistance in large animals similar programmes have not reached the stage of commercial adoption.

However this selection programme, based as it is on a toxic challenge to the animals, is not ideal as it puts valuable breeding stock at risk. Thus a considerable research effort is aimed at providing as a “marker” for resistance some easily measured blood or tissue parameter. Several possibilites have been suggested, tested and abandoned over the years. Currently one such test showing some promise is in the early stages of evaluation but it will be some years before it is known whether it is better and cheaper than performance testing.

Future developments

With the exception of the possible development of a vacine future control strategies will be largely improvements of current methods. Although some other metals can provide protection in the same manner as zinc those potentially more effective are highly toxic. Iron salts provide protection (R. Munday, unpub.) but at higher dose rates than needed for zinc, so while it is unlikely that iron salts will substitute for zinc the two metals together may prove more effective than zinc alone. More practical dosing methods and regimes including subcutaneous injections or slow release boluses may also be developed.

Developing vaccines to protect against a highly active, non-protein toxin such as sporidesmin is not an easy task and an earlier attempt only increased the severity of the FE suffered by vaccinated animals. However the possibility of developing a vaccine is being reassessed as the result of the development of new ways of couplingsporidesmin to the large molecules that elicit the immunological response (R. Gallagher, pers. comm.). Antibodies raised against these new antigens might bind and inactivate sporidesmin before it reaches its target sites preventing any subsequent tissue damage and providing protection for a FE season or even for a lifetime.

Development of such a simple protection method as a vaccine would represent a turning point in FE control as despite the considerable progress made in providing methods for control, facial eczema remains a problem. The sporadic occurrence and insidious nature of the associated production losses ensures that most farmers are unaware of the true cost of FE, and are therefore reluctant to pay for its control, or unwilling to adopt any procedure that disrupts their routine management.