Case report: Facial eczema in a herd of Angus cattle

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Abstract

A herd of rising two-year-old Angus heifers and steers presented for doing poorly. Distance exam revealed ill thrift, hair loss, dull coats and watery diarrhoea among the seven presenting steers/heifers that were worst in the herd. No monitoring or sufficient preventative measures to combat sporidesmin toxicity were in place on the farm. Laboratory results showed mean serum gamma-glutamyl transferase levels to be 879IU/L. Following euthanasia on one heifer a post-mortem revealed extensive bands of fibrosis throughout the liver with proliferation of the biliary ductules. The history, presenting signs, post-mortem liver changes and diagnostic tests were consistent with previous sporidesmin toxicity.

Introduction

Pithomycotoxicosis (commonly known as Facial eczema) is caused by the ingestion of spores by livestock that contain the toxin 'sporidesmin'. The spores are produced by *Pithomyces chartarum*, a saprophytic fungus that grows on the dead organic material at the base of a sward and is often associated with ryegrass-based pastures. Once ingested, sporidesmin leaches out of the spores in the rumen and is absorbed into the bloodstream, it then travels to the liver where it concentrates in bile. The toxin causes necrotising pericholangitis, leading to bile ducts becoming thickened and oedematous before progressing to the occlusion of a variable number of medium and large bile ducts. This results in the accumulation and concentration of waste products in the bloodstream, which are normally excreted in bile. Phytoporphyrin is the breakdown product of chlorophyll and this is one of the waste products that start to build up. Once sufficient concentrations are reached, phytoporphyrin will react with sunlight and cause a release of free-radicals resulting in photosensitivity for animals with non-pigmented areas of skin (Stein 2015).

This case report aims to describe the clinical presentation, location/movement of cattle, ante-mortem laboratory findings and post-mortem changes in a herd of rising two–year–old Angus cattle associated with sporidesmin toxicity.

The diagnostic challenge of this disease will be discussed, emphasizing issues around prevention and management in this case.

History and clinical findings

In August 2022, a herd of rising two-year-old (R2) Angus heifers/steers presented for doing poorly. There were two affected mobs on the farm involved. The first mob consisted of 12/70 (17%) dry heifers not doing well and the second mob consisted of 10/40 (25%) steers not doing well. There was no evidence to show that the proportion of affected cattle in each group was different (Two Sample Proportions test, p=0.46).

The farming enterprise had two integrated blocks of land; the first, the upper block, consisted of twelve hundred effective hectares of steep hill country. Here the climate was windy and cool, as it sits around two hundred and fifty metres above sea level. The second, the lower block, consisted of four hundred effective hectares of rolling hill country with many basins and boggy areas. The climate here was warmer and more humid with parts at sea level. The lower block is

the block where the two mobs were located when presented to the consulting veterinarian.

The cattle on both blocks had access to lush grass as their primary source of feed, supplemented with a small quantity of silage.

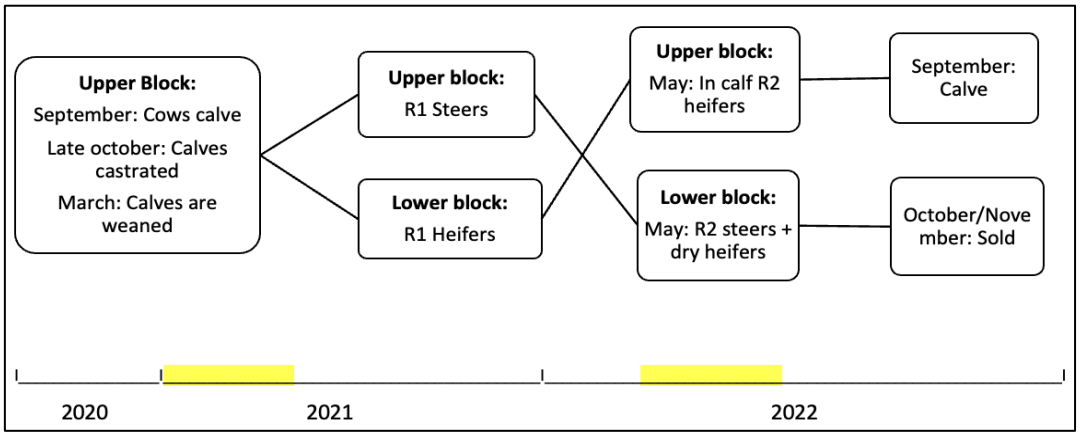
The animal health products given to these two herds of cattle consisted of 2ml/cow Min-Max supplementation via dosatron (Vet Pak Ltd, Te Awamutu), from March to September 2022 on the lower block only. For parasite control these cattle were given 1ml/10kg Matrix C orally (Boehringer Ingelheim Animal Health New Zealand Ltd, Auckland), at weaning (March 2021) and then twice more before winter in April then May (2021).

Yearlings were given 1ml/50kg Dectomax (Zoetis New Zealand Ltd, Auckland) by subcutaneous injection (September 2021), and then again at eighteen months old (March 2022).

The movement of cattle between these two blocks was complicated but essential for trying to understand when these cattle were potentially exposed to sporidesmin. The farmer had his cows calve on the upper block in September 2020. In late October the same year, the bull calves were then castrated. This was then followed by the weaning of all calves in March 2021. After being weaned the rising one-year-old (R1) steers were kept on the upper block and the R1 heifers were shifted down to the lower block. The farmer did this because he wanted to increase the heifer's weight gain to calve them at two years old, and since the grass grows earlier on the lower block this was the logical decision. The R2 heifers were then mated on the first of December 2021. In May 2022 any in-calf R2 heifers were then shifted to the upper block whilst the R1 steers were shifted down to the lower block to be with the non-pregnant (dry) R2 heifers. The two-year-old dry heifers along with all the steers were due to be sold in October - November 2022 and the in-calf two-year-old heifers were due to calve in September 2022. These movements have been summarised in Figure 1. In summary, there were two periods when the two groups were grazed together and potentially exposed to sporidesmin, bearing in mind the facial eczema season is normally January to May in the North Island. These were January - March 2021 on the upper block and May 2022 on the lower block.

Six of the steers and one heifer, that were in the poorest body condition, were brought in for veterinary examination. Distance examination revealed ill thrift, hair loss, dull coats and watery diarrhoea/perineal staining for all seven animals. They were hollow despite only being in the yards for thirty minutes and were estimated to be one hundred to two hundred kilograms below the target weights for their age. At this age in the past, the heifers would normally be reaching between four hundred to five hundred kilograms, with the steers reaching four hundred and fifty to five hundred and fifty kilograms. Unfortunately, a full hands-on physical exam was not performed on any of the presenting cattle, although faecal and plain blood samples were collected from the heifer and six steers. The heifer was then humanely slaughtered by free bullet for post-mortem purposes.

Figure 1. Summary of cattle movements from birth to veterinary examination in August 2022, the highlighted yellow timelines is the periods when both heifers and steers were together on the same farm block



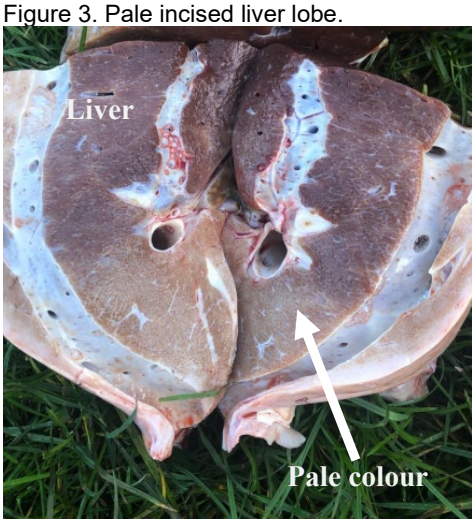
Post-mortem findings

The gross findings on post-mortem of the heifer revealed the liver to be pale and globoid in shape (Figure 2).

Upon cutting into the liver lobes the bile ducts were fibrotic and enlarged (Figure 3). There were no adult liver fluke present and no other gross lesions were observed elsewhere. Samples of the intestine and liver were collected at post-mortem, placed in 10% formalin, and then sent for histopathology.

Figure 2. Liver is pale in colour and globoid in shape.

Figure 3. Pale incised liver lobe.



The primary differential diagnosis at this stage was *Pithomycotoxicosis (Facial eczema)*, due to the loss of condition and the gross post-mortem findings. Other differentials considered for the ill thrift and diarrhoea were a high worm burden due to drench resistance, liver fluke, trace element deficiency (copper, selenium) and Bovine viral diarrhoea.

Laboratory findings

The laboratory tests performed were: trace element selenium and copper serum concentrations along with serum gamma-glutamyl transferase (GGT) concentrations. Individual faecal egg counts (FEC) were requested for each faecal sample.

The FECs were negative and serum copper and selenium concentration results were within normal limits. However, biochemistry analysis revealed a moderate to severe increase in GGT (Table 1).

Table 1: Biochemistry results of serum GGT levels.
NO ID = the heifer that was euthanized for post-mortem.

Animal ID	GGT (IU/L)	Haemolysis Index (mg/dL)
NO ID	961 H	582
231	815 H	284
244	842 H	N/A
253	1034 H	N/A
356	590 H	N/A
363	1152 H	N/A
476	760 H	243
Means	879	370
Adequate range	3-47	

Histopathology

The mucosa of the large/small intestinal junction was normal, but the serosa had adipocytes with shrunken lipid vacuoles and a pale blue matrix between the adipocytes. The atrophy of serosal adipose tissue was consistent with cachexia.

There were extensive bands of fibrosis throughout the liver with a proliferation of the biliary ductules. These areas of proliferation resulted in the bridging of portal areas and had replaced parts of the liver lobules. These severe changes, which would compromise hepatic function, were consistent with those produced by exposure to the sporidesmin toxin; supporting the diagnosis of *Pithomycotoxicosis (Facial eczema).*

No treatment was available for the affected animals in both herds and subsequently they were sent to the abattoir.

Discussion

The diagnosis of facial eczema in a pigmented individual bovine or a pigmented herd can be challenging. Even in animals with non-pigmented skin not all will present with classic photosensitization lesions, with the majority of stock having liver damage without clinical signs (Parkinson *et al.* 2010).

For animals like the ones in this case, black Angus cattle, with non-specific clinical signs such as ill thrift, reaching a diagnosis can become even more challenging. Post-mortem examinations serve as a valuable tool to assess if there are any liver changes present in an animal. Chronic liver changes, after sporidesmin toxicity, include a firm texture with rounded borders (Laven *et al.* 2021*).* In sheep, affected livers will have a left lobe that is almost completely atrophied along with significant atrophy of the lateral part of the right lobe, the medial part of the right lobe will however be enlarged creating the classic boxing glove shape, indicating that the liver has been severely damaged (Munday *et al.* 2021*)*. It remains uncertain whether similar changes are reported in cattle. Although these liver lesions are strongly suggestive of a diagnosis of facial eczema, it is important to recognise that there are other potential causes of liver damage that can result in similar changes.

For instance, cattle that are grazing on turnips or other brassica crops can also develop liver damage, often during the January to May period, which coincides with the risk period for facial eczema (Collett 2014). On histological examination, there appears to be some distinction between these two causes of liver damage. With turnip photosensitisation the liver lesions tend to be associated with the small interlobular ducts, whereas sporidesmin toxicity lesions are associated with the medium to large sized bile ducts (Collett 2014). Additionally, facial eczema is characterised by excessive portal tract fibrosis and bile duct hyperplasia resulting in the bridging of the portal areas (Collett 2014). In this particular case, the histological changes described for facial eczema were present, this combined with a history of being primarily pasture fed, meant we were able to rule out photosensitisation due to brassica or turnip consumption as a potential cause.

In contrast to liver histology, serum biochemistry is a more common route of testing for liver damage as it does not require liver examination (Towers and Stratton 1978). Serum gamma-glutamyl transferase (GGT) measurement is a valuable tool for diagnosing facial eczema and evaluating the effectiveness of facial eczema control methods. GGT is a membrane bound enzyme of the biliary system which is released following damage to the biliary epithelial cells (Bulle *et al.* 1990), and leaks into the circulation after damage to the intercellular junctions (Brouillet *et al.* 1998). Therefore, elevated GGT is associated with bile duct damage and cholestasis, which is consistent with exposure to sporidesmin in both cattle and sheep (Ford 1974). A threshold GGT value of >300IU/L has been adopted to indicate moderate to severe liver damage in cattle (Cuttance *et al*. 2016). Examination of Table 1 shows that all sampled cattle in this case displayed moderate to severe liver damage. However, GGT elevation is not entirely associated with sporidesmin toxicity as any cause of bile duct damage, such as liver fluke, will also result in an increase of GGT concentrations (Laven *et al.* 2022).

A study by Towers and Stratton (1978) demonstrated a high correlation (0.65-0.81) between GGT serum levels and the characteristic pathological effects of the sporidesmin toxin. As a result, GGT can be used to measure the severity of liver damage in a herd previously exposed to the sporidesmin toxin or to monitor the effectiveness of on farm control methods.

As previously stated GGT is not specific to facial eczema and needs to be considered alongside other clinical signs, the season, district spore counts, and further clinical tests such as faecal egg counts for liver fluke (Cuttance *et al*. 2016, Laven *et al.* 2022). Another hepatic enzyme, Glutamate dehydrogenase (GDH), also increases following hepatic damage (Ford 1974). In comparison to GGT, serum GDH will increase rapidly following hepatic injury, followed by a quicker decrease, therefore by using this test alongside GGT there is potential to reduce any false negatives that may occur if testing is performed too early (Laven *et al.* 2022). Laven *et al.* (2022) found that by combining GGT and GDH results there was an improvement in the specificity from 0.33 for GGT alone, to 0.62 for the combination. The improvement in specificity should reduce the false positive results, resulting in a reduction in the misdiagnosis of herds as affected when both markers were used together.

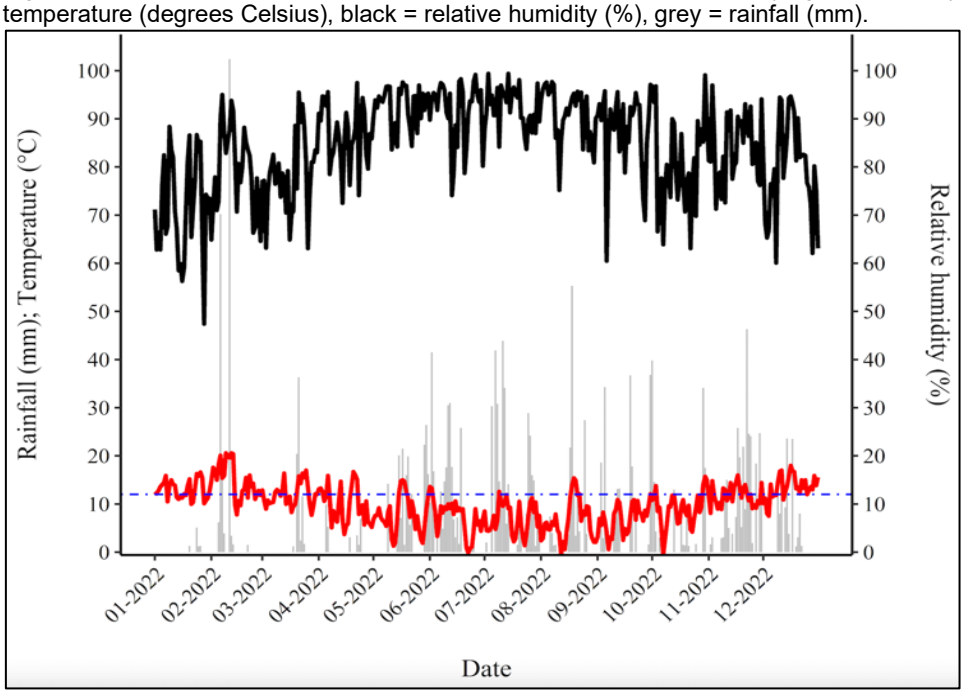
The farmer in this case did not utilise GGT testing to monitor the sufficiency of zinc supplementation methods for the herd. GGT monitoring would have been highly beneficial, as it could have alerted the farmer to the inadequacy of the control methods. If a post-mortem had not been performed or if the vet had been consulted earlier in the year, combining GGT with GDH testing could have been useful. In this case, there was no need for both markers to be used together as this would have incurred unnecessary cost since GGT provided sufficient value alone.

Temperature and humidity play a significant role in the rise of spore counts. *Pithomyces chartarum* is a saprophytic fungus commonly found on ryegrass pasture, that grows on the dead material of a sward and produces spores containing the sporidesmin toxin (Jordan 2020). These spores are most prevalent during the period of January through to May especially when temperatures are warm (>12°C) and humidity is high (close to 100% relative humidity), with recent light rain (around 4mm within 48 hours) for 2-3 nights (Brook 1963, Parkinson *et al.* 2010, D' Amours 2020).

The most ideal conditions in this case for the production of sporidesmin according to the weather patterns at this time of year was around March-April 2022 on the upper block (Figure 4), whilst the lower block experienced dryer and colder conditions (Figure 5). During this period the R2 steers were located on the upper block while the R2 heifers were on the lower block. In May 2022 the shift of in-calf R2 heifers occurred from the lower to the upper block, whilst the R2 steers were moved down to the lower block. The dry R2 heifers remained on the lower farm. This weather pattern fits for the exposure of the steers to spores but does not account for the dry heifers. It is likely that the dry heifers were then exposed when the conditions became more optimal on the lower block later in the year (Figure 5).

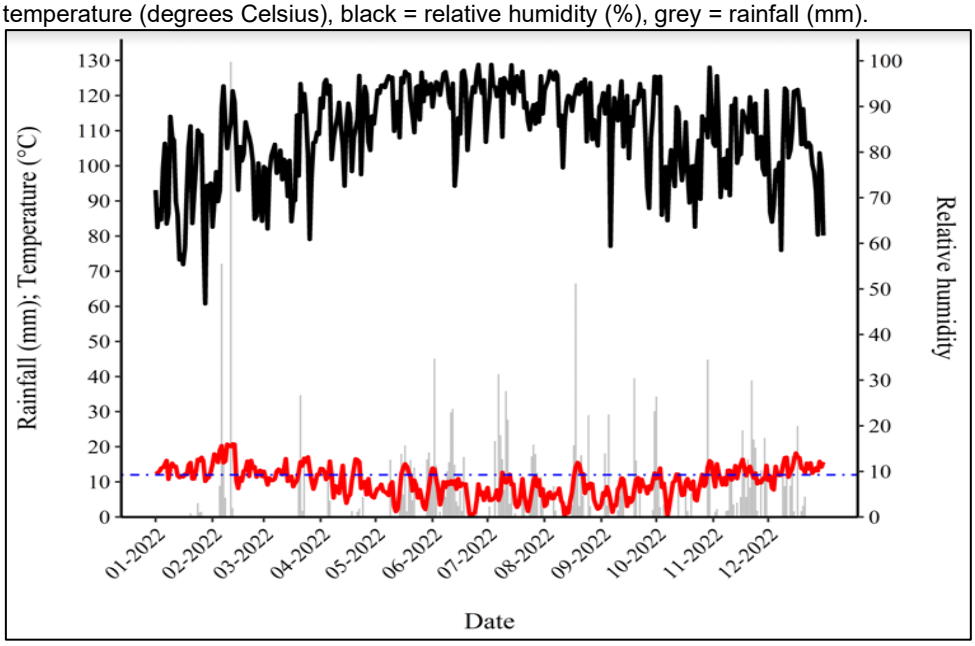
Furthermore, district spore count reports from Gribbles for the region revealed that from the seventh of January 2022, spore counts started at twenty-five thousand and trended up to six hundred thousand by the twenty-sixth of February 2022. From that point, spore counts continued to fluctuate, although never below forty thousand until the twenty-ninth of April 2022, after which the data became unavailable. This information supports our hypothesis that facial eczema was the cause of liver damage in this case.

Figure 4. Upper farm, the blue dotted line = minimum temperature of 12 (degrees Celsius), red = minimum temperature (degrees Celsius), black = relative humidity (%), grey = rainfall (mm).



Courtesy of Kevin Lawrence

Figure 5. Lower farm, the blue dotted line = minimum temperature of 12 (degrees Celsius), red = minimum temperature (degrees Celsius), black = relative humidity (%), grey = rainfall (mm).



Courtesy of Kevin Lawrence

The treatment of liver pathology underlying facial eczema is not possible, therefore prevention is the key to managing this disease. However, the lack of education surrounding prevention methods in the farming sector is a significant problem for the industry (Cuttance and Mason 2022). Many farmers have the common misconception that they are managing facial eczema effectively, due to a lack of signs of photosensitivity (Cuttance and Mason 2022), which can lead to the devastating loss of stock and income.

In this case, Min-Max supplementation was provided to cattle via dosatron from March to September 2022 on the lower block only. It is important to understand that this product is designed to supplement essential minerals, not to prevent facial eczema and is dosed at 2ml/cow/day, providing a Zinc oxide (ZnO) dose of 2.4mg. ZnO is a common tool used in the prevention of facial eczema, but to be protective, dosing needs to start two to three weeks before spore counts rise to dangerous levels. ZnO has a protective effect as it can bind to and oxidize the sporidesmin toxin, inhibiting the generation of the superoxide radical in the rumen (Munday 1984). The most current recommendation is from 1987 and advises that a zinc serum concentration of between 18 and 35µmol/L is required in order to obtain effective facial eczema control in cattle (Cuttance *et al*. 2016). In order to reach this concentration in serum, ZnO needs to be dosed at a rate of 20mg/kg liveweight/day (Dairy Australia Facial Eczema Working Group 2011). The cattle in this case were being supplemented far below the recommended minimum dosage, despite the farmer's belief that he was managing his herd's facial eczema risk well.

Supplementation rates for zinc are confusing and frequently lead to underdosing, as seen in this case, or even toxicity (Greenway 2021). Therefore, more sustainable long term control measures need to be considered. Breeding facial eczema tolerance into sheep and cattle is considered the future of facial eczema control. Previous research in sheep has shown that facial eczema resistance is a heritable trait, with an estimated heritability of 0.45±0.03 (Phua *et al.* 2014). This can be assessed in sheep using either the sporidesmin challenge test (Amyes and Hawkes 2014) or by genomic selection in Romney sheep (Phua *et al.* 2014). In dairy cattle, it has an estimated heritability of 0.34±0.02 (Morris 2013), but unfortunately a DNA based test for cattle is yet to be developed, this is due to the difficulty in identifying suitable DNA markers (Morris 2013).

It is worth noting that although some farmers believe that beef cattle are less susceptible to facial eczema than dairy cattle, research has shown that when faced with the same sporidesmin challenge there is no significant difference in susceptibility between the two (Morris 2013). Developing a breed of cattle that is resistant to facial eczema is not something that will happen overnight, but over a period of years farmers have the ability to slowly introduce this trait into their herd. With a climate that is warming and conditions that are becoming much more favourable for the *Pithomyces chartarum* fungus to proliferate, it is essential that farmers start to consider this option for facial eczema prevention going forward.

The economic importance of facial eczema, as outlined in this case, is substantial. While the cost of the veterinary visit, which came to a total of $927.00 (including travel, labour and laboratory fees), is not insignificant, it is minimal in comparison to the production losses suffered by the affected cattle. Research in dairy cattle has shown a direct correlation between a rise in GGT concentrations (>300IU/L) and milk solid production, with higher GGT concentrations being associated with an increased milk solid production loss (Cuttance *et al.* 2021). This highlights the importance of farmers understanding the financial implications that facial eczema can have, in order to motivate them to implement preventative strategies on farm.

An attempt was made to quantify the losses suffered by this farmer using standard dressing out percentages for cattle (Table 2) and definition of fat depth (Table 3), (PGG Wrightson notebook):

Table 2. PGG Wrightson notebook standard dressing out percentage for cattle

Cattle type	**Dressing out percentage**
Store (not finished)	45-48%
Finished (grass)	50-53%
Finished (crop)	52-55%
Finished (grain)	54-58%

Table 3. PGG Wrightson notebook definition of fat depth

Term	**Fat depth**
Lean (L)	<3mm
Perfect (P)	3-10mm
Trimmer (T)	11-16mm
Fat (F)	>17mm

The farmer in this case normally sells his steers at an average of 500kg but his affected animals were 100-200kg below this weight. The following calculations are based on the assumption the steers were 200kg behind normal weights.

In a normal year, based on the assumption the farmer would have sold his steers or dry heifers as 500kg ‘Prime’ cattle to the abattoir, he would generate $1651.00 per animal (1). In this case, 19 cattle were euthanised on farm so this loss from these animals, if based on the above figures, equates to a total loss of $31,369.00.

Ten cattle were sent to the works at lower-than-normal weights, assuming they were sold as 300kg ‘Lean’ cattle to the abattoir, he would generate $855.60 per animal (2). This results in a loss of $795.40 per cattle beast.

The total resulting loss to the farmer equates to $39,323*.

The outcome of this case demonstrates the value of preventative and monitoring measures as a tool for reducing the susceptibility of livestock to *Pithomycotoxicosis* in New Zealand. It also highlights the challenges surrounding the diagnosis and prevention of facial eczema in pigmented cattle, along with the need for increased farmer awareness of the serious economic impact this disease can have.

(1) Calculated using the following equation: (weight x P dressing out percentage) x $/kg (a)
(2) Calculated using the following equation: (weight x L dressing out percentage) x $/kg (b)
(a) $6.35 per kilogram approximately for P2 cattle deadweight according to beef schedule published in Farmers weekly August 2022.
(b) $6.20 per kilogram approximately for L cattle deadweight (based off L being 0.15cents less than P2 schedule published in Farmers weekly August 2022).
(*) These figures are approximately calculated and do not include factors such as inability to fall in calf and ongoing income from heifers and offspring. They also do not take into account that each cattle beast would have killed at slightly different weights. It is likely the loss would be much greater than portrayed with these figures.

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