

# final report

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## **Assessing cattle motivation for access to pasture or feedlot environments**

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## Abstract

There is a public perception that cattle welfare is reduced under intensive feedlot finishing due to the issue of confinement. A study was conducted to examine cattle perception of the feedlot environment by assessing motivation to access either a feedlot or a pasture environment. Twenty-eight 12-month-old Angus steers ( $264 \pm 2.4$  kg body weight, mean  $\pm$  SEM) were allocated to 2 groups (n=10 per group). A Y-maze testing facility was constructed consisting of two Y-mazes attached to either pasture or a feedlot. Cattle underwent four stages of Y-maze testing in their groups. In stage 1, cattle spent 7 days in the feedlot where they were fed a full daily ration split into two feeding times at 08:30h and again at 16:00h daily. Then they were tested in the same Y-maze twice daily (at 08:30h and 16:00h) for 10 consecutive days. In stage 2, cattle were confined to the feedlot for 4 weeks where they were fed twice daily. Next, they were tested in the same Y-maze twice daily for 5 consecutive days. In stage 3, to determine the influence of maze side on preference, cattle were trained to learn the direction of the alternate Y-maze and were tested twice daily for 6 consecutive days. Stage 4 examined the influence of removing the feed reward by testing once per day at 12:00h without the feed reward for 10 consecutive days and from alternating mazes.

In all the Y-maze tests, once an animal had made a choice in the maze, they were confined to the environment they chose (feedlot or pasture) until the next time of testing, thereby imposing a cost on their choice. Preference for choosing the feedlot was tested by comparing the mean group observed choice to random chance (50%). The results show that when a feed reward coincided with the time of Y-maze testing, cattle showed a preference for the feedlot environment (stages 1 and 2). The time of day did not influence feedlot choice in the maze when there was a cost imposed on the choice. In stage 4, when the feed reward was removed, cattle showed a preference for the feedlot on days 2, 3 and 4 and there was no preference observed for the remaining 6 days. The current study indicated that cattle showed a preference for the feedlot when testing coincided with feeding and that they were willing to pay the cost of their choice where they were then unable to access the pasture environment.

## Executive Summary

There is a public perception that animal welfare is reduced under intensive animal farming systems compared with extensive or free-range systems. Many animal interest groups hold strong positions against intensive systems where animals are confined, and use this as the focus of campaigns. Because feedlots are an intensive system, the feedlot industry is at risk of being presented and targeted as a system in which there is inherent animal suffering due to the nature of the production system itself. Feedlots are perceived by some people to affect welfare because cattle cannot perform normal behaviours, such as grazing, which are evident in pasture environments. There is a lack of scientifically defensible evidence to either support or counter such claims.

The accredited feedlot industry in Australia can point to its QA management systems, animal health records and inspection processes to provide evidence on the health and management of its feedlot cattle. However, there is no current objective data to address any claims of animal suffering due to the confinement and intensity of the production system itself. Accordingly, it is prescient for the feedlot industry to obtain objective, science-based evidence on how cattle perceive the feedlot environment, especially in comparison with being at pasture.

In the previous project (B.FLT.0349), free choice testing was conducted to determine how the preference of cattle for a commercial feedlot or pasture environment changes with different pasture availabilities. It was found that cattle chose to spend 25-30% of their time in the feedlot and this was not influenced by pasture availability. Feedlot feeding periods peaked at the start of the day around 08:00h with cattle preferring to be in the feedlot during the day and at pasture at night, where they spent between 50-80% of their time lying. When given free choice, cattle will take advantage of what they perceive to be the best elements of both environments. For example, cattle obtained the majority of their daily nutritional needs from the feedlot diet.

Whilst preference testing was an important first step in determining cattle perceptions of the feedlot and pasture environments, it did not inform on how important it is for animals to access each environment. The current project has added a cost to the animal's decision to enter a feedlot or pasture environment. The addition of a "cost" to the animal's choice enables assessment of motivation of animals to access each environment. This information provides an understanding of how cattle perceive the feedlot. This study used the accepted behavioural method of Y-maze testing to determine the motivation of cattle for a feedlot or pasture environment.

Cattle showed a preference for the feedlot environment following two separate periods of confinement (7 days and 4 weeks). At no time during testing was there a preference shown for the pasture environment. This result provides evidence that cattle will choose the feedlot environment when there is a cost imposed on their decision. The time of day did not influence feedlot choice in the maze. In stage 4, when the feed reward was removed, cattle showed a preference for the feedlot on days 2, 3 and 4 and there was no preference observed for the remaining 6 days, which suggests that the feed reward was influencing the decision to enter the feedlot.

This was the first time that the Y-maze methodology has been used to assess preference for feedlots. Several design issues were observed and overcome throughout the study. Firstly, the issue of development of behavioural patterns where cattle repeatedly follow the same maze direction due to familiarity, which was overcome by alternating the mazes used for daily testing. Secondly, the feed reward has been shown to influence choice and needs to be carefully managed e.g. through *ad libitum* feeding, which would also more closely represent the commercial feedlot situation, to avoid confounding the design of future choice studies.

The model developed here using Y-maze testing was unique as it assessed preference with the addition of a cost imposed on the choice made, which enables assessment of motivation to access the feedlot or pasture environment, and specific elements or characteristics within each environment. This method provides understanding of the tradeoffs that cattle make in deciding between a feedlot and pasture environment. Development of this methodology and establishment of the testing infrastructure will enable further questions relevant to cattle welfare in feedlots to be addressed. These questions include examination of how cattle perceive different conditions in the feedlot, such as during periods of wet weather when pen surfaces become muddy.

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## 1 Background

There is a public perception that animal welfare is reduced under intensive animal farming systems compared with extensive or free-range systems. Many animal interest groups hold strong positions against intensive systems where animals are confined, and use this as the focus of campaigns. Because feedlots are an intensive system, the feedlot industry is at risk of being presented and targeted as a system in which there is inherent animal suffering due to the nature of the production system itself. The Five Freedoms framework which is used to evaluate animal welfare, includes the ability “to express normal behaviour” as one of its criteria. Confinement of cattle to feedlots restricts their ability to perform their full repertoire of natural behaviours, such as grazing. While access to more natural pasture environments are perceived to result in better welfare by allowing cattle to perform normal behaviour, there is no scientific evidence to support this.

In the previous project (B.FLT.0349), free choice testing was conducted to determine how the preference of cattle for a commercial feedlot or pasture environment changes with different pasture availabilities. It was found that cattle chose to spend 25-30% of their time in the feedlot and this was not influenced by pasture availability. Feedlot feeding periods peaked at the start of the day around 08:00h with cattle preferring to be in the feedlot during the day and at pasture at night, where they spent between 50-80% of their time lying. When given free choice, cattle will take advantage of what they perceive to be the best elements of both environments. For example, cattle obtained the majority of their daily nutritional needs from the feedlot diet.

Whilst preference testing was an important first step in determining cattle perceptions of the feedlot and pasture environments, it did not inform on how important it is for animals to access each environment. The current project has added a cost to the animal’s decision to enter a feedlot or pasture environment. Once an animal makes a choice in the maze, it must remain in the chosen environment (feedlot or pasture) until re-tested. The addition of a “cost” to the animal’s choice enables assessment of motivation of animals to access each environment (Dawkins, 1990; Kirkden and Pajor, 2006). This information provides an understanding of how cattle perceive the feedlot. This study used the accepted behavioural method of Y-maze testing to determine the motivation of cattle for a feedlot or pasture environment.

## 2 Project Objectives

Provide objective, science-based information on the motivation of cattle to access feedlot or pasture environments, utilising the accepted method of Y-maze testing.

## 3 Methodology

### 3.1 Ethical approval of animal experimentation

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The protocol and conduct of this experiment was approved by The CSIRO Chiswick Animal Ethics Committee under the NSW Animal Research Act, 1985.

### 3.2 Animals and facilities

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The experiment was conducted at Armidale NSW, Australia in summer from September 2012 until May 2013. The average daily minimum temperature was 5.8 °C and the average daily maximum was 21.7 °C. A Y-maze testing facility (maze approximately 12 m long, 1.8 m high) was constructed consisting of two Y-mazes leading to an option of a feedlot or 3.6 Ha of pasture (See Figure 1; Figure 2; Figure 3). The feedlot was 162 m<sup>2</sup> in size (15 x 10.8 m) which was sufficient to contain the animals at the recommended feedlot density of at least 9 m<sup>2</sup> per animal (Model Code of Practice for the Welfare of Animals - Cattle, PISC, 2004). The feed was placed in

three troughs (each 0.65 m wide x 0.55 m high x 2.9 m long). The feedlot pad was prepared by laying a gravel base that was covered with feedlot compost (250 mm thick) which was rolled to form a pad that was well drained and sloped. As it is not commercial practice in Australia to use bedding, no bedding was added to the feedlot pad. The feedlot and pasture environments contained identical water troughs and water from the same source. No shelter, trees or shade were offered in either environment. The pasture was of a quality and type typical for extensively farmed cattle. The Y-maze walls were made opaque to ensure cattle could not see through, using split belt (Andromeda Engineering, Moonbi, Australia).

A total of 28 12-month-old Angus steers ( $264 \pm 2.4$  kg body weight, mean  $\pm$  SEM) were used for the study. All cattle were tested in a Y-maze to determine their natural side preference. Side preferences vary between individuals with some behaviours preferentially performed by one side of the body and are the effect of brain lateralization on the way information is processed by animals. Cattle were weighed and flight speed tested to allocate to 2 groups of 10 animals by balancing for weight, side preference and flight speed. Eight steers were kept as spare animals and were used as companions as needed. A summary of the testing procedures is presented in Table 1.

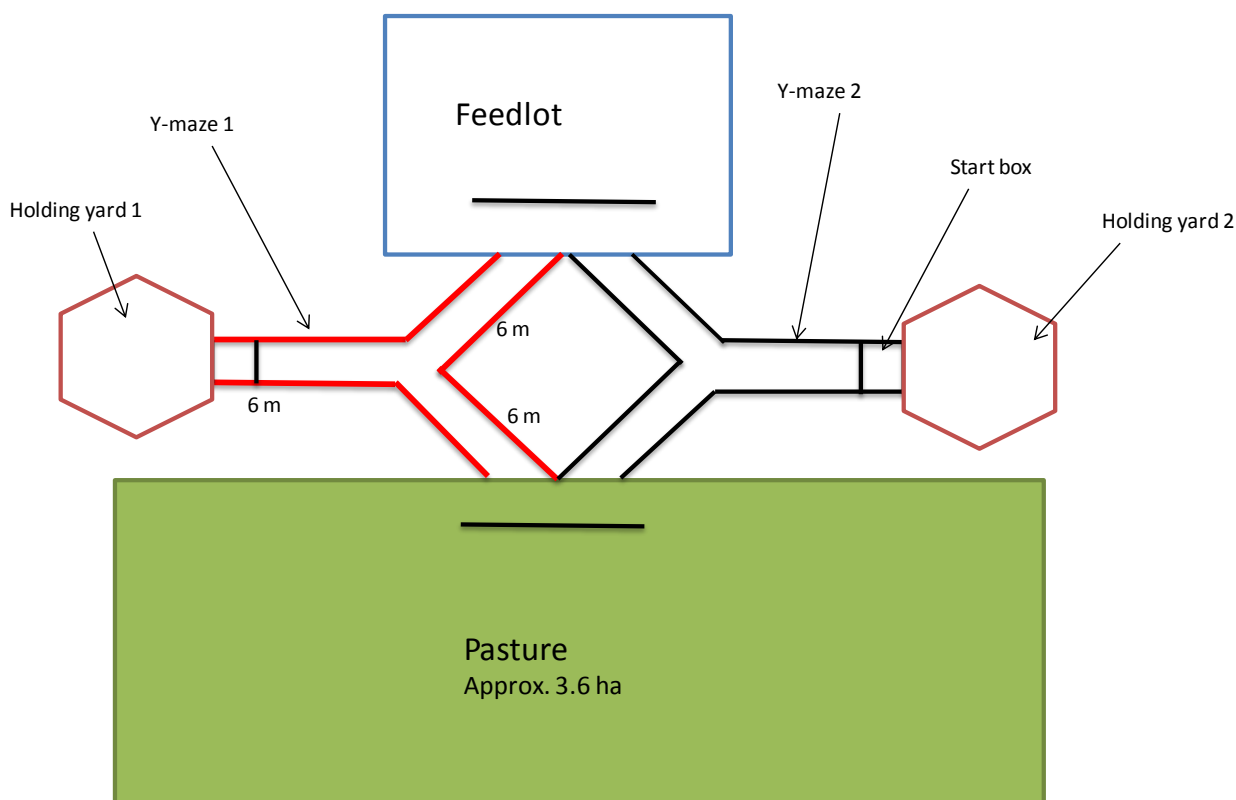


Figure 1. The Y-maze testing facilities.

### 3.3 Feedlot ration

The feed provided in the feedlot was a starter feedlot ration (Ridley Agriproducts, Victoria, Australia; 89% DM, 12% protein, 1.0% crude fat, 0.65% Ca, 9.5 MJ/kg). A buffer pellet was added at a rate of 25 kg/tonne ration to prevent acidosis (Animal Innovations, SA, Australia; 7% protein, 2.1% fat). Cattle were fed the feedlot ration twice a day (at 08:30h and 16:00 h). They were fed the ration at the recommended rate of 2 kg ration per 100 kg live weight. Roughage (pasture hay) was provided *ad libitum* whilst animals were in the feedlot.



### **3.4 Habituation and training**

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Group 1 was first habituated to the pasture (1 week) and feedlot (5 days). During habituation cattle in the feedlot were fed twice daily (08:30 h and 16:00h). They were then trained in a Y-maze to learn the direction of the feedlot and pasture environments. Each animal performed 10 trials per day with a forced choice alternating between the feedlot and pasture for 2 consecutive days (total of 20 trials per animal). The training and testing procedures are summarised in Table 2.

### **3.5 Stage 1: Y-maze testing with a feed reward following 7 days feedlot confinement**

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Following training, all cattle in group 1 were fitted with IceTags (IceRobotics, Midlothian, Scotland; Figure 4) to measure lying and standing behaviours during the testing periods. They were then confined to the feedlot environment for 7 days. Following this, cattle were tested in the Y-maze. At approximately 08:30h, individual cattle were brought into the holding pen whilst a feed ration was placed in the feed troughs in the feedlot. Cattle could hear the auditory cue of the feed being placed in the troughs. Next, an animal was introduced into the start box where it was given a choice of accessing pasture or the feedlot (containing a half daily feedlot ration). Steers were tested in order of entry into the start box. Once a choice was made as categorised by the steer placing two front legs over the arm of the maze, the steer was confined to the environment they chose. The spare cattle were used as companion animals where needed (e.g. if only one animal chose the pasture or feedlot). At approximately 16:00h, all cattle were brought back into the holding yard and Y-maze testing was repeated. This continued for a total of 10 days. Icetags were removed at the end of testing.

### **3.6 Stage 2: Y-maze testing with a feed reward following 4 weeks feedlot confinement**

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Following this, cattle were confined to the feedlot for a total of 4 weeks and fed twice daily at 08:30h and 16:00h. They were then tested in the Y-maze twice daily (at 08:30h and 16:00h) for 5 consecutive days from the same Y-maze they were tested in previously. The testing process was the same as that described in section 3.5.

### **3.7 Stage 3: Y-maze testing with a feed reward from alternate maze**

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Next, cattle were trained from the opposite Y-maze to learn the new direction of the feedlot and pasture environments on one day with 10 forced choice trials (alternating between feedlot and pasture) for each animal. Then they were tested twice per day at 08:30h and 16:00h for 6 consecutive days from the alternate Y-maze. The treatment and testing process was repeated for group 2 with testing starting in the opposite Y-maze to balance the design and account for side biases. The testing process was the same as that described in section 3.5.

Table 1. Summary of feedlot preference testing stages describing the cues and feed rewards tested in the Y-maze.

Stage	Test	Cues		Feed rewards		Cost	Probable learned associations
		Visual cue in maze	Possible auditory cues from activity of workers	Feedlot	Pasture		
1	Feedlot at end of the same arm of Y-maze (left for group 1 and right for group 2)	None	Sound of feed added to trough while cattle in holding yard awaiting testing	Concentrate feed on offer at entry	Pasture fodder after entry to paddock	7 (daytime) or 15 (nighttime) hours confinement to feedlot or pasture environment	Time of day associated with feeding. Auditory cue associated with feeding in feedlot
2	Feedlot at end of same arm of Y-maze (left for group 1 and right for group 2)	None	Sound of feed added to trough while cattle in holding yard awaiting testing	Concentrate feed on offer at entry	Pasture fodder after entry to paddock	7 (daytime) or 15 (nighttime) hours confinement to feedlot or pasture environment	Time of day associated with feeding. Auditory cue associated with feeding in feedlot
3	Feedlot at end of opposite arm of Y-maze (right for group 1 and left for group 2)	None	Sound of feed added to trough while cattle in holding yard awaiting testing	Concentrate feed on offer at entry	Pasture fodder after entry to paddock	7 (daytime) or 15 (nighttime) hours confinement to feedlot or pasture environment	Time of day associated with feeding. Auditory cue associated with feeding in feedlot
4	Feedlot side alternated daily	X on wall to indicate direction of feedlot in Y-maze	None	None	Pasture fodder after entry to paddock	7 (daytime) or 15 (nighttime) hours confinement to feedlot or pasture environment	None

Table 2. Summary describing the protocol of training and testing

<b>Procedure</b>	<b>Detail</b>
Training	10 trials per day for 2 days (alternating sides)
Feedlot	Confined in the feedlot (7 days)
Stage 1: Testing in Y-maze from the same side	10 days (twice per day)
Feedlot	Confined in the feedlot (4 weeks)
Stage 2: Testing in Y-maze from the same side	5 days (twice per day)
Training	10 trails on one day (alternating sides)
Stage 3: Testing in Y-maze from opposite side	6 days (twice per day)
Feedlot	Confined in the feedlot for 2 days
Stage 4: Testing in Y-maze without feed reward and with alternating sides daily	10 days (once per day)

### **3.8 Stage 4: Y-maze testing without a feed reward and from alternating mazes**

As the previous testing coincided with feed ration being placed in the feed troughs in the feedlot, further testing was conducted whilst removing the associated feeding reward by testing at a time when feeding did not occur (once per day at 12:00h). The influence of side biases on choice in the maze was also removed by alternating tests between maze 1 and 2. Cattle in group 1 were fed the feedlot ration for 1 week in their home paddock (to re-acclimatise them to the diet). They were then trained on one day to learn the direction of the feedlot and pasture from both Y-mazes (1 and 2) for a total of 10 trials (5 forced choices from each side of the maze alternating between feedlot and pasture). A visual cue of a black X on A4 paper was placed on the feedlot side wall of the Y-maze at cattle head height to act as an additional cue for cattle to learn the direction of the feedlot. Next they were confined to the feedlot for 2 days. Following this, they were tested once per day at 12.00 h on 10 consecutive days alternating between mazes 1 and 2, with group 1 starting from the maze 1 and group 2 starting from the maze 2. Cattle were fed as normal at 08:30h and 16:00 h whilst in the feedlot but were not fed at 12.00h, thereby eliminating the auditory cue of feeding associated with testing. Group 2 cattle were tested using the same protocol following completion of group 1.



Figure 2. Photograph of the Y-maze testing facility.



Figure 3. Aerial view of the Y-maze testing facility showing surrounding pasture.



Figure 4. Ictag devices attached to the hind leg of cattle, used to remotely measure lying and standing behaviours.



Figure 5. Cattle feeding from the troughs in the feedlot.

### 3.9 Pasture

Pasture samples were collected from the paddock using a quadrant during habituation to pasture and at the start of testing each group. This involved collecting 10 samples from the paddock. Samples were oven dried at 65°C for 4 days for calculation of dry weight (Table 3). Following this, samples were analysed for nutritive value by the Department of Primary Industries, Wagga Wagga, NSW, Australia.

Table 3. Pasture nutritive analysis

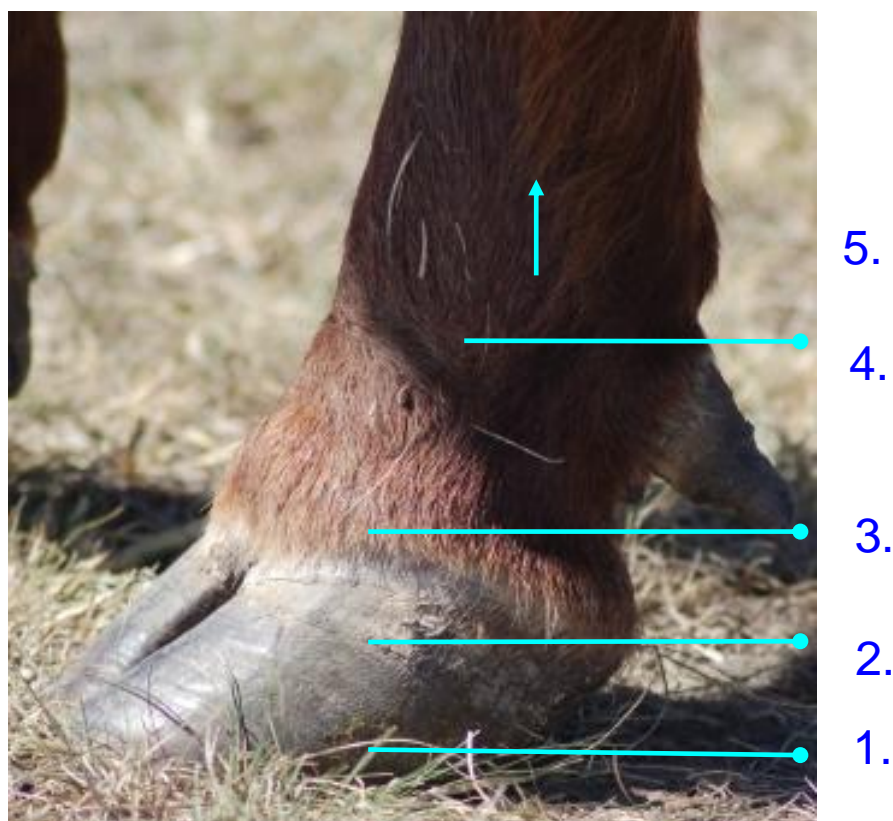
Pasture measure	Group 1	Group 2
Neutral detergent fibre (%)	65	63
Acid detergent fibre (%)	39	38
Crude protein (%)	7.95	8.3
Dry matter digestibility (%)	9	8
Dry organic matter digestibility (%)	91	92
ASH (%)	52.5	56.3
Organic matter (%)	51	54.3
Metabolisable energy (MJ/kg DM)	7.4	8.1
Herbage mass (kg DM/ha)	3792	4464

### 3.10 Climatic conditions

Daily temperature and rainfall were recorded from a portable weather station (Vaisala WXT520, Hawthorn, VIC, Australia) and the feedlot pad was scored. Weather data is summarised in Table 4. Feedlot pad conditions were scored as values between 1 and 5 as shown in Figure 6.

Table 4. Daily average climatic conditions and feedlot pad score.

Testing	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall (mm/day)	Feedlot pad score (1-5)
Stage 1 (10 days)	9.6	21.1	1.4	1.5
Stage 2 (5 days)	10.3	22.5	1.8	1.5
Stage 3 (6 days)	13.4	26.6	1.9	1.4
Stage 4 (10 days)	4.7	18.8	0.006	1



1. Dry feedlot pad.
2. Pad surface up to the heel bulb.
3. Pad surface up to the coronary band.
4. Pad surface up to fetlock height.
5. Pad surface past fetlock height.

Figure 6. Feedlot pad scoring system.

### 3.11 Data analysis

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Preference for choosing the feedlot was tested by comparing the observed choice (as a mean for each group) to random chance (50%). The hypothesis was that if animals have no preference for the feedlot or pasture they would choose the feedlot and pasture environments an equal amount of time (i.e. 50%). Data were analysed using ASREML in a linear model to calculate the mean preference. 95% confidence intervals were calculated as the mean  $\pm$  1.96 SEM. A linear model analysis including fixed effects of day, group, time of day, and treatment were performed to determine the influence on preference for the feedlot. In addition, the effects of weather conditions were tested by fitting rainfall, minimum and maximum temperature and feed pad score as covariates to the base model. Lying time was analysed using a linear model including fixed effects of day, group, time of day and group x day.

## 4 Results and Discussion

### 4.1 Results

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#### 4.1.1 Stage 1: Y-maze testing with a feed reward following 7 days feedlot confinement

Choice for the feedlot is shown in Figure 7. Day of testing significantly influenced preference for the feedlot ( $P=0.029$ ) with cattle showing a preference for the feedlot on days 3 to 10 of testing. There were no significant influences of time of day ( $P=0.322$ ) or group x day ( $P=0.114$ ) on

preference for the feedlot. There was a significant difference between groups on preference for the feedlot with group 2 showing a stronger preference for the feedlot of 87.5% compared to 69% for group 1 ( $P=0.003$ ; SEM = 3.82).

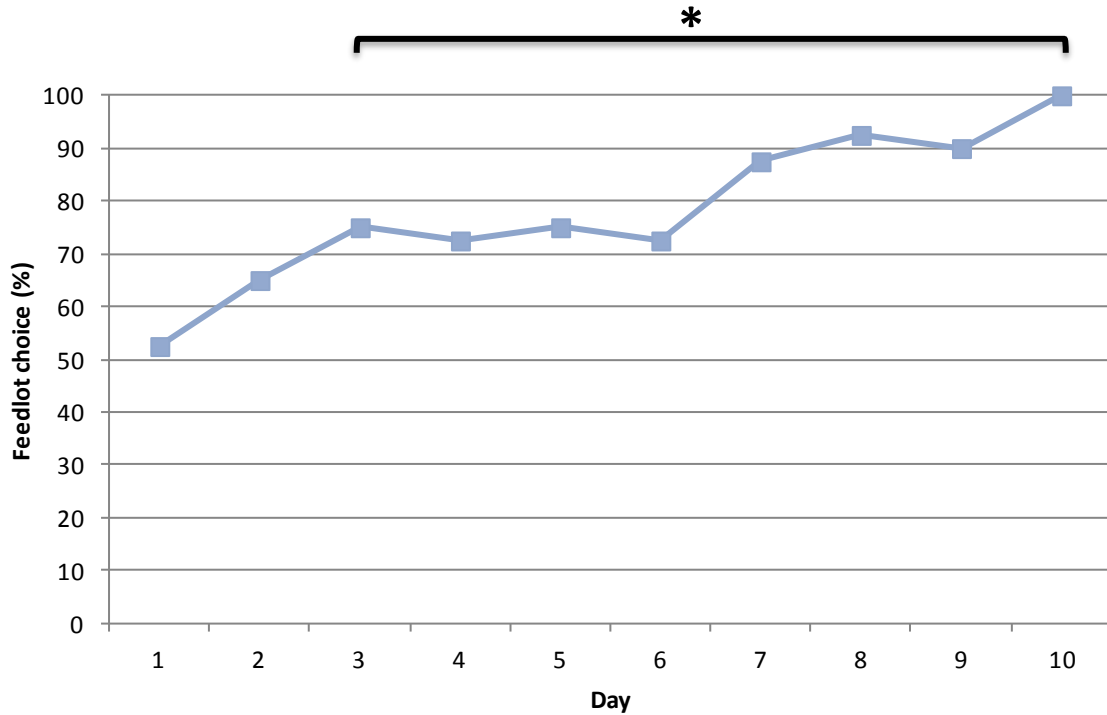


Figure 7. Least squared estimates of day effects on percentage of animals choosing the feedlot during Y-maze testing on days 1 to 10 following 7 days of feedlot confinement. Data has been pooled for group and time of day. \*Choice for the feedlot differs significantly from 50% chance level. SEM = 8.54.



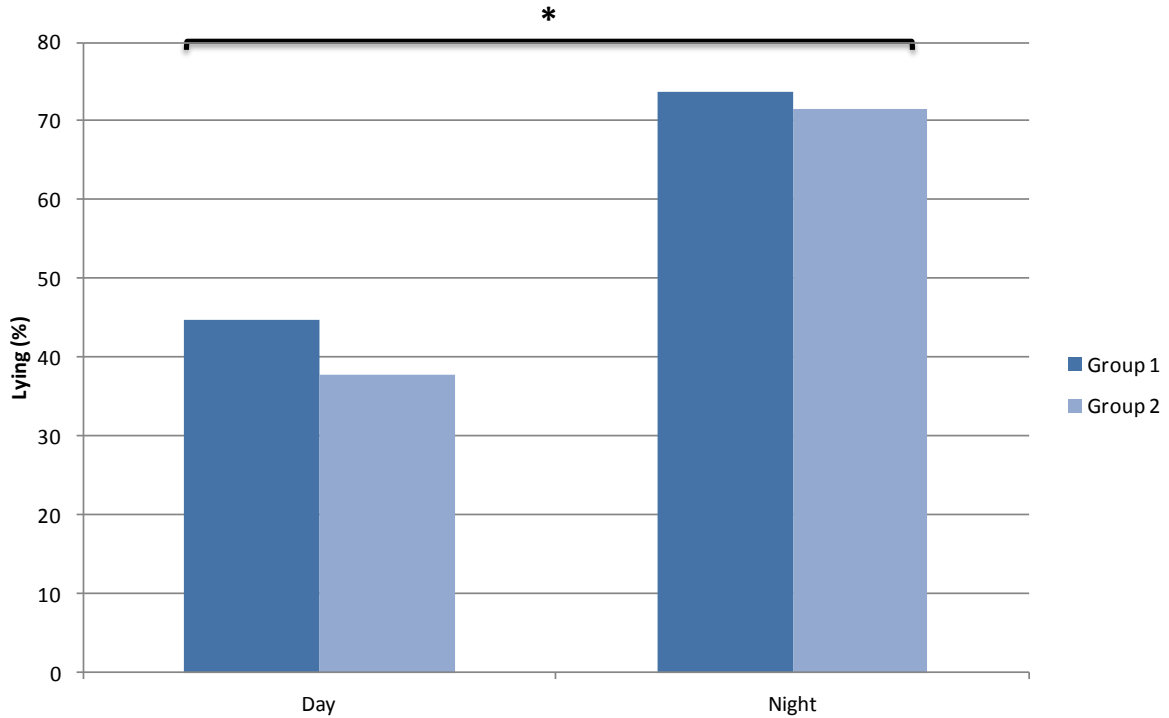


Figure 8. Average percentage of time spent lying during the day (08:30h till 16:00h) and night (16:00h till 08:30h) for cattle during 10 days of testing, while in the feedlot. \*Significant difference between time of day ( $P < 0.05$ ).

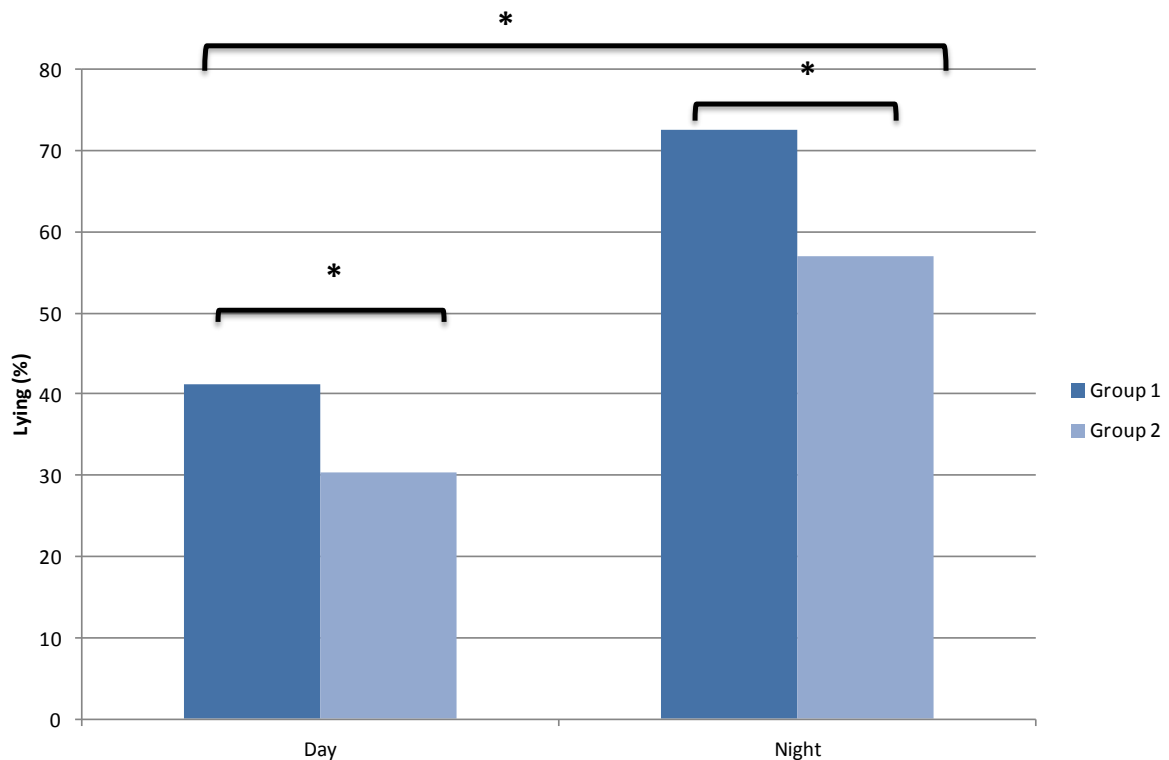


Figure 9. Average percentage of time spent lying during the day (08:30h till 16:00h) and night (16:00h till 08:30h) for cattle during 10 days of testing, while at pasture. \*Significant difference between time of day and between cohort ( $P < 0.05$ ).

Figure 8 and Figure 9 show the percentage of time spent lying while in the feedlot and pasture environments respectively. In the feedlot environment, there was a significant difference in feedlot lying percentage ( $P < 0.001$ ) between time of day with more lying occurring at night (72.6%

$\pm 1.6$ ) than during the day ( $41.2\% \pm 1.6$ ). There was an overall tendency for group 1 ( $59.2 \pm 1.6$ ) to lie more than group 2 ( $54.6 \pm 1.6$ ), irrespective of time of day ( $P=0.058$ ). In the pasture environment, percentage of time spent lying differed between day and night time ( $P=0.025$ ) with an average of 35.8% during the day and 64.8% at night. Groups differed in lying time ( $P<0.001$ ) with an average of 56.9% for group 1 and 43.7% for group 2. Overall cattle lay 56.8% of the time they were in the feedlot and 44.2% they were at pasture ( $P <0.001$ ).

The feedlot pad score influenced the preference for the feedlot ( $P=0.008$ ) with an increased preference for the feedlot when the feedlot pad score increased, however this was not evident in the raw data. Figure 10 shows that there was no relationship between the raw data for feed pad score and choice for the feedlot. The relationship is shown by the equation of the trend line which has an intercept of 74.59 (the predicted value when the pad score is 0) and a slope of 2.48 (the choice preference increases 2.48 points for every unit increase in pad score.). The  $R^2$  of 0.0061 is very low, indicating that only 0.6% of the variation in choice for the feedlot was accounted for by feed pad score. However, in the linear model pad score was significant, this apparent anomaly can be explained by the day effect masking the pad score effects. There were differences between pad score on the same day in the 2 groups, for example the 3<sup>rd</sup> day for group 1 could have been much wetter than for the 3<sup>rd</sup> day of group 2. After correcting for day effects, there was a relationship between pad score and feedlot preference (Figure 11), a higher pad score resulted in increased preference for the feedlot. The  $R^2$  of 0.067 indicates that 6.7% of the variation in choice for the feedlot was accounted for by feed pad score. Minimum temperature influenced preference ( $P=0.016$ ) with an increased preference for the feedlot when the minimum temperature increased (Figure 12). Feedlot choice increased by 1.179% with every 1 degree increase in the minimum temperature and the  $R^2$  of 0.0334 shows that 3.3% of variation in choice was accounted for by minimum temperature. Maximum temperature did not influence preference for the feedlot ( $P=0.205$ ).

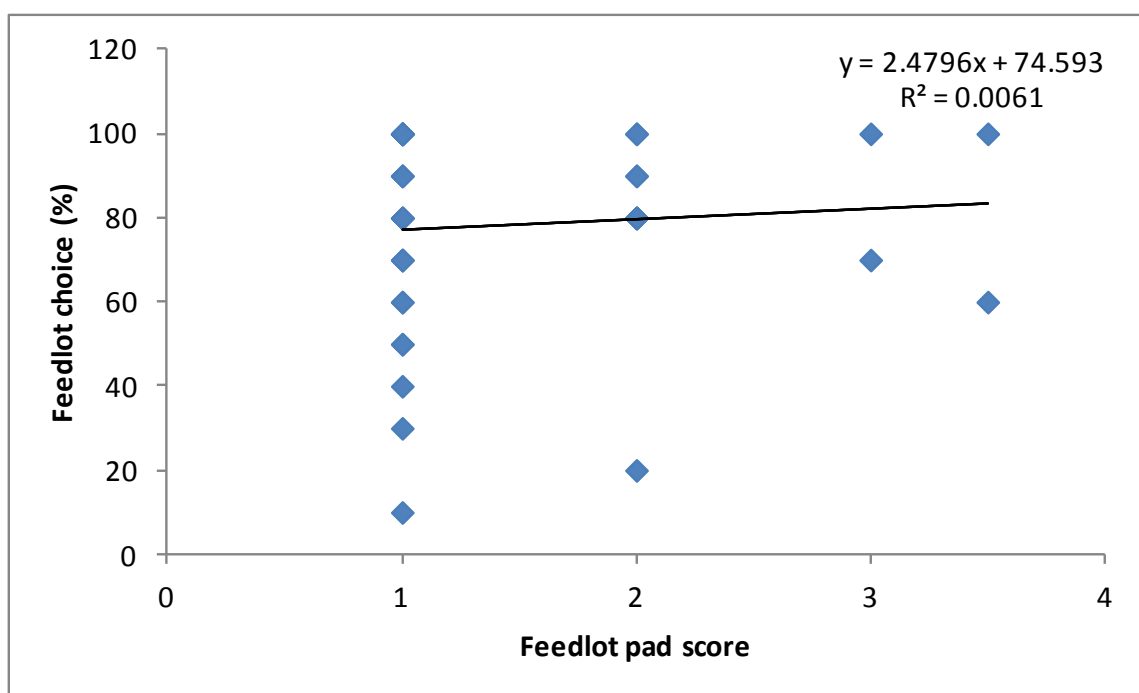


Figure 10. Relationship between feedlot preference and feedlot pad score before correcting for day following 7 days confinement in the feedlot.

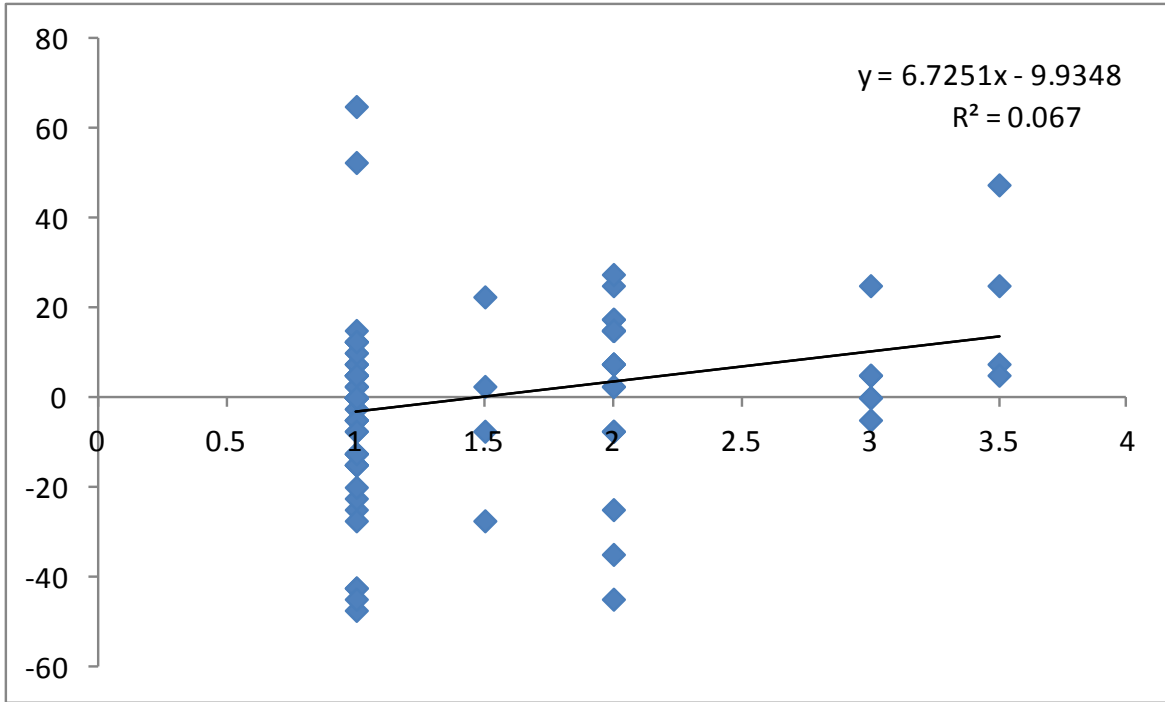


Figure 11. Relationship between feedlot preference and feedlot pad score after correcting for day following 7 days confinement in the feedlot.

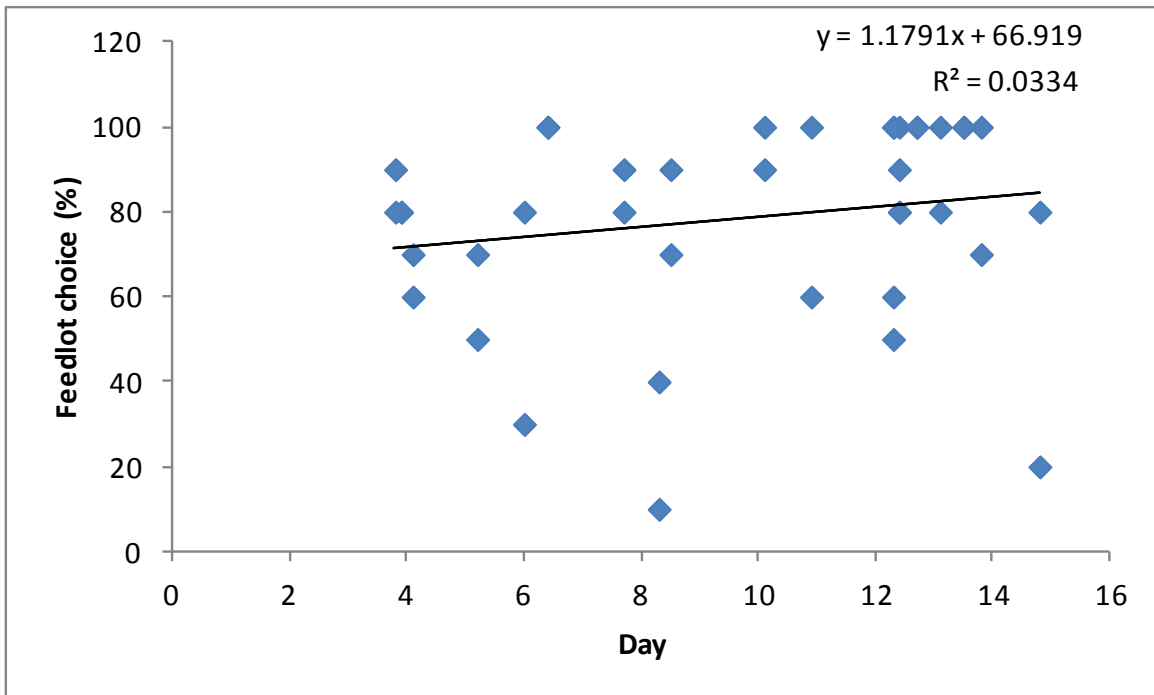


Figure 12. The relationship between feedlot preference and minimum temperature following 7 days confinement in the feedlot.

#### 4.1.2 Stage 2: Y-maze testing with a feed reward following 4 weeks feedlot confinement

There was a significant preference for the feedlot following 4 weeks of confinement for the 5 consecutive days of testing ( $P < 0.001$ ; Figure 13). There was no influence of group, time of day and day. There was no relationship found between any of the weather variables and choice for the feedlot.

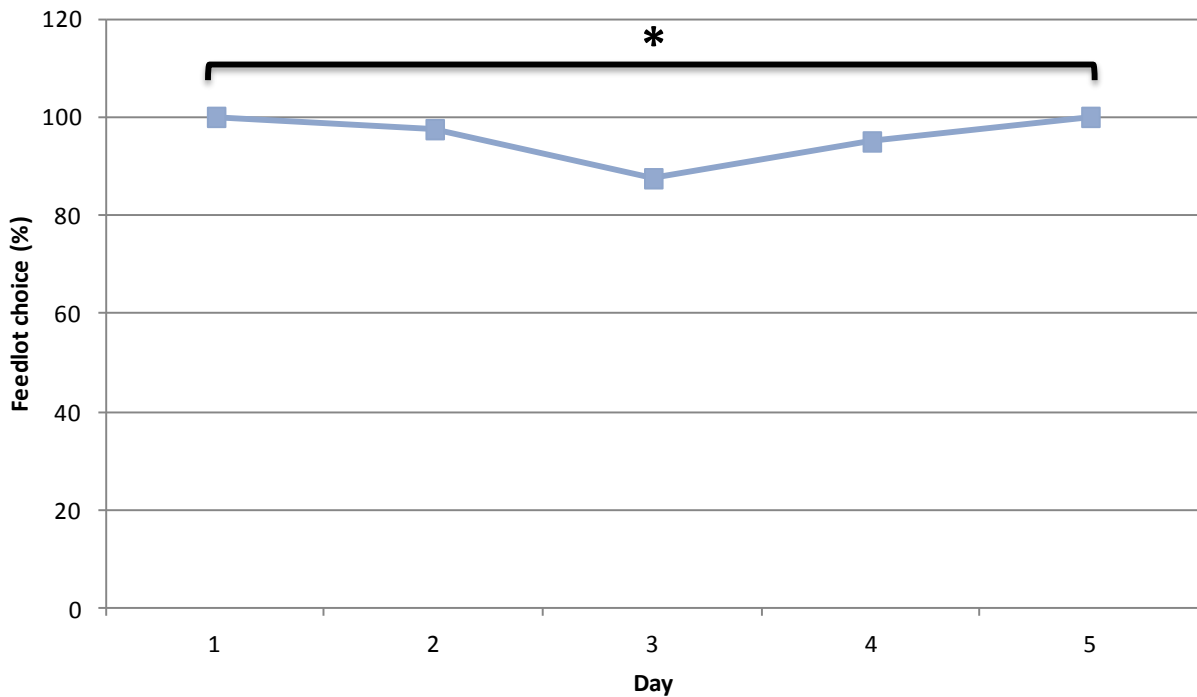


Figure 13. Least squared estimates of day effects on percentage of animals choosing the feedlot during Y-maze testing on stage 2 (following 4 weeks feedlot confinement). Data has been pooled for group and time of day. \*Choice for the feedlot differs significantly from 50% chance level on all testing days. SEM = 3.8.

#### 4.1.3 Stage 3: Y-maze testing with a feed reward from the alternate maze

When the cattle were trained and re-tested from the alternate maze, initially they showed no preference until day 3. They then showed a significant preference for the feedlot on days 3, 4 and 5 (Figure 14). There was no significant influence of day, group or time of day on feedlot preference. Weather conditions did not influence feedlot preference during testing.

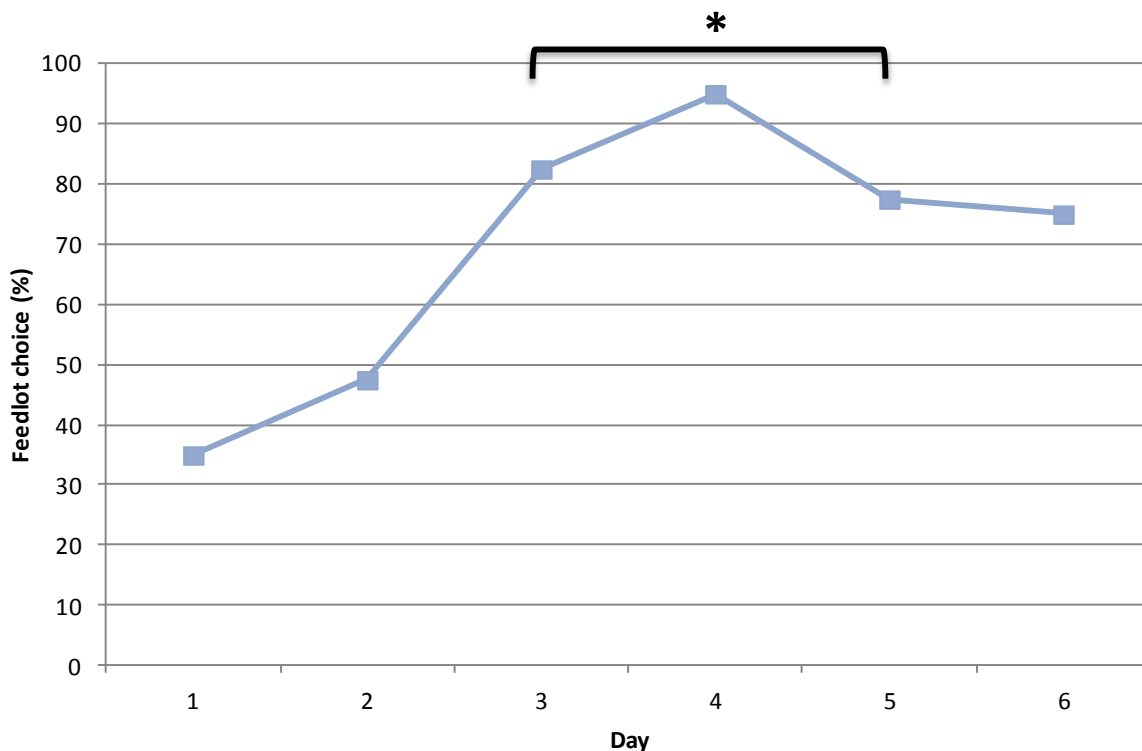


Figure 14. Least squared estimates of day effects on percentage of animals choosing the feedlot during Y-maze testing on days 1 to 6 after swapping sides of testing in the Y-maze. Data has been pooled for group and time of day. \*Choice for the feedlot differs significantly from 50% chance level. SEM = 15.01.

#### 4.1.4 Stage 4: Y-maze testing without a feed reward and from alternating mazes

Cattle showed an initial preference for the feedlot (days 2, 3 and 4) which decreased over the 10 days of testing (Figure 15). On day 1 and days 5 to 10 preference for the feedlot did not differ from the 50% chance level. Preference for the feedlot was not influenced by day ( $P=0.158$ ), group ( $P=0.897$ ) or maze side tested ( $P=0.897$ ). Weather conditions did not influence preference for the feedlot with no significant affect from minimum temperature ( $P=0.287$ ), maximum temperature ( $P=0.39$ ) and rainfall ( $P=0.374$ ).

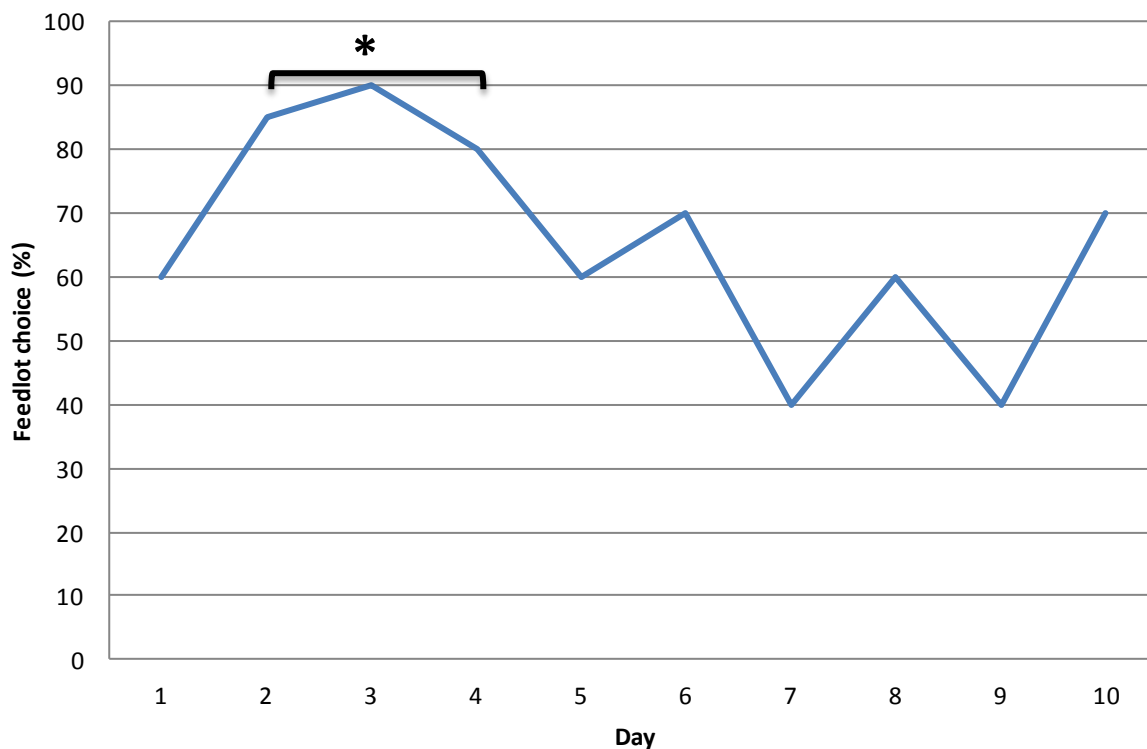


Figure 15. Percentage of animals choosing the feedlot during Y-maze testing without a feed reward. Data has been pooled for group. \*Choice for the feedlot differs significantly from 50% chance level. SEM = 11.83.

## 4.2 Discussion

### 4.2.1 Stage 1: Y-maze testing with a feed reward following 7 days feedlot confinement

This study assessed cattle choice for a feedlot or pasture environment when there was a cost imposed on their decision. Cattle showed a preference for the feedlot environment following two separate periods of confinement (7 days and 4 weeks). While this result provides evidence that cattle will choose the feedlot environment when there was a cost imposed on their decision, there are some factors that may have influenced cattle choice that should be considered. Firstly, cattle were fed twice daily whilst in the feedlot, and feeding time coincided with the times that cattle were tested in the Y-maze. Prior to testing, the cattle were kept in the holding yard while the feed ration was placed in the feed troughs and the sound of this would have acted as an auditory cue, indicating the presence of a feed reward when cattle entered the feedlot. As the cattle were able to consume their half daily rations within 20 min, this was not a typical “feedlot” situation where cattle are normally fed *ad libitum*, therefore this may have influenced the choice cattle made. Another factor that may have influenced cattle preference was that all animals in the same group were tested from the same Y-maze for the first 2 stages and they may have developed familiarity with the feedlot side of the Y-maze, leading to pattern development. It has been shown that repetition of visits to one maze arm may lead to formation of a location preference that could interfere with the effect of the test stimulus on choice behaviour (Rodriguez et al., 1992).

From the previous study (B.FLT.0349) cattle showed a preference for the feedlot during the day of 61% and the pasture at night of 90% where they lay down for around 80% of the time. Therefore, we had hypothesised that the time of day of testing cattle in the Y-maze would influence choice, with cattle choosing the feedlot more often in the morning and the pasture at night. However, this was not the case. The time of day did not influence feedlot choice in the maze when there was a cost imposed on the choice. It appears that cattle were highly motivated

to access the feedlot ration both in the morning and afternoon testing sessions and this may have been stronger than the preference for lying down at pasture at night. Therefore, cattle seem to prioritise accessing the feedlot ration over being able to lie down at pasture. It may be that cattle do not have the cognitive ability to forward think about the implications of choosing the feedlot in the evening as they were simply focused on the immediate feed reward and did not comprehend the future cost of not having access to the pasture environment at night to lie down. However, some animal species including pigs (Kouwenberg et al., 2009), scrub jays (Clayton and Dickinson, 1998) and pigeons (Zentall et al., 2001) have been shown to possess episodic memory which is the memory system that enables the subject to remember past events and imagine the future. There is, therefore, the strong possibility that cattle possess the ability to forward think as well.

In the current study, cattle spent less time lying down when at pasture than in the feedlot. However, this was likely due to the nature of the experimental design which manipulated behaviour by restricting access to the alternative environment. For example, if cattle chose the pasture, they missed out on their half daily feedlot ration and therefore had to consume pasture to compensate. As the comparison of lying time between environments was biased by the experimental design, it was not an accurate reflection of typical lying behaviour and would not be expected to align with free choice testing behaviours. In the previous study, cattle had an 81% preference to lie down at pasture when given free choice (Lee et al., 2013).

The finding that cattle preference for the feedlot increased slightly when the feedlot pad score increased (i.e. was more muddy) seems paradoxical, but may be due to the fact that feedlot pad score increased on the days after rain. In the previous project (B.FLT.0349) cattle tested in the Tullimba feedlot spent less time in the feedlot with increasing rain events, and as rain has been shown to result in less time spent in the feedlot, there may have been a rebound in time spent in the feedlot after rain. It may be co-incidental that surface score increased when preference for the feedlot increased after rain. Overall, there were very few rain events in the current study which limited the ability to objectively examine the relationship between feedlot preference and rainfall due to the inability to control rainfall quantities and occurrences. A further study to measure the influence of feedlot pad surface on the time spent in the feedlot independent of the influence of rain by artificial wetting of the surface would be recommended.

#### 4.2.2 Stage 2: Y-maze testing with a feed reward following 4 weeks feedlot confinement

As discussed in 4.2.1. Cattle had a strong preference for the feedlot following 4 weeks confinement in the feedlot. On all 5 days of testing, cattle showed a clear preference of over 90% for the feedlot. These results should be viewed in the context of the potential issues discussed above. The feed reward and the development of side preferences may have influenced the choice of the animals.

#### 4.2.3 Stage 3: Y-maze testing with a feed reward from alternate maze

To test for the influence of the location pattern development in the cattle, we retested them from the alternative maze following retraining to enable learning of the new directions of the feedlot and pasture. Initially cattle did not show a preference for the feedlot (on days 1 and 2) however, on day 3, 4 and 5, cattle showed a preference for the feedlot. From this finding, it appears that cattle had learnt the direction of the feedlot from both Y-mazes and were making an active cognitive choice to enter the feedlot. It was likely that in the first 2 days cattle were still learning the new direction of the feedlot location and once they had learnt, they chose the feedlot as they did in stage 1 and 2. Further studies using the alternation of mazes would require more days of training to ensure that learning was achieved. As well, it has been shown that cattle will resist changing a choice once they are accustomed to a treatment being associated with a specific side (Grandin et al., 1994). Therefore, it is interesting that cattle appeared to relearn the new sides of the feedlot and pasture quite rapidly within 3 days and overcome the previous experiences of stage 1 and 2.

#### 4.2.4 Stage 4: Y-maze testing without a feed reward and from alternating mazes

To test for the influence of the feed reward and remove patterns of side biases, cattle were tested once per day at 12:00h and from daily alternating mazes. Cattle showed a preference for the feedlot on days 2, 3 and 4 and there was no preference observed for the remaining 6 days. This suggests that the feed reward was influencing the decision to enter the feedlot. It appears that cattle chose the feedlot initially but when their choice did not coincide with the feed reward, their preference for the feedlot was gradually reduced. It has been shown that previous experience can influence preference results and as cattle were trained and tested throughout stages 1 to 3 using the feed reward they would have learnt to expect this. The absence of a reward in stage 4 may have caused the cattle to experience frustration due to forming an expectation of a feed reward which was not received. Sheep have been shown to develop expectations, and a discrepancy from their expectations induces behavioural agitation and cardiac acceleration which may be indicative of frustration (Greiveldinger et al. 2011). Likewise, it was found that sheep are able to anticipate and that their emotional response to an event is affected by the predictability of the event (Greiveldinger et al., 2009), therefore it is likely that cattle experience similar emotional responses.

#### 4.2.5 The use of the Y-maze to test motivation for the feedlot

This is the first time that Y-maze methodology has been used to assess preference for feedlots. Therefore several design issues were observed and overcome throughout the study. Firstly the issue of development of behavioural patterns which form from cattle becoming familiar with one arm of the maze was overcome by alternating the mazes used for daily testing. Secondly, the timing of the feeding reward appears to influence choice and should be removed through *ad libitum* feeding which would also more closely mimic the commercial feedlot situation.

Previous studies using Y-maze testing in cattle have assessed preference for handling treatments (Grandin et al., 1994; Pajor et al. 2003), feeding environments (Rioja-Lang et al., 2009) and noise (Arnold et al., 2009). The model developed here using Y-maze testing is unique as it assesses preference with the addition of a cost imposed on the choice made, which enables assessment of motivation to access the feedlot or pasture environment. This method provides understanding of the tradeoffs that cattle make in deciding between being in a feedlot or pasture environment. Development of this methodology and set up of the facility enables further questions relevant to cattle welfare in feedlots to be addressed. This includes examination of how cattle perceive different conditions in the feedlot, such as periods of wet weather when pen surfaces become muddy.

## 5 Success in Achieving Objectives

The objectives have been achieved through the successful completion of the study. This is the first time that Y-maze methodologies have been applied to assess cattle perception of feedlots. The methodology is now well established and adapted for use to test preference for the feedlot with the imposition of a cost to the animal.

A journal manuscript is being prepared for submission to Applied Animal Behaviour Science and an abstract from this work has been submitted to the International Society of Applied Ethology meeting to be held in Spain in July 2014.

## 6 Impact on Meat and Livestock Industry – now & in five years time

The goal of the project was to provide objective, science-based information on the motivation of cattle to access feedlot or pasture environments, utilising the accepted method of Y-maze



testing. The results of the project provide information on cattle preference when a cost is added to their choice, and can be utilised by industry in defence of feedlot production systems and practices. In addition, the journal paper once published will serve as a peer-reviewed source of information.

## 7 Conclusions and Recommendations

The current study indicated that cattle showed a preference for the feedlot when testing coincided with feeding and that they were willing to pay the cost of their choice, by being unable to access the pasture environment. Whilst the findings from this study are favourable in terms of how cattle perceive the feedlot environment, they must be taken in the context of the testing model used. This finding was based on the Y-maze testing model using a feed reward at the time of testing. When the feed reward did not coincide with testing, preference for the feedlot was reduced. The time of day of testing did not influence preference for the feedlot. However, this may have been masked by the overriding influence of the feeding reward, and it is recommended that the first study (stage 1) be repeated with removal of the feed reward through *ad libitum* feeding. This would enable preference to be assessed under conditions that more accurately reflect a commercial feedlot.

During none of the testing stages was a preference for the pasture found, which indicates that cattle perception for the feedlot seems positive as they are motivated to enter the feedlot more often than pasture. Together with the results from B.FLT.0349, results of the current study indicate that cattle may be more strongly motivated by feed type (concentrate versus pasture) than the environment in which it is offered. The five freedoms framework of welfare assessment states the importance of animals having the ability to display natural behaviour such as grazing. However, cattle themselves seem to prefer concentrates over grazing in our studies.

The Y-maze testing model is now developed and set up for further use. One important issue that could be studied relates to how cattle perceive the feedlot environment during periods of wet weather when the pen surface becomes muddy. The improved model incorporating removal of the feed reward through *ad libitum* feeding and alternating maze testing could be utilised to objectively examine cattle perception of mud and the influence of bedding on cattle perception.

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