Pilbara steer growth evaluation : 1994 - 1996

Wayne Fletcher
Brian McIntyre
Shane Cridland Dr
J L. James

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PILBARA
STEER GROWTH EVALUATION
1994-1996

by Wayne Fletcher, Dr Brian McIntyre,
Bob Nickels, Dr Shane Cridland and John James
PILBARA STEER GROWTH EVALUATION

Foreword

This investigation was instigated by the pastoral community. Funding was provided by the National Landcare Program (NLP), Meat Research Corporation (MRC) and Agriculture Western Australia. The study was conducted at three locations in three different Land Conservation Districts in the Pilbara. Steers for the trial were provided by twenty-one stations, namely Coolawanyah, De Grey, Ethel Creek, Glenflorrie, Hamersley, Hillside, Karratha, Kooline, Limestone, Mallina, Mandora, Marillana, Mininer, Mt Stuart, Red Hill, Wallal Downs, Wallareenya, Warrawagine, Wyloo, Yalleen and Yarraloola.

The trial provides a large amount of data, at times in a complex manner. It was felt necessary to present all of this information as it will have direct relevance to participants and act as a useful reference to many others associated with the pastoral industry not only in the Pilbara.

Acknowledgments

Thanks to:

- the 21 pastoralists who contributed steers to the trial;
- the funding bodies NLP and MRC;
- the three host properties, Mallina, Marillana and Wyloo. They were asked to muster stock three times per year for weighing and looked after the animals for the period;
- John James for getting the stock to their three locations (quite a logistical challenge), conducting the regular weighings and general organisation;
- the stock agents, Elders Burnett Moore and Wesfarmers, who handled the transactions when the steers were sold and slaughtered;
- Clover Meats who went to great lengths to allow us access to the carcasses in the processing chain to carry out our recordings and tolerated a large number of recorders and onlookers through their works at the time;
- Brian McIntyre, Bob Nickels, Dave Pethick, John James and Peter Maloney for assisting at the meat works.

August 1996

(i)
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PILBARA STEER GROWTH EVALUATION

INTRODUCTION
Definitive data on growth performance of steers in the Pilbara is not readily available. Such basic data are important for herd modelling, financial analysis of pastoral enterprises, determining appropriate management systems and budgeting.

Growth rate is a variable that will be influenced by a range of environmental conditions (rainfall, climatic conditions, pasture type, stocking rate) and genetic factors (breed, genetic potential, hybrid vigour). The purpose of this study was to measure growth performance of a genetic mix of steers over a two year period in three locations within the Pilbara. The variation observed during the evaluation period will give an indication of seasonal ranges, allow direct comparisons to be made between sites and variation within sites will give an indication of the range in genetic potential in Pilbara cattle herds.

METHODS

Location
Three differing sites were chosen. The Wyloo site is Ashburton River frontage country with buffel grass as the dominant pasture species. The Marillana site comprises stony plains with wind grass in season, mulga grooves with a range of palatable shrubs, and crabhole areas of productive perennial grass pastures. The Mallina location comprises a mix of soft spinifex with patches of Roebourne Plains grass and buffel grass in the wash lines.

Stock
Twenty-one stations each provided six steers. From each group of six steers, two steers were sent to each location for a total of 42 steers at each site.

Initial weights requested were 140-180 kg but many stations at the time of selection were limited in choice or did not have scales available. Initial weights ranged from 108 to 330 kg.

Management
All were given a five-in-one injection, vaccinated against botulism and given a Backline treatment. They were given one month to settle into their new location before the official first weight was recorded in July 1994.

Subsequent weights were recorded in October, March and July until slaughter of the steers in March 1996, a total period of 625 days. At slaughter, data was collected on carcass weights, carcass characteristics from a full Ausmeat appraisal, meat pH recordings and eye muscle area estimates for each carcass.
Prior to slaughter—‘the ‘Yak Pack’ (from the left Karratha, Red Hill, Kooline, Glenflorrie, Mt Stuart, Glenflorrie, Wallal Downs)

Trial steers yarded at Waroona prior to slaughter

The boning floor at Clover Meats
Growth rates at each location will be correlated with recorded satellite observations on pasture greenness, which may be used as a predictor of animal performance in the future.

RESULTS

Seasonal condition

The trial commenced in July 1994 during a failed winter season. While not uncommon, the following spring and early summer conditions were not favourable. Good summer rains in early 1995 provided ideal conditions for the trial stock and some winter rains assisted in providing stock with pasture through to the summer rain of early 1996. At this point the trial ceased. A graphical representation of monthly rainfall is given in Figure 1.

Growth performance

Individual animals

Individual animal growth performance for the total period July 1994 to March 1996 for each location is represented in Figures 2 to 4. These show the range in observed growth rates to be around 0.3 to 0.55 kg per day for Wyloo and Marillana and a little lower (0.2 to 0.5) for the Mallina location.
Figure 2: Growth rates for individuals at Mallina July 94 to Mar 96

Figure 3: Growth rates for individuals at Marillana July 94 to Mar 96

Figure 4: Growth rates for individuals at Wyloo July 94 to Mar 96
Location
Average growth rates at Wyloo, Marillana and Mallina were 0.45, 0.41 and 0.37 kg per day.

Breed
The average growth rate for *Bos indicus* infused animals over all locations was 0.43 kg per day while that for straight *Bos taurus* breeds was 0.38 kg per day.

Breed by location
Figure 5 shows the performance of *Bos indicus* infused and *Bos taurus* animals at each location. There was no statistically significant advantage of the *Bos indicus* infused animals at Marillana though there was at Mallina and Wyloo.

Seasonal effects
Figures 6 to 8 show the seasonal variation and effect of type for each location. These observed variations can be crudely related to rainfall, but would be more directly related to the amount and quality of feed on offer.

Looking at the seasonal variations by type, the *Bos taurus* animals appeared to do relatively better in the period July to October 1995. This is the period that encompasses the coolest months and seasonal conditions were good in that year. The previous year, 1994, was dry during July to October period and the *Bos taurus* have not shown the same advantage relative to the *Bos indicus* types.
Figure 6: Seasonal growth rates by type for Mallina

Figure 7: Seasonal growth rates by type for Marillana

Figure 8: Seasonal growth rates by type for Wyloo
Carcass characteristics
The recorded carcass characteristics at slaughter allow for comparisons between breed type and between locations.

Dressing percentage
Overall the liveweights at slaughter, carcass weights and dressing percentages for the two breed types are shown in Table 1.

Table 1. Live weight, carcass weight and dressing percentage by breed type

<table>
<thead>
<tr>
<th>Breed</th>
<th>Live weights at slaughter (kg)</th>
<th>Carcass weight (kg)</th>
<th>Dressing %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bos indicus</td>
<td>486.0</td>
<td>249.2</td>
<td>51.3</td>
</tr>
<tr>
<td>Bos taurus</td>
<td>433.4</td>
<td>219.8</td>
<td>50.7</td>
</tr>
</tbody>
</table>

Age
The age distribution of the two breed types (see Table 2) shows that most animals in the trial had four teeth or less (up to 36 months). The Bos indicus infused animals were generally younger than the Bos taurus animals.

Table 2. Age distribution by breed type

<table>
<thead>
<tr>
<th>Dentition</th>
<th>Bos indicus</th>
<th>Bos taurus</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 teeth</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2/3 teeth</td>
<td>31</td>
<td>19</td>
</tr>
<tr>
<td>4 teeth</td>
<td>26</td>
<td>28</td>
</tr>
<tr>
<td>Older than 4 teeth</td>
<td>2</td>
<td>9</td>
</tr>
</tbody>
</table>

Meat colour
Meat colour is visually assessed on the quartered surface of the eye muscle (longissimus) with the aid of standard colour chips. There are three categories within the score 1 range, 1A, 1B, and 1C with 1A being the lightest. As the score increases the meat becomes progressively darker. Generally meat needs to be within the score 1 range to be acceptable for the local market. Meat colour scores are shown by location and breed in Figures 9 and 10.
Approximately 80% of carcasses had a meat colour score of either 1B or 1C while only four had a score of 3 or more. There were no major differences in meat colour scores among cattle raised on the different stations. *Bos taurus* cattle had 27% with scores of 2 and above compared with 13% for *Bos indicus*.

**Muscle pH**

Muscle pH is associated with a number of important characteristics of meat including meat colour, tenderness, cooking characteristics and shelf life. Meat with a high pH (above 5.7) is undesirable and is an indicator of stress before slaughter. Carcasses with a high pH and dark coloured meat are referred to as ‘dark cutters’. Meat pH was measured in the loin (longissimus), topside (semi-membranosis) and silverside (semi-tendinosis) muscles. The proportion of carcasses with a pH above 5.7 was 9%, 26% and 15% in the three muscles respectively. These differences among muscles reflect variation in sensitivity to the effects of pre-slaughter stress. These proportions are not unexpected considering the handling and transport regime leading to slaughter. Carcasses with a high pH tended to have slightly darker coloured meat although this was not necessarily the case and there was no close relationship between the two. The highest pH in the loin where colour is assessed was
6.11. This is not a particularly high value and is still in the range where colour can be relatively normal. There were no differences in pH among stations. *Bos indicus* cattle had slightly lower pH values than *Bos taurus*.

**Fat thickness**

The range of fat thicknesses recorded for the two breed types were similar (see Figure 11) with the same number of animals in the 1 to 3 mm range. The ideal range is 4 to 12 mm though the representative from Clover Meats preferred 4 to 10 mm.

![Figure 11: Distribution of fat thickness by breed type](image1)

Figure 12 shows the distribution of fat thickness by location. The Mallina location shows the highest proportion of animals with less than the optimal 4-12 mm range. Wyloo had only 6 animals with 3 mm or less of fat cover at the P8 site.

![Figure 12: Distribution of fat scores by location](image2)

**Fat colour**

Fat colour is visually assessed on the quartered surface of the carcass with the aid of standard colour chips. As the score increases the fat becomes progressively more yellow. Over 50% of carcasses had scores of 1 or over indicating some degree of yellow.
pigmentation in the fat. This would be expected with animals being raised exclusively on pasture. *Bos indicus* cattle had slightly lighter fat colour than *Bos taurus* (see Figure 13). There were no major differences among stations (see Figure 14). This may have been related to the slightly greater average age of *Bos taurus* cattle having accumulated more pigment in the fat.

![Figure 13: Fat colour score by breed](image)

![Figure 14: Fat colour score by location](image)

**Marbling**

Marbling is visually assessed on the quartered surface of the eye muscle with the aid of standard chips. As the score increases the amount of marbling fat increases. Only a small proportion of the carcasses had marbling scores above the minimum level. This is not surprising with the relatively low level of fatness of these cattle. In general carcasses with the higher levels of marbling also tended to be fatter than the others.

*Bos taurus* cattle showed slightly more marbling than the *Bos indicus* (see Figure 15). Cattle raised at Wyloo had slightly more marbling than those from the other stations, probably as a result of their greater weight and fatness (see Figure 16). In this case, higher marbling levels were not associated with greater fat thickness, but were probably due to the
influence of the Shorthorn breed type which has been shown to have a greater ability to marbling than most other breeds.

![Figure 15: Marbling score by breed](image1)

![Figure 16: Marbling score by location](image2)

**Butt profile**

Butt profile or muscle shape is visually assessed on the slaughter floor. There are five categories (A to E) determined by the degree of convexity/concavity of the butt with profile A having the most convex shape, C having a ‘straight’ profile and E having the most concave shape. A more desirable butt profile has been associated with higher yield of saleable meat, higher muscle to bone ratio and greater proportion of saleable meat in higher priced cuts. However, extensive research has shown no reliable relationships exist between butt shape and any of these characteristics. Nevertheless price premiums are sometimes paid for carcasses with a more desirable shape.

The distributions of butt profiles (Figures 17 and 18) show a greater tendency to the C profiles in the *Bos indicus* infused type and a higher proportion of C profiles at Wyloo and lower proportion at Mallina. These differences are most likely due to differences in carcass fatness as in all cases the shape scores reflect fat thickness measurements. Greater
fatness has been consistently shown to have an association with more desirable carcass shape.

**Figure 17: Distribution of butt profiles by breed type**

![Bar chart showing distribution of butt profiles by breed type.](image)

**Figure 18: Distribution of butt profiles by location**

![Bar chart showing distribution of butt profiles by location.](image)

**Eye muscle area**

Eye muscle is normally measured on the cut surface after quartering at the preferred position. Due to the ‘chain’ boning system, the carcasses were not quartered sufficiently between the 10 and 11 rib to allow measurements using this procedure. Other assessments on the cut surface were made using the ‘slit’ method, whereby a knife cut is made through the soft muscle and fat but the bones remain intact. Measurements were made using a grid marked in square centimetres placed over the surface of the eye muscle between the 10/11th rib after removal of the cube roll from both sides of the carcass.

Average eye muscle areas have been calculated within the liveweight range of 50 kg between 350 and 550 to compare breed type and location. Above 400 kg liveweight, the *Bos indicus* infused animals show an average in eye muscle area (see Figure 19). Location had no consistent effect on the eye muscle area (see Figure 20).
Estimated lean meat yield

The yield of lean meat was estimated from the following regression equation:

\[
(ELMY) \text{ Estimated lean meat yield (kg)} = 8.68 + [0.54 \times \text{HSCW} \text{ (Hot standard carcase weight)}] + [0.259 \times \text{EMA} \text{ (Eye muscle area)}] - [1.338 \times \text{FT} \text{ (Fat thickness)}]
\]

This equation has been derived from a number of studies involving dissection of carcasses and represents the most accurate method of estimating the lean meat content of the carcass without physical separation of tissues. It provides an estimate of the lean meat content (i.e. muscle) rather than saleable meat which contains fat.

ELMY can be expressed as a weight of yield as predicted from the equation above or as a percentage by dividing the weight of yield by the carcass weight. Percentage yield may be the most useful measure as it provides an indication of the relative value of the carcass. It has been proposed that ELMY be used as the basis for payment rather than weight and fat thickness ranges as it would more accurately reflect the true value of the carcass.
Table 3. Estimated lean meat yield by location and breed type

<table>
<thead>
<tr>
<th></th>
<th>ELMY (kg)</th>
<th>ELMY (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mallina</td>
<td>134.1</td>
<td>63.4</td>
</tr>
<tr>
<td>Marillana</td>
<td>148.7</td>
<td>61.6</td>
</tr>
<tr>
<td>Wyloo</td>
<td>152.8</td>
<td>60.6</td>
</tr>
<tr>
<td>B. indicus</td>
<td>153.3</td>
<td>61.7</td>
</tr>
<tr>
<td>B. taurus</td>
<td>135.6</td>
<td>61.9</td>
</tr>
</tbody>
</table>

Cattle from Wyloo had a higher yield in kilograms than those from either of the other two stations. This is a result of the Wyloo cattle being heavier than those from the other properties. The Wyloo cattle however had the lowest percentage yield. This is due to their greater fat thickness (6.4 mm average compared with 5.0 mm and 3.5 mm for Marillana and Mallina) and therefore greater fat percentage and lower muscle percentage than cattle from the other stations. *Bos indicus* cattle had a higher yield in kilograms than *Bos taurus* as a result of their higher live and carcass weight. However, there was very little difference in fat thickness and percentage yield.

Carcass quality

The specifications for the preferred carcass were provided by a Clover Meats representative and were as follows:

- **age**: no more than four tooth
- **fat thickness**: 4-10 mm
- **meat colour**: in the score one range
- **fat colour**: less than 3
- **pH**: no more than 5.7
- **butt profile**: B or C

Based on the assessed carcass traits the carcasses were classified as ‘preferred’ or otherwise. Of the 114 carcasses assessed, only 43 met these specifications. The effect of breed type and location on carcass suitability is shown in Figure 21. There is an apparent affect of location on carcass quality but the affect is much less on the *Bos indicus* infused types.

![Figure 21: Percentage of 'preferred' carcasses by location and breed](chart.png)
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Kooline Steer 162 at Wyloo—best overall growth rate

Wallareenya steer 63 at Marillana—best growth rate at Marilana

Wallal steer 83 at Mallina—best growth at Mallina
Coolwanya steer 11 at Wyloo—ranked 12 at Wyloo

Warrawagine steer 77 at Marillana—best *Bos Taurus* growth rate at Marillana

De Grey steer 97 at Mallina—best *Bos Taurus* growth rate at Mallina
# Specifications of steers shown on pages 16 and 17

<table>
<thead>
<tr>
<th>Station of origin</th>
<th>Kooline</th>
<th>Wallareenya</th>
<th>Wallal</th>
<th>Coolawanyah</th>
<th>Warrawagine</th>
<th>De Grey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Wyloo</td>
<td>Marillana</td>
<td>Mallina</td>
<td>Wyloo</td>
<td>Marillana</td>
<td>Mallina</td>
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<tr>
<td>Breed</td>
<td>Droughtmaster</td>
<td>Brahman cross</td>
<td>Brahman</td>
<td>Santa Gertrudis</td>
<td>Shorthorn</td>
<td>Shorthorn</td>
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<tr>
<td>Starting weight July 1994 (kg)</td>
<td>230</td>
<td>118</td>
<td>235</td>
<td>175</td>
<td>160</td>
<td>220</td>
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<tr>
<td>Final weight March 1996 (kg)</td>
<td>590</td>
<td>440</td>
<td>540</td>
<td>480</td>
<td>455</td>
<td>475</td>
</tr>
<tr>
<td>Average growth rate (kg/day)</td>
<td>0.57</td>
<td>0.52</td>
<td>0.49</td>
<td>0.49</td>
<td>0.47</td>
<td>0.41</td>
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<td>Dentition at slaughter</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Status</td>
<td>Best growth rate overall</td>
<td>best growth rate at Marillana</td>
<td>best growth rate at Mallina</td>
<td>ranked 12 at Wyloo</td>
<td>Best <em>Bos indicus</em> growth rate at Marillana</td>
<td>Best <em>Bos indicus</em> growth rate at Mallina</td>
</tr>
<tr>
<td>Fat depth (mm)</td>
<td>5</td>
<td>2</td>
<td>6</td>
<td>7</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Butt shape</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>Eye muscle area (sq cm)</td>
<td>54</td>
<td>63</td>
<td>65</td>
<td>69</td>
<td>65</td>
<td>53</td>
</tr>
<tr>
<td>Meat colour</td>
<td>1B</td>
<td>1B</td>
<td>1B</td>
<td>1B</td>
<td>1C</td>
<td>1B</td>
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<tr>
<td>Fat colour</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Dressing percentage</td>
<td>49.2</td>
<td>53.5</td>
<td>53.5</td>
<td>53.4</td>
<td>52.2</td>
<td>44.4</td>
</tr>
</tbody>
</table>
DISCUSSION

Individual variation

There is a recorded variation in growth rates of around 0.25 to 0.3 kg per day at each site. This variation will be a result of a number of factors including breed, genetic variations within a breed, hybrid vigour, environmental factors affecting individuals (e.g. health problems) and conformation. Still, with the best steers growing at around 25% greater rate than the average at each site (and the worst performers growing at 25% less than average), it indicates that there are gains to be made from genetic improvement and culling.

Location

The stock at Wyloo performed the best. This is indicated by the average growth rate during the trial (0.45 kg/day), the highest recorded average rate for any time period (over 0.9 kg/day between March and July 1995) and that the six best performing individuals overall were located at Wyloo.

Performance at any location will be influenced by rainfall pattern, stocking rate and pasture type. The Ashburton River frontage where the steers were run on Wyloo is regarded as of high productivity and the stock were initially put onto fresh pasture at a conservative rate.

Conversely, the pasture type at Mallina is not regarded as highly productive and initially there were some sheep in the steer paddock. This competition from the sheep probably adversely affected the performance of those steers for the first half of the trial.

The better performance of the steers at Wyloo was also reflected in the carcass traits recorded for these animals.

Breed effects

In general the *Bos indicus* infused animals performed better. Hybrid vigour must be a consideration here with many Brahman Shorthorn cross breeds represented as well as the straight Brahman, Droughtmaster and Santa Gertrudis breeds.

The better performance of the *Bos indicus* types was not only reflected in the growth rates but also in better dressing percentages, meat colour, fat colour, butt shape, eye muscle area and general carcass quality.

Without considering marketing issues, the *Bos indicus* steers must be considered better performers for the Pilbara environment. It is then up to producers to consider this in conjunction with available pasture types, market demands, market price and reproductive capability of different breeds when choosing a breed type for their enterprise.
Growth potential of steers in the Pilbara - a summary

The trial was conducted over a range of conditions on three locations. The pasture type at Wyloo, the Ashburton River frontage, which is regarded as one of the most productive pasture types in the area, combined with conservative stocking, a fresh paddock and excellent seasonal conditions during 1995, gives us an indication of the District’s potential.

In extrapolating any of these data to other cases, consideration must be given to adjustment based on pasture type, seasonal condition and some evaluation of the genetic quality of the stock.

Based on the results achieved in this trial and excluding the exceptional (good or bad) performers, the following figures are presented.

In a good year, on a better pasture type, the annual average growth of steers can be expected to be 0.6 kg per day. Better animals can be expected to average 0.7 kg per day.

Within a good year, growth rates up to 0.9 kg/day can be expected when available feed is green and plentiful. Better animals can be expected to average 1.0 kg per day. When the feed dries off in the autumn and is less plentiful, growth rates of 0.5 kg/day can be expected.

On the less productive pastures, growth rates varied from 0.05 kg/day in the dry times, up to 0.65 kg/day in the summer. Average rates of 0.45 kg/day can be expected on this pasture type on an annual basis during reasonable seasonal conditions.

The final destination of the meat

The carcasses were boned at Clovers on the day following slaughter and cuts vacuum packaged. Meat was left to age for 10 days in cold storage at Waroona. The meat colour was considered to be of a good standard. The meat with the best meat colour was sent to domestic butchers and to the supermarkets where its main use was probably as a ‘special’, as distinct from the top quality highest priced beef. The meat was not considered of the highest quality because of lesser characteristics of meat colour, shape of cuts (conformation) and tenderness (although not tested).

The remainder of the meat, being of slightly less quality went to the Catering Division and was held for a further weeks’ ageing to ensure better eating quality. Its main destination was in the catering trade (such as mining camps and local catering groups) where its main use was likely to be in slow cooking dishes such as curries and casseroles.

The main reason proposed for the meat not being of the highest quality was the age of the animals compared with that normally used on the domestic market. For a line of cattle from the north-west these were considered to be good quality mainly because they were younger and better grown than many cattle from this region.
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**Elders Burnett Moore**

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Location</th>
<th>Office Phone</th>
<th>Alternate Phone</th>
<th>Mobile Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kim Goad</td>
<td>Live Export Manager</td>
<td>Carnarvon</td>
<td>(09) 273 5888</td>
<td>(09) 450 1984</td>
<td>018 931143</td>
</tr>
<tr>
<td>Alastair Moore</td>
<td>Operations Manager</td>
<td>Carnarvon</td>
<td>(09) 273 5888</td>
<td>(09) 386 1472</td>
<td>018 926662</td>
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<tr>
<td>Peter Trezise</td>
<td></td>
<td>Meekatharra</td>
<td>(099) 41 1554</td>
<td>(099) 41 1243</td>
<td>015 199647</td>
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<tr>
<td>Michael Campbell</td>
<td></td>
<td>Meekatharra</td>
<td>(099) 81 1171</td>
<td>(099) 80 1105</td>
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</tbody>
</table>

*Photos courtesy of Farm Weekly.*
Trace element and mineral analysis

Trace element deficiencies in ruminants tend to be confined to specific geographic areas. The area affected may cover hundreds of square kilometres or be limited to a small district. The realisation that the ultimate problem lay in the soil in which the plant was grown has led to the development of geochemical surveys and regional trace element maps. Such surveys have not occurred in the pastoral regions due to remoteness and extensive areas involved.

With certain trace elements, the requirements of the plant for a particular mineral are not the same as that of the grazing animal. Consequently while plant requirements may have been met, the same does not follow for the dependent ruminant and trace element deficiencies can occur on what appears to be excellent grazing.

In this particular instance the opportunity was taken to sample all animals at slaughter to assess the trace element profile to provide background information on the three depots used in the trial.

All animals had liver and blood collected at slaughter and these were then analysed for copper, zinc, iron, manganese, selenium, cobalt (Vit B12) and phosphate.

**Selenium**
The clinical sign of mild selenium deficiency in ruminants is one of ill thrift.

Analysis was carried out on blood collected in lithium heparin tubes using Glutathione Peroxidase, a seleno-enzyme. The levels were confirmed with liver sample analysis from a random selection of the slaughter steers. All levels were in the adequate range.

**Liver copper**

| Deficient | < 6 mg/kg |
| Marginal  | 7-20 mg/kg |
| Adequate  | 20-250 mg/kg |
| Toxic     | > 500 mg/kg |
| Animal range | 28-472 mg/kg |

Most animals were in the range 28-245 mg/kg with only two recording 437 and 472 mg/kg respectively.

**Zinc**
Zinc deficiency in ruminants is rare and is manifest in poor growth rate caused by depressed appetite and skin disorders.

**Liver zinc**

| Deficient | < 90 mg/kg |
| Marginal  | 90-100 mg/kg |
| Adequate  | 100-200 mg/kg |
| Toxic     | > 400 mg/kg |
| Animal range | 98-207 mg/kg |

**Iron**
Iron is an important component of numerous enzyme systems. Nutritional iron deficiency in grazing animals has not been recorded in this State although occasional low levels are encountered as secondary manifestations of other conditions such as parasitism.

**Liver iron**

| Deficient | < 100 mg/kg |
| Normal    | 100-300 mg/kg |
| Toxic     | > 2000 mg/kg |
| Animal range | 92-492 mg/kg |

**Manganese**
Manganese is essential for growth in animals and deficiency can result in bone defects, testicular degeneration in males and defective ovulation in females. Liver levels of the cattle were all in the normal range.
Liver manganese

<table>
<thead>
<tr>
<th>Status</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deficient</td>
<td>&lt; 6 mg/kg</td>
</tr>
<tr>
<td>Adequate</td>
<td>&gt; 6 mg/kg</td>
</tr>
<tr>
<td>Animal range</td>
<td>6.8-14.2 mg/kg</td>
</tr>
</tbody>
</table>

Cobalt

The best measure of adequate cobalt intake is an estimation of Vitamin B\textsubscript{12} status. Deficiency signs of cobalt are loss of appetite, wasting and anaemia due to a lack of Vitamin B\textsubscript{12}. Plasma Vit B\textsubscript{12} results are variable in cattle but all samples were very high giving a good indication that Vit B\textsubscript{12} status was adequate.

Plasma Vit B\textsubscript{12}

<table>
<thead>
<tr>
<th>Status</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deficient</td>
<td>&lt; 0.12 ug/L</td>
</tr>
<tr>
<td>Marginal</td>
<td>0.13-0.20 ug/L</td>
</tr>
<tr>
<td>Animal range</td>
<td>0.82-1.58 ug/L</td>
</tr>
</tbody>
</table>

Phosphorus

The importance of phosphorus in the nutrition of cattle in Australia has been known for most of this century. Phosphorus deficiency was confirmed as a problem in Northern Australia in the 1940s and is now recognised as a major limitation to beef cattle production in Northern Australia.

Phosphorus is the second most plentiful mineral in the body and has an important role in the conversion of feed into energy and the build-up and repair of body tissues. In addition pregnant cows must supply phosphorus to the developing foetus and after calving for the production of milk. If animals are to grow, reproduce and milk well they must have sufficient phosphorus in the diet.

Grazing cattle get their phosphorus from the pasture they eat. Pasture plants take up phosphorus from the soil and since soil phosphorus levels vary, the levels in plants in different regions also vary. Phosphorus deficiency manifests as reduced growth rate, lowered branding rates, increased deaths and broken bones in cattle.

The publication ‘Phosphorus Nutrition of Beef Cattle in Northern Australia’ lists the Pilbara region (South to a line from Exmouth to Newman) as phosphorus deficient. Some coastal areas and river frontages are shown as marginal to adequate.

Indicators of soils with low phosphorus status include termite mounds, sandy soils, vegetation types (e.g. Mulga, wattle, spotted gum, cypress pine), grasses with a short growing period (e.g. Spinifex).

Limited soil testing through the area has indicated soil phosphorus levels in the range 1 ppm-70 ppm. Levels below 5 ppm are regarded as deficient.

Plasma phosphate levels were analysed for all of the steers from the three depot areas at Mallina, Marillana and Wyloo. All results were within the normal range. However, pastoralists are urged to assess phosphorus availability and animal responses on their individual properties.

Plasma phosphate

<table>
<thead>
<tr>
<th>Status</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low</td>
<td>&lt; 25 mg/L</td>
</tr>
<tr>
<td>Low</td>
<td>25-35 mg/L</td>
</tr>
<tr>
<td>Medium</td>
<td>35-45 mg/L</td>
</tr>
<tr>
<td>High</td>
<td>&gt; 45 mg/L</td>
</tr>
<tr>
<td>Animal Range</td>
<td>35-140</td>
</tr>
</tbody>
</table>

It is important to realise that phosphorus levels can vary with season, time of year, physiological status, site of sample collection and method of analysis.

No single symptom or sign is positive proof that a phosphorus deficiency exists. The presence of the following signs will point towards a possible phosphorus deficiency.

- Bone chewing
- Broken/brittle bones
- Peg - leg
- Botulism

In summary

The tests indicated that at the time of sampling all animals over all sites had adequate levels of the tested minerals and nutrients and so no comparisons between sites were required. Further testing of stock may be required to determine possible variations caused by class of animal, time of year and seasonal conditions.
Pasture evaluation using satellites - satellite observed ‘Greenness Index’

Historically, rangeland extension advice from Agriculture Western Australia to pastoralists has recommended stocking rates for modal seasonal conditions. Change in range condition, determined from data collected at vegetation monitoring sites, is used to evaluate the long term effects of stocking rates. This system does not provide information about seasonal conditions on which short term tactical stocking rate decisions are made. Therefore Agriculture Western Australia has been investigating ways of providing pastoralists with objective spatial and temporal measures of seasonal conditions.

Normalised Difference Vegetation Index (NDVI) values are being calculated from data collected by the National Oceanic and Atmospheric Administration satellite. These NDVI values are strongly correlated with intercepted photosynthetically active radiation and thus photosynthesis. In other words it is a measure of pasture greenness. The frequency of data collection allows within season changes in photosynthetic activity to be tracked. At Agriculture Western Australia the NDVI data are being processed into time series (average NDVI plotted against time) for various areas. This steer growth rate evaluation provided an opportunity to relate observed data to actual animal performance. Assessment of seasonal condition in any year is based on a comparison with the time traces of past seasons for that area.

Initial work indicated that seasonal conditions are not correlated with total NDVI but are correlated with the NDVI ‘flush’ (flush is defined as NDVI minus a base – the base is defined as the lowest NDVI value in the ‘dry season’ immediately before the ‘wet season’). Assuming no change in the composition of the vegetative response, a greater flush should mean greater amounts of all vegetation types including the animal feed components. Therefore, temporal comparisons of the NDVI flush values should give an indication of the relative amounts of animal feed available.

In this trial the flush values for the trial paddock on Wyloo were 146 NDVI units for 1994 and 259 for 1995. This would indicate that the 1994 season was only about 60% as good as the 1995 season. The corresponding values for the paddock on Marillana are 67 for 1994 and 301 for 1994 indicating that the 1994 season was only about 20% as good as the 1995 season.

The relative season ratings estimated from the NDVI should be correlated with growth rates of the animals over the ‘flush’ part of the year. Unfortunately the trial started in July 1994 so there is no 1994 growth value to compare with the March to October 1995 growth period. However, in the July to October period the growth rates for Wyloo were 0.30 kg/d for 1994 and 0.51 kg/d for 1995. This indicates that 1994 was only about 60% as good as 95 and matches the seasonal ratings obtained from the NDVI. The corresponding values for Marillana are 0.15 for 1994 and 0.51 for 1995 indicating that 1994 was only about 20% as good as 1995 again matching the ratings from the NDVI.

Flush values are not appropriate to compare with animal performance across the October to March period because the base values change. The base values (i.e. green photosynthesising material present through the ‘dry’ season) are heavily influenced by the presence of trees. However they are also influenced by carryover from the run of preceding seasons. A good ‘wet’ season usually elevates the base value in the following ‘dry’ season presumably due to the survival of facultative biennials and enhanced perennial growth (new germination and new growth on existing plant structures). Therefore the base values should be indicators of dry season animal production. For both Wyloo and Marillana the base values for summer 1994/95 were higher than for summer 1995/96 and so were the growth rates.

The results for Mallina are invalidated because of the complications of having the animals moved between two paddocks during the trial period and the presence of sheep for the earlier part of the evaluation.

The results from this trial support the hypothesis that the relative rating of seasonal conditions calculated from the NDVI match the relative animal production rates. Therefore, the NDVI seasonal ratings should be a useful aid to pastoralists in making tactical stocking rate decisions. Comparisons can be made between the NDVI timetraces (and thus feed availability) between years. The pastoralist can then reflect on the stocking rates applied and the productive performances achieved by his animals against the relative feed availabilities for the various previous years. This comparison can be used as an aid to setting stocking rates for the present year. This should lead to better tactical stocking rate decisions.
Average growth rate and NDVI reflectance at Wyloo during the trial period.