On farm

# Effects of sorghum ergot on feedlot cattle performance during the cooler months

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Feedlots

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# 1.0 Executive summary

Sorghum ergot is a fungal disease, which has the potential to have a major impact on the economic viability of Queensland's sorghum crop but also on livestock production systems reliant on sorghum as a feed grain. It was first detected in sorghum in Australia in early 1996 but was initially considered harmless to livestock. However, evidence of depressed milk production in sows and dairy cattle in 1997 prompted an urgent revaluation of its effect on cattle in feedlots, a major user of grain sorghum. Meat and Livestock Australia (MLA), the Australian Lot Feeders Association (ALFA), Grains Research and Development Corporation (GRDC) and the Department of Primary Industry (DPI's), have jointly funded this research conducted by DPI.

An initial study carried out in the 1998 summer / autumn period at the DPI's Animal Husbandry Research Farm (AHRF), Rocklea evaluated the effect of 4 levels of ergot contamination of sorghum on the performance of Hereford steers in the feedlot, viz., 0, 0.5, 1 and 2% ergot, representing 0, 1.5, 3 and 6 parts per million (ppm) ergot alkaloid in the grain. The alkaloids are the toxic compounds in the ergot. The results of this study indicated that:

- Ergot at any concentration in the grain depressed growth rates of cattle in the feedlot (by between 26 and 45%), and thereby increased the period taken to finish steers for slaughter;
- Growth rate depression tended to increase with alkaloid concentration, but differences in growth rate between different concentrations were small;
- Depressed growth rates were associated with reduced intake of feed with only small effects on food conversion ratios;
- The effect of ergot appeared to be more severe in the hotter, more humid months (ie., high temperature/humidity index; THI) and it appeared that presence of ergot in the diet reduced the tolerance of the cattle to heat stress;
- Rectal temperatures of the steers were increased when ergot was included in the diet.

In view of the apparent association between alkaloid concentration, heat tolerance and animal performance, the current study was designed to measure the effects of ergot in sorghum when fed predominantly during the cooler months of the year (June to November).

A feedlot study, similar to that described above, was carried out in which 35 Hereford steers (271 kg, initial liveweight) were individually fed conventional feedlot rations (90% rolled grain/concentrate: 10% hay) with various concentrations of ergot alkaloid in the grain, achieved by mixing different proportions of clean (no ergot) and contaminated (ca. 24 ppm alkaloid) sorghum grain. Concentrations of alkaloid used were control, 0; E 3, 3; E 6, 6; E 9, 9; and E 12, 12 (ppm in grain). Steers were fed *ad libitum*, once daily in the morning, and weighed with rectal temperatures taken once weekly.

Despite the experiment continuing into the spring months, ambient temperatures remained relatively low and THI remained below 70 throughout the experiment. Nevertheless, some steers receiving ergot in their ration showed signs of mild heat stress, especially after exercise. Steers receiving ergot also had longer, rougher coats than those on clean grain, which is characteristic of ergot feeding.

Control steers grew at a relatively slow rate (1.26 kg/d) throughout the 20 week (139 d) feeding period, which is thought to be related to their previous lack of experience with feed troughs and also possibly to growth retardation at the source property, as indicated by most steers having two or more permanent teeth despite their low weights. Nevertheless, this growth rate was on average 49% greater than that for the ergot treatments (0.83 kg/d; $P<0.05$). There were no significant differences between growth rates for the different levels of ergot.

Over the total feeding period, intake for the control steers averaged 2.7% of liveweight (LW) whilst for steers receiving ergot, intake was 13% lower on average (P<0.05). There was a general trend for intake to decrease with increasing alkaloid concentration except that E 12 steers had similar intake to E 3 steers (2.5% LW), which were higher than for E 6 (2.3% LW; P>0.05) and E 9 (2.2% LW; P<0.05) steers. Food conversion ratios (FCR; kg feed/kg liveweight gain) were greater for steers receiving ergot (average 9.1) than for their control counterparts (7.5).

Rectal temperatures were not significantly different between treatments except in weeks 10, 17 and 19 (P<0.05), with trends in weeks 14 and 18. These differences tended to occur in the hotter weeks when steers receiving ergot had higher rectal temperatures than the controls. On all of the above occasions the controls had lower temperatures than the E 6 and E 9 groups and also lower than E 12 in week 17 and E 3 and E 12 in week 19 (P<0.05). Generally there were no differences in temperature between the four groups receiving ergot, the one exception being in week 17 when the E 3 group had lower temperature than the other ergot groups (P<0.05).

Prolactin concentration in blood plasma of the steers followed a similar pattern to that experienced in earlier experiments, viz. a sharp decline in concentration soon after exposure to ergot followed by a slight but not total recovery, relative to control steers, in subsequent weeks. At most sampling times, differences between the control and other ergot groups (except E 3) were significant. There tended to be a gradational effect of increasing ergot, with the E 3 treatment only different to the controls at the first sampling following exposure to ergot, and different to the other ergot treatments in most instances. Prolactin concentrations increased sharply in the 3 weeks after the ergot was removed from the diet.

An economic assessment of the cost of ergot contamination in sorghum was carried out. A single feedlot situation was used in which home-bred steers were sent to a commercial feedlot to be contract finished for the domestic market over 70 days. The effects of different concentrations of ergot alkaloid in grain were assessed using results from the current and previous experiments.

Two methods were used to calculate profitability within this general framework, viz., (i) where the owner of the cattle paid for the feed at cost ($160/tonne) plus a daily yardage fee of $0.60/steer/day; and (ii) where the feedlot charged the cattle owner a margin on the cost of the feed used ($35/tonne; ie. $160 + $35 = $195/tonne total), but there was no daily yardage cost. The results of these simulations on the effects of ergot on feedlot returns indicated that:

- For Method 1 of calculation, profitability was reduced with ergot by between $42 and $110 per steer, depending on ergot alkaloid concentration.
- For Method 2, profitability was reduced with ergot by between $31 and $91 per steer. These effects were due to prolonged feeding times and higher feed conversion ratios (feed consumed per kg liveweight gain).
- In order to maintain profitability at the same level as for uncontaminated grain, the amount paid for sorghum would need to be reduced by between $39 and $82/tonne using Method 1 calculations, and by between $29 and $67/tonne using Method 2.

Other costs relating to potential higher mortalities during summer, missed market opportunities due to delayed finishing of cattle, rougher appearance of cattle and increased incidence of dags, discredited reputation of feedlot operators, are real but have not been quantified.

The implications of these costs, and of ergot in general, for the feedlot industry are discussed.

In conclusion, this project has shown that, even under cooler climatic conditions, ergot will impair the performance of cattle in feedlots. This effect occurs even at very low concentrations of alkaloid (3 ppm) in the grain. In view of the demonstrated serious impact on profitability of feedlotting, it is of paramount importance to re-evaluate the current industry standards for ergot inclusion in sorghum grain.

## 2.0 Background

Sorghum ergot is a fungal disease, which has the potential to affect a large proportion of Queensland's sorghum crop. It was initially thought to be relatively harmless to livestock, for instance compared to rye ergot, because no cases of poisoning had been reported in Africa or elsewhere despite the presence of the disease in these countries for some time. However, recent reports of reduced milk production in sows and dairy cows in central Queensland associated with feeding sorghum infected with ergot (Blaney *et al.* 1998) have challenged this initial premise.

A feedlot study completed in May 1998 indicated that sorghum ergot also adversely affects beef cattle in feedlots (Blaney, McLennan *et al*., unpublished data). In this study, Hereford steers (initial liveweight 295 kg) were fed a ration based on dry-rolled sorghum (90:10, concentrate: hay) over a 119 day feeding period during summer/autumn. Growth rate was reduced from 1.37 kg/day for steers given clean (no ergot) grain to 1.01, 0.92 and 0.77 kg/day for those receiving grain (sorghum) mixes containing ergot alkaloid concentrations of 1.5, 3 and 6 ppm, respectively. The current Queensland stockfeed standard is 0.3% ergot in sorghum, equivalent to about 1 ppm ergot alkaloid. These reduced growth rates reflected depressed feed intakes. The effects of the ergot seemed to be most pronounced during hot, humid weather when affected animals were apparently unable to dissipate heat and showed signs of severe heat stress. Our preliminary examination of the results indicates that the temperature-humidity index (THI) threshold above which *Bos taurus* steers suffered heat stress was reduced from 79 without ergot to about 70 for those consuming ergot-contaminated grain. Thus cattle receiving ergot showed signs of heat stress at much lower temperature and humidity levels than those for cattle with non-infected grain.

It should follow from these findings that the effects of ergot would be considerably reduced if the infected sorghum was fed during the cooler months of the year. If so, this could represent a management option for using the infected grain. The present experiment was designed to explore this possibility by feeding graded levels of infected and clean sorghum to cattle during the cooler winter-spring months.

## 3.0 Objectives

1. To measure the effect on animal performance of increasing sorghum ergot alkaloid concentration in feedlot rations fed to cattle during the cooler months of the year.
2. To quantify the interactive effects of ergot alkaloid concentration and climatic conditions on the performance of cattle in feedlots, based on the response curves established in the present study and in the previous one conducted in the summer.
3. To make recommendations to the feedlot industry on the practical utilisation and commercial value of ergot-infected sorghum.

# 4.0 Methodology

## 4.1 Formulation of rations

Feedlot rations based on a combination of grain concentrate and Rhodes grass hay (90:10; as fed) were prepared and fed to cattle. The grain concentrate composition was (g/kg, as fed): dry rolled sorghum grain, 866; urea, 10; limestone, 12; cottonseed meal, 30; molasses, 56; bentonite, 20; ammonium sulphate, 2; and pre-mix, 4. The premix included both Rumensin© and Eskalin© (20 g virginiamycin/tonne feed). Treatments were formulated so that the sorghum component of the ration had concentrations of 0 (Control), 3 (E3), 6 (E6), 9 (E9) or 12 (E12) ppm ergot alkaloid, by mixing different proportions of ergot-infected (*ca.* 24 ppm ergot alkaloid) and non-infected (clean) sorghum.

## 4.2 Cattle and their husbandry

The experiment was carried out at the Queensland DPI's Animal Husbandry Research Farm, Rocklea, commencing on 14 June 1999. Thirty-five Hereford steers of initial liveweight 271.2 ± 15.85 (± s.d.) kg were used in a random block experimental design involving 7 replicates (individual steers) of the 5 treatments. The steers were allocated to treatments and to blocks by stratified randomisation on the basis of fasted (24 h without food, 15 h without water) liveweight, and then randomly allocated to individual pens within these blocks. All steers were gradually adapted to a high-concentrate ration by incrementally increasing the ratio of grain concentrate (using clean grain): hay from 1:9 to 9:1 over a 14 day period. Following this equilibration period, ergot alkaloid concentrations in the rations were incrementally increased so that designated treatment concentrations of 3, 6, 9 and 12 ppm were achieved after a further 3, 7, 11 and 14 days, respectively. After 139 days the control steers were slaughtered (2 November 1999) and other treatment groups were changed over to the control (non-ergot) ration until they also were slaughtered at 167 days (30 November 1999).

Rations were fed once daily in the morning. The amount fed to each steer was adjusted on a daily basis so that some residue (about 10% in excess of intake) remained in the trough the next morning, thereby ensuring *ad libitum* intake. Feed residues were removed once weekly and weighed. Sub-samples of feed and residue feed were dried in a fan-forced oven at 60°C for 48 h for DM determination, and proximate analysis was carried out on the hay and grain concentrates sub-sampled weekly and bulked over 6 week periods. Grain samples were taken weekly, bulked over 2 weeks, and analysed for alkaloid concentration.

The steers were weighed (unfasted) once weekly prior to the morning feeding. Fasted liveweights were also recorded on all steers on the day before slaughterings. From the end of week 2 and coinciding with the introduction of ergot into the rations, rectal temperatures were also recorded once weekly at the time of weighing. Blood samples were taken from the tail or jugular vein just prior to feeding on days 14 (just prior to feeding ergot), 35, 77, 139 (just before Control steers were slaughtered) and 161 (ergot groups on control ration). These samples were used for prolactin assays and, in the case of the day 77 sample, for biochemical and haematological assays also. Steers were observed closely at least twice daily for signs of heat stress.

Climate data from the Meteorological Bureau has been collected and has been used to define climatic conditions prevailing during the feeding period.

# 5.0 Results

## 5.1 Composition of feed ingredients and mixed rations

The chemical compositions of the hay and sorghum and of the mixed concentrate (without hay) fed to the various treatment groups, for the main experimental period and the post-ergot phase (weeks 21-24) of the experiment, are shown in Table 1. A new batch of sorghum grain was used after week 20. The ergot-infected grain tended to have higher protein and crude fibre but lower starch content than the clean grain. The fungal sclerotes of sorghum ergot are of relatively high protein, high fibre and low starch content and their replacement of grain kernels in infected crops would have contributed to this finding. Estimated metabolisable energy density was similar for the clean and infected grain.

The composition of the mixed concentrate rations fed to the different treatment groups were similar in most attributes, particularly in estimated ME content (13.4 MJ/kg DM). There was a trend for protein content to increase slightly with increasing ergot content in the diet, presumably in direct response to increasing content of ergot sclerotes in the mix, but it is unlikely that much of this additional protein would be available to the animals from the fungal sclerotes. Inclusion of limestone in the grain concentrate mix corrected a Ca deficiency in the rations, with the Ca:P ratio in the final concentrate rations varying between 1.4:1 and 1.8:1, or 1.4:1 to 1.7:1 for the total diet (including hay), within the desired range for optimal animal growth. It is unlikely that the differences measured in animal performance between treatments was related to these small differences in chemical composition of the rations.

**Table 1. Composition of the feed ingredients and mixed concentrates (DM basis)**

| | OM (%) | CP (%) | CF (%) | NDF (%) | ADF (%) | Starch (%) | Fat (%) | Ca (%) | P (%) | IVOMD (%) | ME (MJ/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hay (wk 1-24)** | 89.9 | 5.0 | - | 73.6 | 43.7 | - | - | 0.42 | 0.47 | 44.0 | 5.9 |
| **Clean Sorghum (wk 1-20)** [A] | 98.6 | 11.5 | 3.1 | - | - | 68.2 | 3.3 | 0.02 | 0.24 | - | 13.9 |
| **Clean Sorghum (wk 21-24)** [AB] | 98.7 | 10.3 | 3.1 | - | - | 72.0 | 3.4 | 0.04 | 0.26 | - | 13.6 |
| **Ergot-sorghum (wk 1-20)** [A] | 97.5 | 12.2 | 4.5 | - | - | 55.5 | 3.3 | 0.03 | 0.43 | - | 13.6 |
| **Mixed rations** [C] | | | | | | | | | | | |
| **Control** | 94.3 | 11.9 | 2.1 | - | - | 62.1 | 3.3 | 0.58 | 0.32 | - | 13.3 |
| **E3** | 94.5 | 11.8 | 2.1 | - | - | 62.6 | 3.3 | 0.52 | 0.29 | - | 13.4 |
| **E6** | 94.4 | 11.9 | 2.2 | - | - | 61.3 | 3.5 | 0.51 | 0.30 | - | 13.4 |
| **E9** | 94.7 | 12.1 | 2.5 | - | - | 60.0 | 3.4 | 0.47 | 0.33 | - | 13.4 |
| **E12** | 94.6 | 12.4 | 2.9 | - | - | 60.2 | 3.3 | 0.49 | 0.35 | - | 13.3 |

[A] Grain sorghum only
[B] New grain used weeks 21-24 (post-ergot phase)
[C] Total grain concentrate mix (without hay) – weeks 3-20, following equilibration

## 5.2 Climatic conditions

The experiment was conducted during the winter/spring months in order to compare the effects of ergot on cattle performance during the cooler months with results obtained in the previous experiment conducted in summer/autumn. Despite continuing into October/November, ambient temperatures remained relatively low during this period due to a south-easterly influence and wet days. The temperature-humidity index (THI) for the trial period is shown in Figure 1. At no time did the average weekly THI exceed 70. This value represents an arbitrary threshold, established in the previous project, above which Hereford steers on ergot-infected rations appeared likely to show signs of heat stress. Under normal conditions, in the absence of ergot, the THI threshold for *Bos taurus* cattle is 79.

## 5.3 Animal health

In the first 4 weeks several steers showed signs consistent with acidosis, in particular depressed food intake and diarrhoea, which often lasted for several days. This condition was observed across all treatment groups and appeared to be related to poor intakes early in the study, due perhaps to lack of previous exposure of the cattle to feed troughs. Steers were generally slow to start eating and very low intakes were recorded in the first week of equilibration. Steers removed from the experiment included one from group E 6 after 35 d (very low intake – non-eater); one from the control group after 13 weeks (suspected urinary calculi and not eating); and one steer from group E 6 after 20 weeks (injured in yards and lame).

Several physical differences were observed between steers receiving ergot and those on the control ration, particularly in relation to coat appearance. Steers were scored for coat length and roughness at the end of week 18 and average scores were 1.2, 2.2, 3.0, 3.6 and 3.0 for the Control, E 3, E 6, E 9 and E 12 groups respectively, where the scale was 1, sleek; 2, short (coat length); 3, medium; 4, medium-long; and 5, long. Thus the coat of the ergot steers tended to be longer and rougher than that of control steers. Several of the steers receiving ergot showed signs of heat stress during the second half of the experiment, including open-mouth breathing, panting, excessive salivation and high respiration rates. One animal was often found standing with its front feet in the water trough. The apparent heat stress was exacerbated after exercise, as for instance during weekly weighings. No control steers exhibited these signs. There were no clinical signs of gangrene, often associated with ergots in cooler climates, in any of the experimental animals.

All biochemical and haematological parameters measured in the blood samples taken on day 77 were within the normal range.

## 5.4 Liveweight changes

The changes in liveweight of the steers are illustrated in Figure 1 and average daily gains for various phases of the experiment are detailed in Table 2. The control steers seemed to gain at a relatively constant rate throughout the experiment whereas growth rates for the ergot groups generally appeared to decline after week 11 (see Figure 1). This is indicated in the lower growth rates between days 78 and 139 for all ergot treatments except group E12 (Table 2). On average, the growth of the ergot steers was 26% lower compared to the controls to day 77, and 41% lower between days 78 and 139. These interim growth rates have not yet been statistically analysed. Over the total 139 days, the controls grew at a relatively slow rate of 1.26 kg/d which was on average 49% faster ($P<0.05$) than that for steers receiving ergot (0.83 kg/d). There were no significant differences in growth rate between ergot treatments over this period.

The trend was for steers from the ergot groups to gain at slightly higher rates in the last 4 weeks (days 140-167) when the clean grain ration was fed, and for gains to be inversely related to the concentration of ergot alkaloid in their previous rations (Table 2). However, these differences were not statistically significant. Similarly, growth rates were not different between ergot treatments over the total feeding period (167 d), averaging 0.87 kg/d. Despite this additional period of feeding on clean grain, the ergot steers did not attain the final liveweights of the control group slaughtered 4 weeks earlier.

## 5.5 Intakes

Changes in the weekly DM intakes (calculated on a LW basis) are also shown in Figure 1 and average intakes over various phases of the experiment are summarised in Table 2. Consistent with the trend for liveweight changes, intakes declined after week 11 for all treatment groups but more markedly so for the ergot treatments. Intake for control steers was 5% lower after, compared with before, week 11 but in comparison with these control values, intakes for groups receiving ergot were, on average, 10 and 20% lower in weeks 1-11 and weeks 12-20 respectively. Over the 139 d feeding period the ergot groups all consumed less feed than the controls (P<0.05), the average depression in intake being 13%. The general trend was for intake to decline with increasing alkaloid concentration, except for the E12 group which had a higher intake than the E9 (P<0.05) and E6 groups (P>0.05), but not the E3 group. There was no marked increase in intake by ergot groups during the last 4 weeks when clean grain was provided and no treatment differences occurred.

**Table 2. Effect of level of ergot inclusion in sorghum on intake, liveweight, liveweight change (average daily gains; ADG) and feed conversion ratio (FCR; kg DM intake/kg ADG) for Hereford steers receiving a sorghum-based feedlot ration**

| | **Control** | **E3** | **E6** | **E9** | **E12** |
|---|---|---|---|---|---|
| Initial liveweight (14 June 1999) (kg) | 268.6 | 270.9 | 268.8 | 270.2 | 274.7 |
| **Days 1-77** (14 June – 31 August) [A] | | | | | |
| Intake (% LW) | 2.74 | 2.52 | 2.46 | 2.33 | 2.55 |
| ADG (kg) | 1.23 | 0.90 | 0.92 | 0.91 | 0.90 |
| Liveweight – 31 Aug 1999 (kg) | 363.3 | 340.1 | 339.5 | 340.0 | 344.1 |
| **Days 78-139** (31 August – 1 Nov) [A] | | | | | |
| Intake (% LW) | 2.60 | 2.31 | 2.00 | 1.92 | 2.15 |
| ADG (kg) | 1.26 | 0.82 | 0.62 | 0.64 | 0.91 |
| Liveweight – 1 Nov (kg) | 441.2 | 390.7 | 378.0 | 379.9 | 400.9 |
| **Days 1-139** (14 June – 1 Nov) | | | | | |
| INTAKE (% LW) | 2.72 $^{A}$ | 2.50 $^{B}$ | 2.30 $^{BC}$ | 2.21 $^{C}$ | 2.47 $^{B}$ |
| ADG (KG) | **1.23** $^{AB}$ | **0.86** $^{B}$ | **0.77** $^{B}$ | **0.78** $^{B}$ | **0.90** $^{B}$ |
| FCR (kg food/ kg LW gain) | 7.5 | 9.4 | 9.3 | 8.9 | 8.8 |

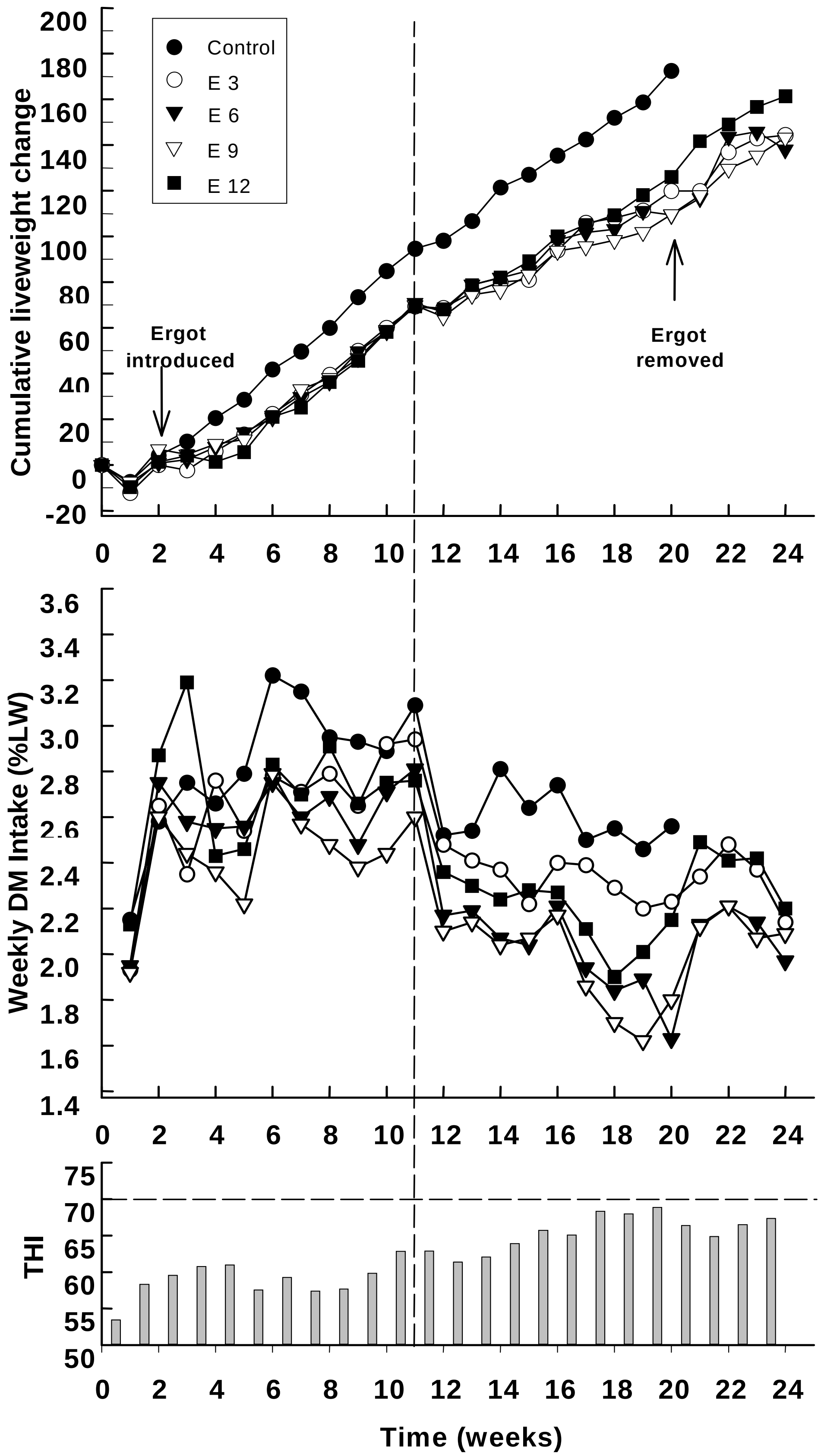
| | | | | |
|---|---|---|---|---|
| **Days 140-167** (1 Nov – 29 Nov) | | | | |
| Intake (% LW) | 2.25 | 2.05 | 2.05 | 2.32 |
| ADG (kg) | 0.87 | 0.94 | 1.20 | 1.25 |
| Liveweight – 29 Nov (kg) | 415.1 | 403.8 | 413.4 | 436.0 |
| **Days 1-167** (14 Jun – 29 Nov) | | | | |
| Intake (% LW) | 2.47 [A] | 2.26 [B] | 2.20 [B] | 2.45 [A] |
| ADG (kg) | **0.86** | **0.80** | **0.85** | **0.96** |
| FCR (kg food/ kg LW gain) | 9.6 | 9.1 | 8.5 | 8.6 |

[A] Differences between treatments for sub-periods 1-77 and 78-139 not tested here

[B] Means with different superscripts are significantly different (P=0.05)

Feed conversion ratios (kg food DM eaten/kg liveweight gain) were greater for steers receiving ergot than for the control steers over the total feeding period (days 1-139; Table 2). This resulted from the greater proportionate reduction in growth rate than of food intake in association with the presence of ergot in the sorghum.

*Figure 1. (over page) Effect of level of ergot inclusion in sorghum on the pattern of change in liveweight and intake for Hereford steers receiving a sorghum-based feedlot ration, and changes in the temperature-humidity index (THI) over the experimental period*



Control
E 3
E 6
E 9
E 12
Cumulative liveweight change
Ergot introduced
Ergot removed
Weekly DM Intake (%LW)
THI
Time (weeks)


*Figure 1.*

## 5.6 Rectal temperatures

Changes in rectal temperatures are illustrated in Figure 2. When the data were analysed over the initial 139 d feeding period, there was no significant overall effect of ergot concentration on rectal temperature but a significant treatment x time interaction ($P<0.05$), i.e., ergot had a significant effect at some times but not others. These effects were significant at weeks 10, 17 and 19 ($P<0.05$) and approached significance at weeks 14 ($P=0.08$) and 18 ($P=0.054$). In the case of weeks 17, 18 and 19, the high rectal temperatures and significant effects from ergot coincided with high temperature/humidity conditions, as indicated by the high THI (Figure 1). The control group had lower rectal temperature than the E6 and E9 groups on all the above occasions, and lower than E12 in week 17 and than E3 and E12 in week 19. Generally there were no differences in rectal temperature between the four groups receiving ergot, the one exception being week 17 when the E3 group had lower temperature than the three other ergot groups. Neither the treatment or treatment x time effects were significant in the last four weeks when ergot groups were given clean grain.

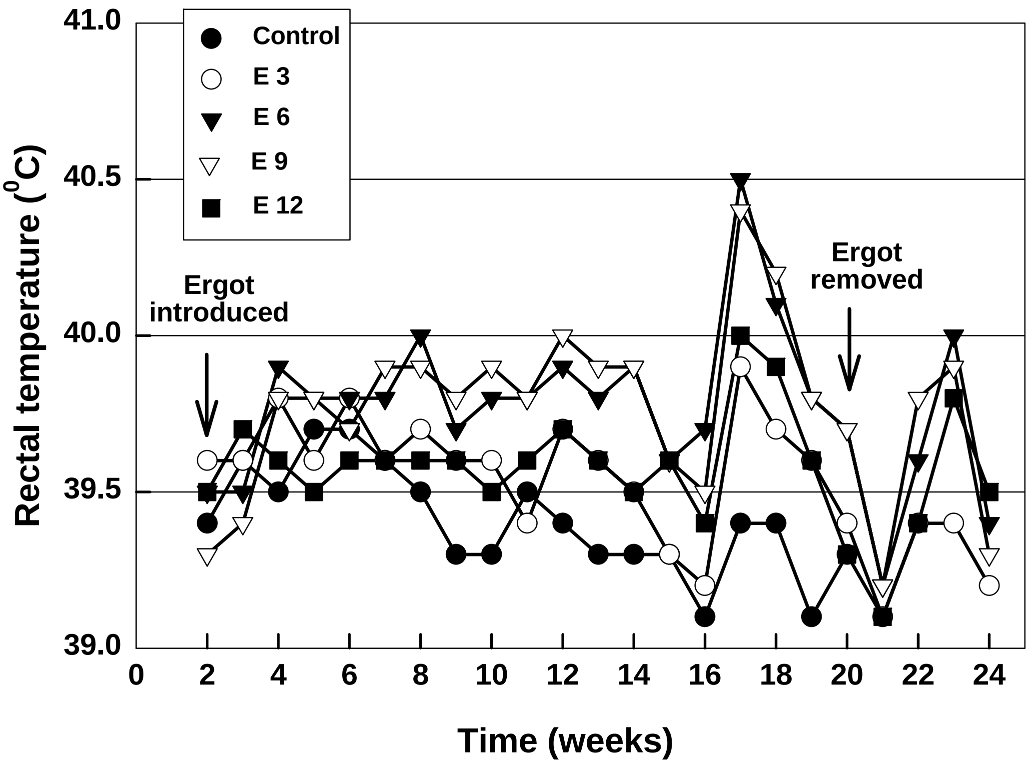



*Figure 2. Effect of level of ergot inclusion in sorghum on the pattern of change in rectal temperatures for Hereford steers receiving a sorghum-based feedlot ration*

## 5.7 Plasma prolactin concentration

Changes in the concentration of prolactin in blood plasma over the feeding period are shown in Figure 3. For the ergot groups, prolactin concentration decreased sharply (to almost zero for some treatments at week 5) soon after exposure to ergot alkaloids in contrast to the control steers which maintained a relatively high concentration throughout. There seemed to be a slight recovery by these groups in the subsequent 6 weeks. Treatment effects were significant at all sampling dates encompassing the period the steers had access to ergot, ie., except for week 2 (before ergot inclusion) and week 23 (after ergot removal). For the period of ergot access, the negative effect of ergot on prolactin concentration appeared to be gradational with a lower depression in concentration for the E3 group in general compared to other ergot groups. Thus control steers had higher concentration than the E3 group at week 5 but not at weeks 11 and 20, and higher concentrations than other ergot treatments at all other samplings except at week 20 when there was no difference between the control and E12 groups. Within the ergot treatments, the E3 group also had higher concentrations than other ergot groups except in week 11 when there were no significant differences between E3 and E6 groups.

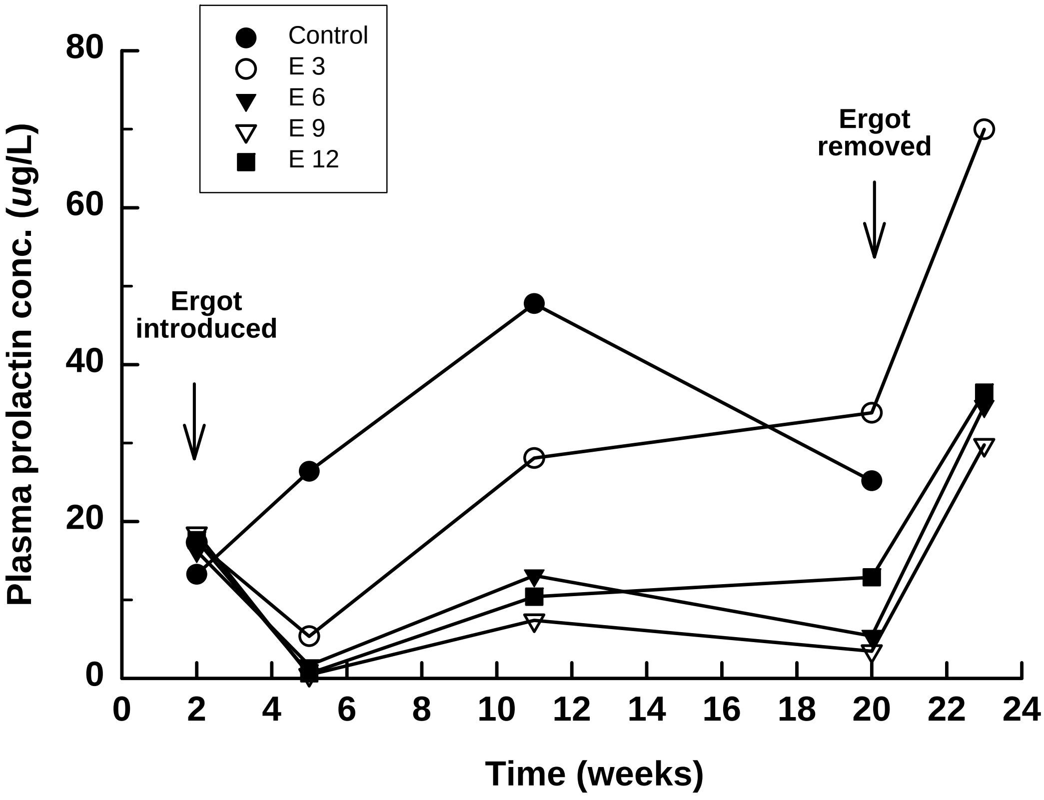



*Figure 3. Effect of level of ergot inclusion in sorghum on the pattern of change in prolactin concentrations in plasma for Hereford steers receiving a sorghum-based feedlot ration*

# 6.0 Discussion of results

The depression in cattle growth rates associated with feeding grain contaminated with ergot in this project is consistent with the results from the previous experiment. In the current project, feeding took place in the cooler months of the year as opposed to the previous experiment conducted in summer / autumn. Regardless, the depression in growth rate was similar for the two experiments up to an ergot alkaloid concentration of about 3 ppm, ie., *ca.* 30-35% depression in growth rate, after which the effects of ergot seemed to be more severe in the hotter months (see Figure 4). In fact, under the winter / spring feeding regime used here, there was no additional depression in cattle growth rate from increasing ergot alkaloid concentration above 3 ppm. The implication of this reduced growth rate was that, even with an additional 4 weeks of feeding on clean grain, the ergot steers did not attain the finishing liveweight or condition of the control steers. The economic consequences of this finding are discussed further later.

At 1.26 kg/d, the growth rate of the control steers was relatively low in relation to what might be expected of Hereford steers on this type of diet (1.4-1.5 kg/d), and in fact was considerably lower than that achieved in the previous project (1.43 kg/d) with similar cattle and a similar feedlot ration. Several reasons are offered for these poor growth rates. Firstly, it was obvious that the cattle had had little if any previous exposure to trough feeding, as it took several days for some steers to consume any appreciable amount of food. In addition, the physical appearance of the cattle, viz., low weights despite having 2 or more permanent teeth, suggested that they had suffered considerable growth retardation in early life which may have impacted on their capacity for rapid growth under a favourable nutritional regime.

The reduced growth rates by steers receiving ergot were associated with reduced feed intakes. Animals suffering from heat stress will reduce intake and thus metabolic heat production as a mechanism to reduce body temperature. This is particularly relevant during the hotter months of the year and in the previous study it was apparent that, in the presence of ergot, the animal's capacity to endure high temperature and humidity was reduced. In that study, the threshold THI was apparently reduced from 79 for *Bos taurus* cattle without ergot to about 70 when ergot was present. In the present study, the THI at no time exceeded 70 and only in a few weeks were rectal temperatures significantly increased due to ergot in the diet. Nevertheless, some steers at times showed obvious signs of heat stress, especially after exercise involved with being weighed. These effects were most pronounced in the later spring period of the experiment (weeks 17-20). Intakes were, however, depressed even during the early phase of the experiment carried out in winter, which suggests that the intake depression was not due to effects on body temperature alone. Instead there appears to be some metabolic effect attributable to the ergot alkaloids which contributes to reduced intake, probably in unison with temperature effects.

The depression in feed intake was not proportional to the reduction in growth rate, with the result that ergot-fed steers had considerably higher FCR's than the controls. This was less so in the previous experiment in which FCR's changed only marginally when ergot was included in the ration. These higher FCR's obviously exacerbate the economic consequences of ergot in feedlot rations (see later).

As has occurred in previous experiments, plasma prolactin concentrations in the steers receiving ergot were severely depressed, to virtually zero in some cases, in the period immediately after exposure to the ergot but then recovered slightly subsequently, although generally not to concentrations measured in control steers. In the present experiment there appeared to be a gradational effect with a lesser depression in concentration occurring at the 3 ppm alkaloid level compared with higher levels. By contrast, in the previous experiment plasma prolactin concentration remained at almost zero throughout the period of exposure to ergot at all levels of feeding, including 1.5 ppm alkaloid. This experiment was conducted in summer but the connection with time of feeding is not apparent. Also consistent with previous studies was the rapid recovery in prolactin concentrations after ergot is removed from the ration. The connection between ergot alkaloids, plasma prolactin and animal performance is not clear but could be critical to understanding the mechanisms of intake depression associated with ergot, and to devising strategies to overcome or lessen these effects.

It is noteworthy that the E12 group had very low prolactin concentrations throughout the period of ergot exposure, as might be expected, yet there was a trend for this group to outperform some of the other groups receiving lower amounts of ergot. For instance, intake over the first 139 d for this group was similar to that of the E3 group but higher than that of the E6 ($P>0.05$) and E9 ($P<0.05$) groups. Liveweight changes followed a similar trend but were not significantly different. There is no obvious biological reason for the effects of ergot alkaloids to be reduced at higher concentrations and it appears therefore that this result is anomalous. Between animal variability is very high in feeding trials such as this and sometimes the experimental design fails to accommodate this extreme variability. It is also apparent from the results of this experiment, and those that have preceded it, that some animals are able to cope with the high alkaloid intakes better than others. For instance, one of the steers from group E12 had an overall gain during the first 139 d of 1.20 kg/d, only marginally lower than the average for the controls yet this steer had consistently low plasma prolactin, high rectal temperature and a long, rough coat consistent with high ergot intake. The average and range in growth rates (kg/d) for the various treatments over this same period were: control, 1.23 average, 1.07-1.55 range; E3, 0.86, 0.47-1.20; E6, 0.77, 0.63-1.00; E9, 0.78, 0.60-0.97; E12, 0.90, 0.69-1.20. Again this reinforces the need for a robust experimental design capable of coping with the variability between animals.

# 7.0 Economic cost of ergot in feedlot rations

Below an attempt has been made to put a figure on the cost of ergot to the feedlot industry. The first step has been to establish the dose response effect of varying levels of ergot infestation on the performance of cattle in the feedlot. Figure 4 shows the dose response curves for liveweight gain in relation to ergot alkaloid concentration, for the present study (1999 winter) and also for the previous study which was conducted in the 1998 summer/autumn. Curves have been arbitrarily fitted to these data sets. These curves are trend lines only as there has been no formal statistical analysis of the difference between the two experiments, which in reality would be difficult given the low number of data points. Nevertheless, the trend is for the depression in performance due to ergot to be more acute during summer feeding than in winter, especially at higher concentrations, with the data suggesting a tendency to plateau out at higher concentrations in winter. The reduction in LW depression when ergot alkaloid concentration is 12 ppm is presumably an anomaly as there would be no biological explanation for this finding. The relationships presented suggest a 35% depression in growth rate at the higher levels of ergot inclusion. Furthermore, using the same trend line, ergot contamination at the industry standard (0.3% ergot, *ca.* 1.0 ppm alkaloid with the grain used previously) might result in a 20% depression in growth rate. This is being investigated in current studies (FLOT.114).

Data from these studies, as represented in Figure 4, have been incorporated into a small feedlot budget model to determine the effects on economic returns of prolonging the time on feed due to ergot contamination. The budget has been developed on the basis of sending 'home-bred' steers to a commercial feedlot to be finished for the domestic market. Some of the fixed inputs include:

| | |
|---|---|
| Entry liveweight (LW) | 340 kg |
| Final LW | 450 kg (243 kg dressed weight (DW) @ 54% dressing %) |
| Initial value of steers | $1.25/kg LW |
| Finished value of steers | $1.40/kg LW ($2.60/kg DW) |
| Interest rate | 8% |

Costs have been determined in two ways, ie., (i) Method 1 - on the basis of the owner of the cattle paying for the feed at cost ($160/tonne) plus a daily yardage fee of $0.60/steer/day; or (ii) Method 2 - where the feedlot charges the cattle owner a margin on the cost of the feed used ($35/tonne; ie., $160 + $35 = $195/tonne total), but there is no daily yardage cost.

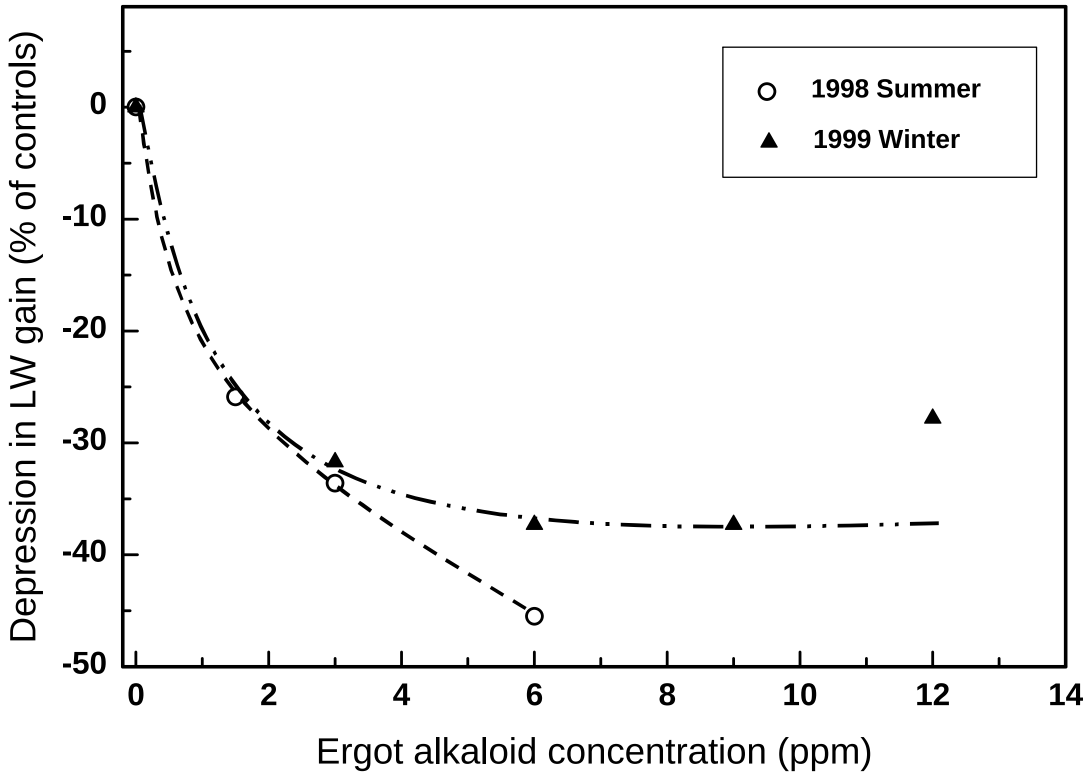



*Figure 4. Dose response curves for the effect of sorghum ergot alkaloid concentration in the grain on growth rate of cattle in the feedlot. Separate theoretical relationships are shown for summer/autumn and winter/spring feeding. Points on the curve represent group means.*

All of the induction costs, veterinary costs, mortalities etc. have been kept constant for the different feeding treatments. The absolute values for the various inputs are not critical as they are the same regardless of whether ergot is present or not, with the possible exception of the mortalities which might be higher for animals receiving ergot in hot weather. Obviously the economic return will vary according to these inputs but the relative differences in profitability between clean grain and ergot-infected grain will not. The growth rates and intakes used in the model are those recorded during the experiments. Data for the 1999 (winter) experiment have been bulked due to the small differences between ergot treatments, whereas separate calculations have been done for the various treatments employed in 1998 (summer). An example of the input and output sheets from the model are shown in Appendices 1 and 2.

Treatments are compared on the basis of the profitability of the feedlot enterprise, expressed on a per steer basis. Thus the reduction in profitability is determined where the feed costs (per tonne) remain constant. In addition, the amount ($) that the feed would have to be down-valued in order for the profitability to be maintained at the level achieved in the control (no ergot) situation, is determined. For the purpose of this exercise, it is assumed that all of this devaluation would be borne by the sorghum grain component of the ration.

The results of this exercise are presented in Table 3 and are summarised below. It should be stressed that **the absolute values for economic effects of ergot will vary according to the feeding circumstance** Profitability for instance cost of feed, duration of feeding and hence market targeted, interest rates etc., and only one feeding scenario is examined here.

- For Method 1 (feedlot costs based on daily yardage fee), the presence of ergot in the grain reduced the returns by between $42 and $110/steer (approximately $1.55-$1.91/steer/additional day on feed (over and above control feeding period)) with the depression in return directly related to ergot alkaloid concentration.
    - This effect was due both to a prolonged feeding period but also to the fact that FCR's were generally higher with ergot compared with clean grain so that the steers consumed more feed for the same overall LW gain.
- For Method 2 (feedlot costs based on feed cost margin), the reduction in profitability was between $31 and $91/steer (approximately $1.14-$1.58/steer/additional day on feed).
    - This effect was again due to the prolonged feeding period and the higher FCR with ergot in the ration.
- Indications from the trials to date, and summarised in Figure 4, are that the effects of ergot will be amplified in the hotter months of the year and profitability will be more severely affected in summer compared to winter for a particular level of ergot contamination.

1. Discounted costs for feed (sorghum)

- In order to maintain profitability (at the control (clean grain) level), the amount paid for sorghum would need to be reduced by between $39 and $82/tonne, based on Method 1 calculations, and between $29 and $67/tonne using Method 2.

There are obviously other less easily quantified costs related to the ergot contamination of feed. Whilst with Method 1 it could be argued that under this arrangement the destination feedlot is being paid a daily yardage fee irrespective of the time the cattle are in the yards, and is therefore not financially disadvantaged by prolonging the turn-off time (as opposed to the owner of the cattle), the reputation of the custom feeders would obviously be compromised if cattle returned these low growth rates in the feedlot.

Other losses could result from cattle not reaching market deadlines for weight and grade at a designated time. There is also the potential for increased deaths with ergot if hot, humid weather conditions are experienced. Furthermore, cattle receiving ergot have been observed to have longer, rougher coats providing less visual appeal if sold in the yards but also increasing the potential for dags to establish, with obvious costs for management or increased risk of carcass condemnations.

Where the owner of the cattle also owns the feedlot, the reduced throughput of cattle will also have a major impact on the viability of the feeding operation. In the domestic market situations shown (Table 3), there could be 4.7 lots of steers finished annually with the clean grain but only 3.5, 3.2 and 2.6 lots with ergot alkaloid levels in grain of 1.5, 3 and 6 ppm.

Inputs into the economic model are either experimental results or are fixed inputs as outlined in the text. Two methods are used in the calculations, ie., 1, owner of the cattle pays for the feed at cost ($160/tonne) plus a daily yardage fee of $0.60/steer/day; or 2. feedlot charges the cattle owner a margin on the cost of the feed used ($35/tonne; ie., $160 + $35 = $195/tonne total), but no daily yardage cost. The extent to which feed costs would have to be discounted (from $160 (Method 1) or $195 (Method 2)) in order to maintain profit at the level achieved by control steers is estimated.

**Table 3. Economic analysis of the effect of ergot infestation of sorghum at different levels (alkaloid concentrations) on the returns from finishing steers in a commercial feedlot.**

| | | Ergot alkaloid concentration (ppm) | | | |
|---|---|---|---|---|---|
| | | Summer feeding | | | Winter |
| | **0** | **1.5** | **3** | **6** | **3-12** |
| Growth rate (kg/d) [A] | 1.43 | 1.06 | 0.95 | 0.78 | 0.95 |
| DM intake (kg total) | 822 | 945 | 990 | 1,192 | 1,077 |
| DM intake (%LW/d) [B] | 2.70 | 2.30 | 2.16 | 2.14 | 2.35 |
| Time to finish (d) | 77 | 104 | 116 | 141 | 116 |
| **1. Daily yardage fee** | | | | | |
| Estimated profit ($/head) | 16.86 | -24.88 | -45.13 | -93.14 | -57.66 |
| Estimated cost of ergot ($/head) | - | **41.74** | **61.99** | **110.00** | **74.52** |
| Cost ergot ($/head/additional day) | | 1.55 | 1.59 | 1.72 | 1.91 |
| Feed cost - profit maintenance ($/t) | (160) [C] | 121.20 | 106.00 | 77.90 | 99.30 |
| Discounted value of sorghum ($/t) [D] | - | **-38.80** | **-54.00** | **-82.10** | **-60.70** |
| **2. Feed cost margin** | | | | | |
| Estimated profit ($/head) | 30.58 | -0.07 | -11.66 | -60.41 | -31.01 |
| Estimated cost of ergot ($/head) | - | **30.65** | **42.24** | **90.99** | **61.59** |
| Cost ergot ($/head/additional day) | - | 1.14 | 1.08 | 1.42 | 1.58 |
| Feed cost - profit maintenance ($/t) | (195) | 166.50 | 157.60 | 128.40 | 144.80 |
| Discounted value of sorghum ($/t) [E] | - | **-28.50** | **-37.40** | **-66.60** | **-50.20** |

[A] Data from experiments used in calculations
[B] Intakes from experiments
[C] Assuming feed costs of $160/tonne for controls
[D] Value for grain to be discounted to maintain profit levels, ie., discount on $160 for total ration
[E] Value for grain to be discounted to maintain profit levels, ie., discount on $195 for total ration

# 8.0 Implications for feedlot industry

Results of research reported here indicate that ergot will adversely affect animal productivity at concentrations in the grain of 0.5% ergot and greater, irrespective of whether it is fed in summer or winter. Sorghum ergot is present in all sorghum-growing regions and future prevalence of ergot cannot currently be predicted as it is dependent upon seasonal weather conditions. While the bulk of grain sorghum crops have escaped heavy contamination over the past two seasons, it should be recalled that many late-planted crops in central Queensland in 1997 contained up to 30% ergot. It has now become urgent that the lowest level of ergot capable of affecting cattle be established.

If managers of feedlots are not aware of the effects of ergot, then they may suffer severe financial loss. The first priority therefore is to ensure industry participants are aware of the risk, and can detect ergot in grain. The DPI, through its extension notes, newspaper articles and other media are attempting to address this.

Assuming that feedlotters are aware of ergot and can detect it, then its main effects will be on grain prices and availability. Many moderately sized feedlots (turning off 40,000 - 100,000 head per annum) in northern Australia rely on home-grown grain – usually sorghum in Summer and barley in Winter. If this sorghum contains ergot, it may well be unusable in the feedlot. Having to purchase grain will drive up costs greatly. The costs of growing sorghum are around $80/tonne, but purchased grain will range from $100 to $150/tonne. The economic evaluation in this report shows that sorghum containing 0.5% ergot would need to be discounted by more than $20/tonne just to maintain profits. Even if sorghum does contain ergot at the regulated concentration of 0.3%, it is very unlikely to be discounted by $20/tonne, as its value on the export market (largely for chicken feed) would then be greater. The consequence is that in some seasons, ergot-free sorghum may not be available for feedlotting at an economical price.

The end results will be that some small operators who feedlot as a sideline will simply not take the opportunity. However, those larger operators with existing markets will have to buy grain, either wheat, barley or maize. This will drive up grain prices across eastern Australia. As a rough estimate 2.1 million tonne of feed-grade grain, including 300,000 tonne of sorghum, are used each year in Australia for feedlots. If sorghum is out of the equation, it would not be surprising if the price of remaining feed grain was to increase by $10/tonne as a result of supply and demand, which would have a major economic impact on even those feedlot operations that never use sorghum. On the other hand it must be remembered that not all sorghum is infected with ergot in any year and it may only be 5% of the total sorghum crop that is affected, although this figure will be quite variable between years depending on growing conditions.

# 9.0 Communication strategy

Results from the various projects have been communicated to industry in several ways:

1. ALFA Newsletter articles
2. Beeftalk articles (no. 9 – Autumn / Winter 2000 edition)
3. Queensland Country Life (1 June 2000).
4. Poster prepared for use at producer field days / meetings, including a NABRC visit.
5. Radio talk on the ABC by Mr Barry Blaney
6. DPI Farm Note
7. Sorghum ergot technical meetings involving various research organisations, funding providers and producers (two meeting to date)

The results of this and other experiments in the series will be presented in the near future in scientific journals, principally the Australian Journal of Agricultural Research.

## 9.1 Example newsletter article

**Sorghum ergot still an important issue for feedlotters**

Steers offered feedlot rations contaminated with sorghum ergot had reduced feed intakes and slow growth rates compared to those fed clean grain. These were the results of the second trial conducted at the DPI's Animal Husbandry Research Farm at Rocklea. Similar to the first trial that was conducted in the hotter summer months, the latest trial conducted in winter clearly demonstrated that even moderate levels of ergot in sorghum could severely impact on the economic viability of grain feeding.

Ergot is a fungal disease which was first detected in sorghum in Australia in early 1996. At that stage there were concerns about its impact on grain yield but there was no evidence anywhere that feeding ergot-infected sorghum to livestock would have any negative effects. In late 1997, however, lactation failure in sows and dairy cattle in central Queensland was shown to be attributable to the feeding of ergot-infected sorghum. This prompted a series of experiments with feedlot cattle, funded by Meat and Livestock Australia (MLA), Australian Lot Feeders Association (ALFA) and the Grains Research and Development Corporation (GRDC), to determine the effects of ergot on cattle performance and the economic impact of using this infected grain source.

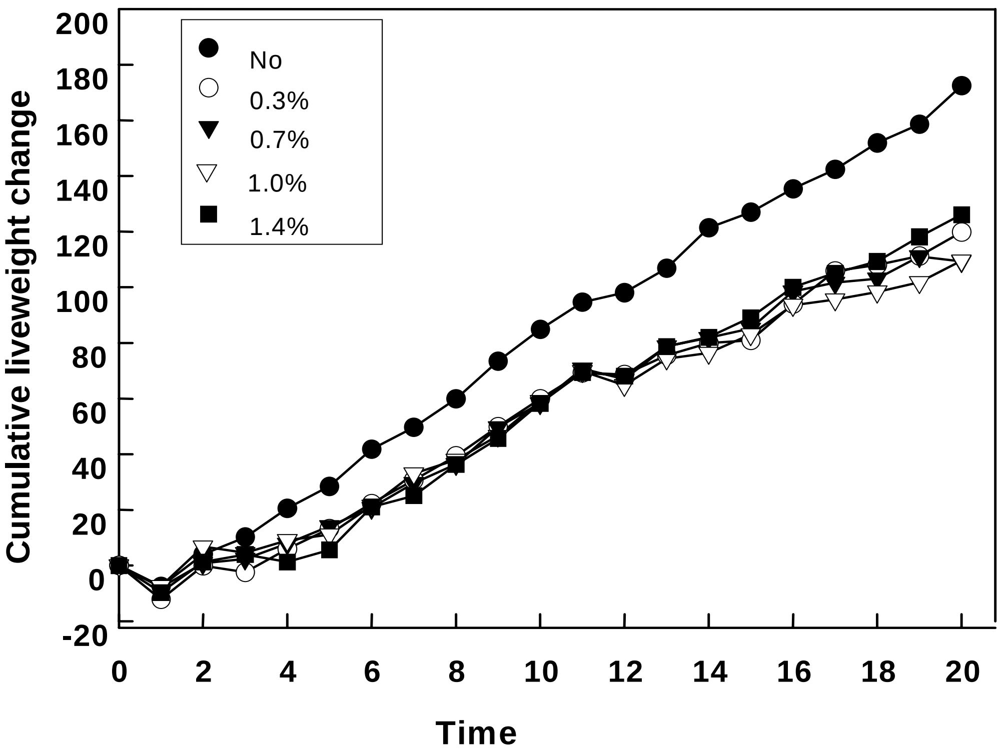
Mr Barry Blaney of the DPI Animal & Plant Health Service coordinates the research on sorghum ergot toxicity to livestock in DPI. He said that the effects of sorghum ergot on cattle are similar to those for rye ergot which has caused problems for cattle producers in New South Wales and Victoria over the past two seasons. The interaction of ergot with high temperatures has led to serious stock losses on some farms.

Project leader, Dr Stuart McLennan of the Queensland Beef Industry Institute, explained that ergot inhibited the animal's ability to regulate body temperature, and decreased feed intakes seem to be related to this. The trial just completed was investigating whether ergot was tolerated better in cooler winter months than in summer when the animal's inability to dissipate heat often led to heat stress symptoms. Unfortunately, the graph below shows that this was not the case, although the effects of ergot were noticeably worse on hot days.

The Hereford steers used in this experiment (270 kg initially) were fed rations based on dry-rolled sorghum with either no ergot or with 0.3, 0.7, 1.0 and 1.4% ergot contamination, equivalent to about 3, 6, 9 and 12 parts per million (ppm) ergot alkaloid concentration for this grain. The alkaloids are the toxic compounds in the ergot. Steers receiving clean grain gained 1.26 kg/day over the 140 day trial period but the ergot reduced this growth rate by 33% on average. This depression in growth rate reflected both reduced feed intake (by 13%) and reduced feed conversion efficiency (7.5 and 9.1 kg feed/kg gain for control and ergot groups) by the steers receiving ergot-contaminated grain. In the present experiment there were no appreciable differences between the different levels of ergot contamination in terms of the depression in intake and growth rate of steers. Other noticeable effects of the ergot were higher rectal temperatures and longer, rougher coats compared to the control steers. The longer coats could also contribute to a greater problem with feedlot dags under some circumstances.

So far, these trials have demonstrated that even 0.3% of ergot in sorghum will have adverse effects on feedlot cattle. However, most levels of ergot fed to date have exceeded the current industry standard of 0.3% and Dr McLennan and his team have commenced research to determine the effects of ergot contamination at this level or lower, and thereby ascertain whether this current industry standard needs to be modified. Ergot levels of 0.08 to 0.3% are currently being evaluated in feedlot rations.

**Figure 5. Effects of ergot concentration in sorghum on cumulative liveweight change of Hereford steers**




Whatever the result, Mr Blaney maintains that there is still a strong future for sorghum as a feed grain. He emphasised that ergot infection in sorghum crops could be managed, and that the incidence of sorghum ergot contamination was actually very low (<1% of the crop) in the 1999 sorghum crop. The bulk of crops which are planted at the normal time seem to be escaping ergot infection. Late planted crops usually present the greatest risk of contamination as they are pollinated under cooler, wetter conditions. Furthermore, it is thought that generally speaking it is okay to graze animals on ergot-affected sorghum at the honeydew stage. It seems to be mainly when the grain goes to full maturity that it becomes most toxic.

Mr Blaney also indicated that sorghum crops could display symptoms of ergot but have a very low level of ergot sclerotes in the harvested grain. The DPI is currently working with the funding bodies to develop rapid tests for ergot.

Further information:

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**Dr Stuart McLennan**

***DPI's Animal Research Institute, Yeerongpilly***

*Phone: 07 3362 9470 / 3362 9477*

# 10.0 Conclusions

The results of this project indicate that, even under cooler climatic conditions, the presence of ergot in sorghum will reduce animal performance in the feedlot. Furthermore, it appears that this depression in performance occurs even at low concentrations of ergot alkaloid. In this experiment, there were only marginal differences between ergot treatments for most parameters. Nevertheless, all of the ergot inclusion rates exceeded the current industry standard for ergot contamination of 0.3%, or approximately 1 ppm alkaloid in the grain used in this experiment. There is an urgent need now for further research to (i) determine how low a level of ergot inclusion needs to be attained before there is no depression in animal performance, that is, whether the current industry standard is appropriate; (ii) what the value of the contaminated grain should be in the market place; and (iii) whether there are ameliorative measures which might be used to lessen the effect of the ergot contamination. One specific question requiring an answer is whether the reduced growth rate is merely due to reduced intake, or whether there are other metabolic effects which lead to reduced utilisation as well.