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Ill-thrift in young growing cattle and sheep

A.J. LITHERLAND, D.L. LAYTON, C.J. BOOM¹, T. L. KNIGHT², M. HYSLOP²,
M.G. LAMBERT, AND T.L. COOK³

AgResearch Limited, Grasslands Research Centre, Private Bag 11008, Palmerston North, New Zealand.

ABSTRACT

Live weight gain (LWG) of groups of lambs and bulls was predicted from the quantity and quality of grazed pastures using the Q-Graze model. This was compared with actual LWG and ill-thrift was diagnosed where there was substantial negative divergence. Tagged lambs (n=50) or bulls (n=20) were monitored, on 22 farms, monthly between January to May in 2002 and/or 2003. Pastures were visually assessed by farmers at each shift. Stock were weighed monthly and blood, urine, faecal and pasture samples were collected. The average mob LWG of healthy young bulls in autumn was 0.84 kg/d (actual-predicted = +0.33 kg/d) and 0.39 kg/d (actual-predicted = -0.4 kg/d) for ill-thrift mobs (P<0.01). There was a 36% incidence rate of ill-thrift in cattle, 50% of which was undiagnosed, 30% was associated with parasites (0.29 kg/d, actual-predicted = -0.7 kg/d) and 20% associated with high *Fusarium* fungus toxicity (0.64 kg/d, actual-predicted = -0.2 kg/d). The average growth rate of healthy and ill-thrift ewe lambs was 142 g/d (actual-predicted = +33 g/d) and 46 g/d (actual-predicted 64 g/d) respectively (P<0.01). There was a 62% incidence rate of ill-thrift in lambs, 36% of which was undiagnosed, 45% was associated with parasitism (38 g/d, actual-predicted = -67 g/d) and 19% was associated with high *Fusarium* fungus toxicity (48 g/d, actual-predicted -45 g/d). Animals growing slower than Q-Graze predicted are likely to have ill-thrift.

Keywords: sheep; cattle; live weight-gain; ill-thrift; parasites; ergovaline; fungi.

INTRODUCTION

Stock grazing summer and autumn pastures have long been known to grow slower than farmers expect and are said to suffer from "ill-thrift" (Scott *et al.*, 1976). When ill-thrift existed it had been difficult to separate the effect of pasture quality from that of animal health or other animal factors. The effects of pasture quality and quantity on LWG can be predicted using a computer programme called Q-Graze (Woodward *et al.*, 2000). When actual LWG is less than predicted for given pasture conditions, diagnostic protocols need to be developed to account for the LWG suppression.

Animal health issues likely to suppress LWG include viral pneumonia, gastrointestinal parasitism, effects of fungal toxins and trace element deficiencies. The trace elements commonly implicated are selenium in sheep and cattle, cobalt (vitamin B₁₂) in sheep and copper in cattle (Grace, 1983). Clinical parasitism has symptoms of scouring and elevated faecal egg counts and high blood pepsinogen levels in cattle. Sub-clinical parasitism can result from animals consuming large numbers of L3 larvae to which they mount an immune response leading to LWG lower than expected (Van Houtert & Sykes, 1996).

There are a number of species of fungi that grow on pasture and produce toxins that reduce LWG. These include the facial eczema (FE) toxin sporidesmin, associated with the spores of the saprophytic fungus *Pithomyces chartarum*, which causes liver damage and photo-sensitivity symptoms and eventual liveweight loss

and even death (Smith, 2000). Ergot alkaloids, toxins produced by the endophytic fungus *Neotyphodium lolii*, reduce LWG by causing heat stress and intake suppression (Woodfield & Matthew, 1999; Layton *et al.*, 2004). Type B trichothecenes mycotoxins such as nivalenol (NIV) and deoxynivalenol [vomitoxin] (DON), are produced by saprophytic *Fusarium* fungi (D'Mello *et al.*, 1999). There is no evidence that trichothecenes affect ruminant LWG at the concentrations found in New Zealand pastures.

The objective of this Meat and Wool NZ funded experiment, was to determine, given the pastures offered, if Q-Graze could be used to identify when groups of young stock were growing more slowly than predicted. Then to account for this LWG suppression using diagnostic protocols (a combination of commercial and experimental tests).

MATERIALS AND METHODS

Twenty two sheep and beef farms with chronic ill-thrift problems were selected under veterinary advice, from the Waikato (n=7), southern North Island (SNI) (n=6) (Manawatu, Tararua and Gisborne), and Canterbury regions (n=8). Three mobs of 18-month and 4 mobs of 6-month bulls, and 18 mobs of 6-month old ewe lamb replacements were monitored in total. Stock were monitored in 2002 or 2003 with four of the farms being monitored in both years. On each farm individually tagged lambs (n=50) or bulls (n=20, all located in the Waikato) were monitored 3 to 5 times at

¹ AgResearch Ltd, Ruakura Research Centre, Hamilton, New Zealand

² AgResearch Ltd, Lincoln Research Centre, Christchurch, New Zealand

³ Manawatu Veterinary Services Ltd., Feilding, New Zealand

approximate monthly periods between January to May. Stock were weighed (totalling 30 and 68 monthly weighings for bulls and lambs respectively). Blood samples were collected from an identified subset (n=12 per mob) of the monitored animals by venipuncture and analysed (AOAC methods, Alpha Scientific) for whole blood selenium, vitamin B₁₂ (sheep only) and gamma glutamyl transferase (GGT, resulting from liver damage due to facial eczema (FE)). In 2003, blood pepsinogen level in cattle were also measured. Faecal samples (n=12 per mob) were collected for faecal egg and FE spores counts. Urine was collected from sheep using the occlusion technique, for analysis of lysergol:creatinine ratio. Lysergols are the metabolites of ergot alkaloids and were measured in the urine of animals by an ELISA (Layton *et al.*, 2004). After samples were collected farmers administered animal health remedies according to their normal farm practise.

Pastures were visually assessed by farmers at each paddock shift for pre- and post-grazing pasture mass (kg DM/ha), and pasture components (dead:green, clover:grass and leaf:stem ratios). At monthly intervals pasture representative of the next two weeks grazing was plucked every 2 steps (minimum of 300 plucks) to ground level using a sharpened teaspoon. Samples were not taken adjacent to large faecal pats or on stock camp areas. A sub-sample was dissected into dead matter, green clover plus herbs, green grass leaf, and green grass flowering stem plus low-quality weeds to provide a guide to the farmers for their eye assessments. The pasture components were dried for a minimum of 12 hours (60 °C, forced-air oven) and weighed to determine pasture DM composition. In 2003 on cattle pastures, the metabolisable energy (ME) content (MJME/kgDM) was predicted using NIR (FeedTech, Palmerston North). The DON, NIV and lysergol concentration of a sub-sample of herbage were determined by an ELISA assay. In the North Island a further sub-sample was analysed for FE spores. The final sub-sample (average weight 320g fresh weight) was analysed for parasitic nematode L3 content.

The methodology used to estimate L3 larvae had an extraction efficiency following seeding with known numbers of L3 larvae of 44%.

Diagnosis of ill-thrift

For each measured ill-thrift factor a trigger level was set at which mob LWG might be expected to be suppressed (Table 1). For a group to be considered to be under challenge from parasites it had either a high faecal egg count (FEC) and/or consumed pasture with high levels of L3 larvae. Cattle were categorised as being “ill-thrifty” when as a group they grew slower than Q-Graze predicted and lambs more than 30% slower than Q-Graze predicted otherwise they were considered “healthy”

Statistical analysis

Multiple regression models associating mean mob act-pred LWG and mob average ill-thrift factors were fitted using the all-possible-subsets regression facilities provided by the RESEARCH procedure (Genstat, 2002). Effect of ill-thrift status, year and region were analysed using the general linear model (SAS, 1990).

RESULTS

Blood trace element concentrations were not associated with LWG suppression, so results are not included in this paper. In both years, liver FE damage (average GGT 41 iu/L, range 9 to 281) was too low to suppress LWG in young growing stock. Lysergol levels were high enough in pasture and urine (lysergol:creatinine ratio mean 2.2, range 0.2 to 8.4) to potentially cause ill-thrift on 30% of occasions (Layton *et al.*, 2004), equally distributed in both North and South Island, but LWG was not reliably reduced so it was excluded from the diagnosis of ill-thrift.

TABLE 1: Estimated levels of potential ill-thrift factors above which live weight gain is expected to be suppressed in young growing lambs and bulls.

Ill-thrift measure	Species	Trigger level
Pasture L3 larval	Young bulls, lambs	500 epg/kgDM
Faecal egg count	Young bulls	300 epg
Facial eczema	Lambs	500 epg
	Young bulls	GGT = 400 IU/L
Trichothecenes	Lambs	GGT = 200 IU/L
	Young bulls, lambs	0.8 ppm ¹
Pasture ergot alkaloids (lysergol ring)	Young bulls, lambs	0.5 mg/kgDM
	Lambs	2.5 ¹ lysergol:creatinine

¹ The levels quoted here are suggestive and should be treated with caution until further research can validate the level. Successful diagnosis was deemed to have occurred either when animals grew slower than Q-Graze predicted and designated trigger levels were exceeded or when no ill-thrift occurred and all ill-thrift factors were less than their trigger levels. When an ill-thrifty mob was matched with an ill-thrift factor then the difference between actual and predicted LWG (act-pred) was used to assess the magnitude of the ill-thrift effect.

TABLE 2: Mean ± SEM and actual-predicted live weight gain and percentage of cattle categorised according to ill-thrift trigger level and growing either faster (healthy) or slower (ill-thrift) than Q-Graze predicted. Figures in bold represent successful diagnosis.

Ill-thrift factors above trigger levels	%	Healthy		%	Ill-thrift	
		Live weight gain (kg/d)			Live weight gain (kg/d)	
		Mean	Act-pred	Mean	Act-pred	
2002						
None above trigger	42	0.81±0.11	0.26±0.09	8	0.41	-0.08
Parasites	33	0.69±0.08	0.35±0.09			
Fusarium				17	0.65±0.18	-0.23±0.11
2003						
None above trigger	55	0.87±0.12	0.36±0.05	22	0.21±0.13	-0.47±0.11
Parasites				17	0.29±0.11	-0.71±0.23
Fusarium	6	0.08	0.08			

Cattle

Q-Graze predicted LWG accounted for 73% (P<0.001) of the variation in the actual LWG of mobs of bulls with no ill-thrift factors above trigger level but LWG was consistently under-estimated. In 2002 and 2003 the average mob LWG of healthy young bulls was 0.75 kg/d (act-pred +0.30 kg/d) and 0.87 (act-pred +0.36 kg/d) respectively. The underestimation of LWG by Q-Graze in 2003 was not associated with the estimation of ME by Q-Graze. When measured in 2003, the average difference between Q-Graze predicted metabolisable energy (ME) on cattle pastures and ME measured using NIR technology was only 0.01 MJME/kg DM. Ill-thrift mobs of bulls grew at 0.57 kg/d (healthy vs ill-thrift bulls, P>0.20), act-pred -0.18,(P<0.01) and .24 (P<0.01), act-pred -0.57. kg/d, (P<0.0001) in 2002 and 2003 respectively. The incidence of ill-thrift was 33% in 2002 and 39% in 2003.

Successful diagnosis occurred 73% of the time (Table 2). Fifty percent of ill-thrift was unidentified, 30% was associated with parasitism (0.29 kg/d, act-pred -0.7 kg/d) and 20% was associated with high *Fusarium* fungus toxicity (0.65 kg/d, act-pred -0.23 kg/d).

Over both years, when FEC and/or L3 pasture contamination were above the specified trigger levels ill-thrift only occurred 42% of the time. Eighteen month old cattle always had FEC of less than 50 epg. On three occasions 18 month cattle were grazing pastures between 800 and 2000 L3 larvae (50% *Cooperia*) per kg DM and on two of these occasions the bulls suffered ill thrift (act-pred -0.8 and -1.0 kg/d). In the 6 month cattle ill thrift only occurred when both FEC and L3 contamination of the pastures were above trigger levels. On 3 occasions young bulls had high FEC but no apparent LWG suppression. In 2003 when serum pepsinogen was measured levels did not exceed trigger levels of greater than 2.9 mM/L normally considered to be indicative of parasitism. However there was a negative relationship between act-pred LWG and pepsinogen (r = -0.4, P<0.05) and L3 contamination of pasture (r = -0.54, P<0.01).

Sheep

Predicted LWG explained 63% (P<0.001) of the variation in actual LWG of healthy sheep. Over two years sheep mobs exceeding the parasite trigger levels manifest ill-thrift 73% of the time (Table 3). FEC was a more important indicator than L3 larval contamination. Sixty three percent of parasite ill-thrift cases had been grazing pastures with low L3 pasture larval counts but had FEC above trigger level. A further 31% had high FEC and were also grazing high L3 pastures and only 15% had low FEC but had been grazing high L3 pastures. However there were 3 occasions when despite high FEC, and 2 occasions when despite high L3 pasture levels, lambs continued to grow with no signs of ill-thrift.

Canterbury: In 2002 and 2003 the average growth rates of healthy ewe lambs were 212 g/d (act-pred 78 g/d) and 147 g/d (act-pred 40 g/d). Lambs with ill-thrift grew slower (P<0.0001) at 85 (act-pred -53 g/d) and 56 g/d (act-pred -77 g/d) in 2002 and 2003 respectively.

Ill-thrift was present in lambs 67% and 52% of the time in 2002 and 2003 respectively. In 2002, parasites accounted for 63% of the incidence of ill-thrift (83 g/d, act-pred -63 g/d), 9% with high *Fusarium* fungi activity (115 g/d, act-pred -39 g/d) and 25% of the cases remained unidentified. In 2003, 23% of cases of ill-thrift were associated with parasites (74 g/d, act-pred -51 g/d) and the remaining 77% of cases could not be identified. The level of ill-thrift factors FEC, L3 contamination, NIV and DON levels were not significantly related to level of act-pred LWG.

North Island: Healthy lambs grazing permanent summer/autumn pastures in the North Island grew at 102 (act-pred 17 g/d) and 113 g/d (act-pred 6 g/d) in 2002 and 2003 respectively. Ill-thrift lambs grew slower (P<0.0001) at only 40 (act-pred -53 g/d) and 0 g/d (act-pred -69 g/d) in 2002 and 2003 respectively. The incidence of ill-thrift was very high at 67% in both years. "Correct" diagnosis of ill-thrift occurred in 80% and 100% in 2002 and 2003 respectively.

In 2002, 21% of the causes of ill-thrift were unexplained; 50% were associated with parasitism (32 g/d (act-pred -58 g/d) and 29% with high *Fusarium* fungi (49 g/d, act-pred -49 g/d). In 2003, ill-thrift causes were equally divided between parasites (-55 g/d, act-pred -113 g/d) and high *Fusarium* fungi activity (27 g/d, act-pred -42 g/d).

There were no significant relationships between level of act-pred LWG and the level of ill-thrift factors for North Island lambs.

DISCUSSION

In this study, Q-Graze conservatively predicted LWG of healthy Waikato cattle and Canterbury lambs. Under-estimation of cattle LWG was not associated with the under-estimation of herbage ME. Rather it could have been due to the under-estimation of intake or energy requirements.

In healthy stock, Q-Graze accounted for a pleasing proportion (73% and 63%) of the variation in cattle and lamb summer/autumn LWG, given that the prediction was done on-farm, over a month by 18 different farmers. Q-Graze proved to be effective in identifying mobs of cattle and lambs growing slower than expected for the pasture conditions. For these slow growing lambs and bulls diagnostic tests revealed a possible animal health issue on 64 and 50% of occasions respectively. The incidence of unexplained ill-thrift remains high either due to inadequate sampling procedures and interpretations, inappropriate trigger levels or unidentified ill-thrift factors. An unidentified ill-thrift factor associated with the wide-spread and unexplained ill-thrift in lambs in Canterbury in 2003 seems likely. On individual farms there were periods of good performance followed by periods of ill-thrift. As a consequence months of poor performance were easily identified relative to months of good performance.

On farms identified as having chronic ill-thrift, the incidence of ill-thrift in cattle was only about 35%. This low rate of ill-thrift is probably due to cattle's greater resistance to parasite infection (Sykes, 1997) and the greater age of some of the monitored cattle mobs. The incidence of ill-thrift in lambs was much higher at 62%. This confirms farmer observations in summer moist environments that ill-thrift is more a problem of sheep than cattle.

Of the explained incidences of ill-thrift, parasitism was the most important cause of ill-thrift despite regular drenching. The magnitude of the LWG suppression (approximately 65%) was similar to that recorded in undrenched animals, animals dosed with L3 larvae, and animals drenched regularly but grazing heavily contaminated pastures (Brunsdon & Adam, 1975; Brunsdon & Vlassoff, 1982; McAnulty *et al.*, 1982). In experiments where three weekly drenching of lambs occurred in the face of continued moderate larval challenge, feed intake was suppressed. Although protein metabolism was not impaired, substantial LWG penalties

still occurred, which were similar to those found in this study (Coop *et al.*, 1982; McAnulty *et al.*, 1982).

Drench resistance to benzimidazole anthelmintics is thought to be now common and levamisole resistance is increasing (Vlassoff & McKenna, 1994). Therefore it is possible that on some of these farms, drenching was ineffective and this contributed to the LWG suppression.

In 18-month bulls, as found by other authors (Brunsdon, 1971; Vlassoff *et al.*, 1987) FEC proved to be an ineffective diagnostic tool. It is possible on 2 weighings that the 18 month bulls were suffering from type II Ostertagiasis when substantial (approximately 85%) LWG suppression was recorded with no clinical symptoms. In young cattle high FEC did not necessarily result in ill-thrift. In agreement with other authors (Brunsdon, 1970; McKenna, 1997), FEC trigger level was much more reliable in the young lambs. However after the North Island drought broke in 2003, moderate FEC in lambs were associated with very large LWG suppressions.

On every occasion (10 out of 70) when Type B trichothecenes toxins NIV and DON level were above 0.8 mg/kgDM, both cattle and lambs grew relatively slowly. However, NIV and DON level did not have a significant relationship with act-pred LWG in the regression analysis. *Fusarium culmorum* and *F. gramineum* which are known to produce NIV and DON, are commonly found in NZ pastures as well as a large number of other fungal species (Keogh, 1973; Latch *et al.*, 1975; Lauren *et al.*, 1988). In cattle DON, the least toxic of the trichothecenes, causes intake suppression at levels greater than 10 mg/kg DM (Ingalls, 1996). New Zealand lambs were unaffected by DON level in experimental diets up to values of 40 mg/kgDM (N. Towers *pers. comm.*). However, *Fusarium* fungi are concentrated (200-fold higher) in pasture growing in urine patches and within the urine patches further concentrated in the lower 2.5 cm of the pasture and in the dead matter (Keogh, 1973). In autumn, animals preferentially graze urine patches (Keogh, 1986) and with the right grazing conditions it is possible that animals could consume much larger quantities of trichothecenes than a whole pasture test would indicate. Alternatively high NIV and DON may be indicative of the presence of other toxic *Fusarium* or other species of fungi. Speculatively the immuno-suppressive nature of some of these toxins could also compromise an animal's immunity, making it more susceptible to ill-thrift factors such as parasites (Placinta *et al.*, 1999).

In conclusion, Q-Graze can be used to identify ill-thrift on farms. Ill-thrift poses a serious threat to cattle and particularly lamb performance in summer wet environments. Preliminary analysis has shown that some causes of ill-thrift can be identified. The further development of diagnostic tests will hopefully increase successful diagnosis. Parasitism remains the predominant cause of ill-thrift despite intensive drenching regimens.

TABLE 3: Mean \pm SEM and actual-predicted live weight gain and percentage of sheep categorised according to ill-thrift trigger levels and growing either faster (healthy) or slower (ill-thrifty) than Q-Graze predicted. Figures in bold represent successful diagnosis.

Ill-thrift factors above trigger levels	%	Healthy		%	Ill-thrifty	
		Live weight gain (g/d)			Live weight gain (g/d)	
		Mean	Act-pred		Mean	Act-pred
2002						
None above trigger	23	140\pm24	41\pm15	21	60 \pm 16	-57 \pm 21
Parasites	12	127 \pm 10	15 \pm 3	29	50\pm13	-52\pm7
Parasites+Fusarium				3	32	-46
Fusarium				12	69\pm17	-48\pm5
2003						
None above trigger	35	150 \pm 9	41 \pm 9	26	53 \pm 18	-92 \pm 14
Parasites	6	161 \pm 40	24 \pm 52	21	11\pm30	-74\pm19
Parasites+Fusarium				6	52\pm36	-26\pm5
Fusarium				6	32\pm21	-48\pm13

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