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Management practices of *Bos taurus* bulls in non-temperate Australia

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Abstract

Bos taurus genetics have the potential to improve the productivity of production systems in non-temperate Australia, however only if producers are willing to allow bulls to adapt to environmental stressors. This report details the results from sixty face-to-face interviews with seedstock and commercial producers from across Australia, currently selling or purchasing *Bos taurus* genetics.

The results from these interviews were used to develop an online decision support system, which, after producers answer a number of questions, provides them with best practice recommendations to help with the successful adaptation of *Bos taurus* bulls.

Executive summary

Sixty semi-structured interviews were conducted between Angus Australia and the managers of seedstock and commercial beef cattle operations. The purpose was to document the management practices currently used by producers to facilitate the successful adaptation of *Bos taurus* (including crossbred) bulls in northern, non-temperate Australia. The interview process identified management practices pre and post relocation that affect the successful adaptation of bulls sold into northern, non-temperate Australia.

Benefits of infusing *Bos taurus* genetics into (predominantly) *Bos indicus* herds

Producers were asked to discuss the benefits of *Bos taurus* bulls in their herds. Producers listed the ability of progeny to meet market specifications and increases in reproduction rates as the main benefits of using *Bos taurus* bulls; other benefits identified are presented below. The benefits listed below are primarily achieved through hybrid vigour and/or genetic improvement of the herd.

The benefits of infusing *Bos taurus* genetics into (predominantly) Bos indicus herds include:

- Increase in progeny growth rates.
- Improved ability of progeny to meet market specifications.
- Reduced animal welfare concerns and costs associated with dehorning progeny through the use of poll *Bos taurus* bulls.
- Increased reproductive rates, achieved by reducing age at puberty, and increased calving rates.

Adaptation period

A minimum adaptation period of three months was recommended to eliminate any reductions in bull semen quality due to relocation. The length of the adaptation period varied depending on the:

- Age of the bulls at purchase.
- Availability of infrastructure to secure bulls for three months without increasing injuries.
- Variation in quality and availability of feed pre and post relocation.
- Parasite and disease burden, particularly in animals that have not been vaccinated.
- Distance bulls have been transported.

Bull management to reduce breakdowns

The management of bulls for the first 12 to 18 months is very important for successful adaptation of bulls into northern environments and greatly impacts survival and longevity.

The following is a summary of management practices used by northern producers to reduce breakdowns:

- Age segregation of bulls to reduce fighting while with cows and when removed.
- Culling of mickey and scrub bulls (feral bulls).
- The removal of bulls from the female herds during the dry season (in order to maintain body condition).
- Parasite control for *Bos taurus* animals.

Requirements of commercial producers when purchasing bulls for use in northern, non-temperate Australia

The main requirements commercial producers raised during interviews relate to the fertility and structural assessment, and are listed below:

- Bulls should have full morphology testing conducted prior to sale to ensure the bull's semen at the time of sale is of an adequate quality.
- Inclusion of independent structural assessment scores in sale catalogues.
- Inspection of the maternal pedigree to ensure the dam and grand-dam raised a calf every year.

Vaccinations required (in the order of importance) include:

- Three germ blood (tick fever).
- Bovine ephemeral fever (three-day sickness).
- Clostridial botulism.

These vaccinations are in addition to standard vaccinations (pestivirus, vibriosis and 7-in-1).

Online decision support system

An online decision support system has been created as a portal for producers to access the best practice recommendations that were informed by the results of this research. This online decision support system has been developed to have a user-friendly interface and allows producers' access to information relevant to their enterprise by answering a short questionnaire.

Acknowledgements

Angus Australia would like to thank the following groups of people for their involvement throughout this project:

- The commercial producers, seedstock producers and feedlot managers, who generously gave up their time to be interviewed. This project could not have been successfully completed without their input.
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- Breedlink for providing advice and knowledge during the research phase of this project.
- Greenleaf Enterprises for the development of the online tool.
- Sefton & Associates for input during the development of the communications plan.

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List of abbreviations

ADG	Average daily gain
Arbovirus	A virus transmitted by arthropods
BBSE	Bull breeding soundness evaluation
BCS	Body condition score
BEF	Bovine ephemeral fever
DAFFQ	Department of Agriculture Fisheries & Forestry, Queensland
DAFWA	Department of Agriculture and Food, Western Australia
EBV	Estimated breeding value
MLA	Meat & Livestock Australia
MSA	Meat Standards Australia
ODSS	Online decision support system
PTIC	Pregnancy tested in calf

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1. Introduction

Angus Australia embarked on this project to increase the understanding of environmental stressors imposed upon *Bos taurus* bulls post sale. The project was undertaken to collect information relevant to the beef industry regarding the requirements of *Bos taurus* bulls in northern, non-temperate Australia. Knowledge gained from this project can be extended to industry and may reduce the impact of stressors on the performance of *Bos taurus* of bulls in Northern Australia.

The background for the project is presented below.

1.1. Preparation of *Bos taurus* bulls for the north

The adaptation and management process undertaken when introducing *Bos taurus* bulls into tropical or sub-tropical Australia will affect the performance of the animals in the new environment. Successful introduction of desirable genetics into a production system can result in increased productivity; such as increased weaning percentages, rebreeding rates and weight gains.

The greatest factor influencing successful adaptation is management of *Bos taurus* bulls before and after they reach their new environment. In cases where adaptation is not managed well, it can cause a drop in body condition and in worst-case scenarios, animals die due to malnutrition, disease and/or heat stress.

Areas of management that require attention include bull age, adaptation period post relocation, nutritional regime pre- and post-shipment, controlled joining period, vaccination programs prior to shipment as well as pest and disease management. All of these factors can affect the performance of animals within their new environment.

1.2. Dynamics of the Australian beef industry

The Australian beef herd is predominantly northern based (Figure 1.1.) with approximately 51% of the national herd based in Queensland and the Northern Territory. The Northern beef industry covers a total area of 158 million hectares. In this area, there are 107 pastoral leases in Northern Western Australian (Ref.1), 243 pastoral leases in the Northern Territory and about 18,310 in Queensland (Ref.2). The large percentage of cattle used in these rangelands are Brahman-derived breeds with some tropically adapted composite herds. 18.2% of the national herd consists of Brahman cattle and 14.7% comprised of *Bos indicus* and *Bos taurus* composite breeds (Ref.3).

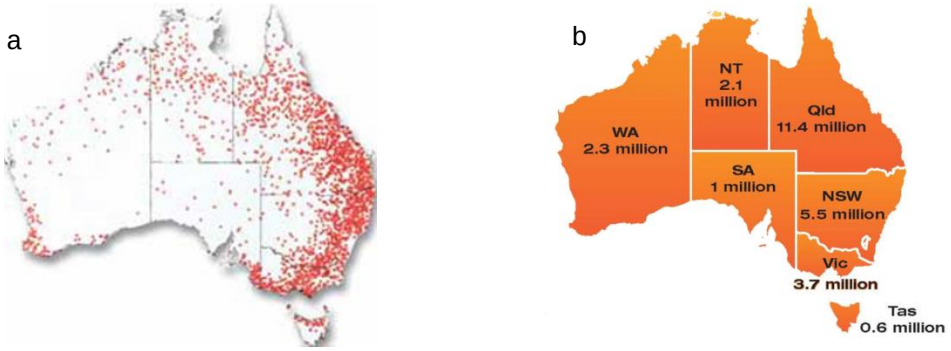

Figure 1.1.a) Cattle distribution in Australia per state, as at June 2012
Figure 1.2.b) Cattle numbers per state, as at June 2012

Figure 1.1.a) shows that over 50% of Australia's cattle herd is found in Queensland and the Northern Territory and Figure 1.1.b) shows that the cattle population in Queensland is more than double that of the second most populous state (NSW).

The majority of purebred *Bos taurus* bulls in Australia are bred in more temperate areas of the country. This adds to the complexity of the adaptation process when bulls are sent into the north for crossbreeding. The distances and changes in environmental factors experienced affect the ability of cattle, in particular bulls, to adapt. The length of time required for adaptation is affected by the degree of variation in climate and environmental factors of the destination region compared to the bull's origin.

Since the introduction of *Bos indicus* cattle into Australia in the 1960s they and breeds derived from *Bos indicus* cattle, have dominated northern, non-temperate Australia as they have better adaptation to tropical environments compared to *Bos taurus* breeds.

1.3. Differences between *Bos indicus* and *Bos taurus* sub-species of cattle

The differences between *Bos indicus* and *Bos taurus* cattle tend to be associated with the tropical adaption of the animals, and the subsequent effect on meat quality. The difference between these types of cattle allow them to complement each other in breeding operations in northern, non-temperate Australia. The distinct variation of genetic makeup between animals increases production through hybrid vigour in progeny.

Tropically adapted *Bos indicus* cattle originated from tropical environments such as India. Genetic attributes of *Bos indicus* cattle are ecto-parasite resistance and reduced heat production because of smaller organ size and reduced maintenance requirements (Ref. 6). These traits result in a decrease in the heat production by the rumen increasing the ability of

Bos indicus animals to reduce the impact of prolonged periods of heat exposure in arid, sub-tropical and tropical environments (Ref.7).

The *Bos taurus* sub species is less adapted to tropical environments. Therefore, breeding herds may be required to maintain a level of *Bos indicus* content. The introduction of *Bos taurus* genetics can increase the reproductive rates and positive carcase attributes in first cross progeny and therefore should be considered for introduction into northern herds. The recommendations provided throughout this report will assist producers to overcome the issues that arise when using *Bos taurus* bulls that are not well adapted to northern, non-temperate Australia.

1.4. Climatic differences between temperate and non-temperate Australia

The delineation of northern, non-temperate Australia is in accordance with the Bureau of Meteorology's classifications of the Australia environment. These environmental zones were established using the Köppen classification (Ref.8) and can be seen in Figure 1.3. Climatic regions of Australia (Ref.9)

The Köppen classification analyses the mean monthly rainfall, annual rainfall, maximum temperature and minimum temperature to classify the different areas. This classification was used in conjunction with the location of the majority of beef breeding cattle in Australia to define the research area. The northern areas of non-temperate Australia have been defined as the areas north of the Queensland border and north of the 26^{o} south line in the Northern Territory (Southern NT border) and Western Australia. Within these areas there are patches of temperate country, these are identified in Figure 1.2.

The timing of wet seasons can have an effect on the periods during which producers can shift bulls into northern, non-temperate Australia. This variation in rainfall will, in turn, affect the stressors imposed on an animal.

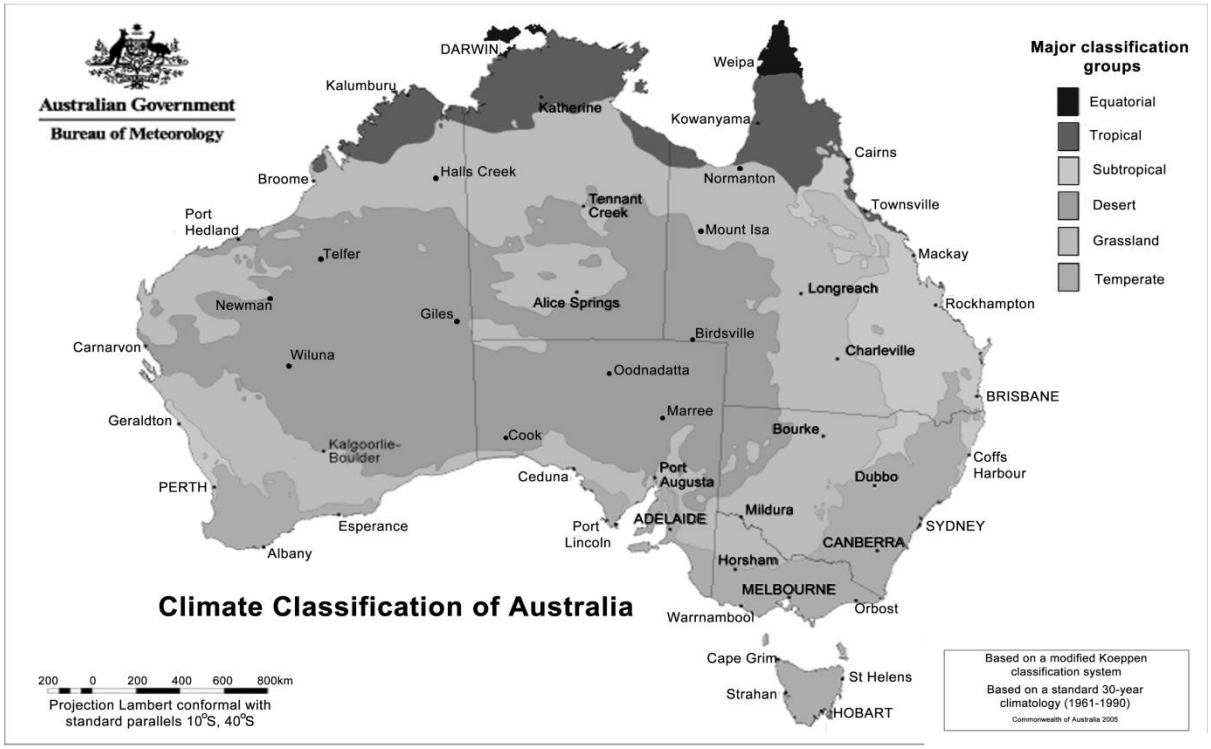

Figure 1.3. Climatic regions of Australia (Ref.9)

2. Objectives

The project comprised of two phases: research and online tool development.

The first phase aimed to:

- Document the management practices required for the effective use of *Bos taurus* (and crossbred) bulls in northern, non-temperate Australia.
- Develop and extend best practice recommendations for seedstock producer supplying *Bos taurus* bulls into northern, non-temperate Australia and for commercial bull buyers purchasing *Bos taurus* bulls.
- Obtain objective data on the benefits of *Bos taurus* genetics with reference to carcase quality in northern, non-temperate Australia (eg market premiums, meat quality, polledness etc).
- Gain a better understanding of the factors affecting the fertility of females and the minimum *Bos indicus* content required to maintain fertility.

The second phase developed an online decision support tool that included:

- Selection of locations to identify specific stressors imposed by the environment.
- Location specific recommendations:

  - Parasite and disease.
  - Adaptation of new bulls.
  - Female herd composition and minimum *Bos indicus* content to be calculated by the system, with current and future composition incorporated.
- The ability to add recommendations, as they are defined and developed.

3. Methodology

This project comprised two distinct research and development phases as the outcomes of the research phase were required for the development phase. The research phase of this project was developed through the completion of 60 semi-structured, face-to-face interviews that were conducted between 1st December 2011 and the 18th September 2012.

The semi-structured interviews were conducted between K. Bryan and seedstock producers, commercial producers and feedlot managers. The information gathered throughout this project is detailed throughout this report and was used to develop best management practices for the adaptation of *Bos taurus* bulls into northern, non-temperate Australia.

The information and recommendations from the first phase of the research were used in the development of the online tool. The tool was developed to allow producers to identify the stressors present on their property, providing them with information relevant to their production system.

3.1. Phase 1. Research into the benefits and adaptation of *Bos taurus* cattle in northern/non-temperate Australia

Interviewees were kept anonymous and have only been identified by their producer type (C = commercial producer, S = seedstock producer and F = feedlot manager). The survey zones identified in Figure 3.1 were used as the second letter in the identification code. For example: CB3 is a commercial producer that is located in area B on Figure 3.1. Due to the small number of feedlots surveyed they have not been identified by area to reduce the chance of them being identified.

Some commercial producers managed small feedlots or had contract feeding arrangements for their own branded products. These managers were identified as commercial producers, as their main role was the management of the breeding and backgrounding herds.

The seedstock producers were interviewed to gain an understanding of their management and production systems prior to the movement of bulls into northern, non-temperate Australia. The commercial producers, who were identified by the seedstock producers, were

interviewed to develop an understanding of the management of *Bos taurus* bulls post relocation. This process allowed management practices that aid in the success of bulls post relocation to be identified.

3.1.1. Survey regions

The regions used in this research were based on zones developed by Nicol (Ref.10) for Angus Australia and developed to represent the level of stressors imposed on animals post relocation. The geographical location of these areas can be seen in Figure 3.1. Within each of these areas, there are considerable variations in pasture quality, which will affect the management of animals depending on each particular property.

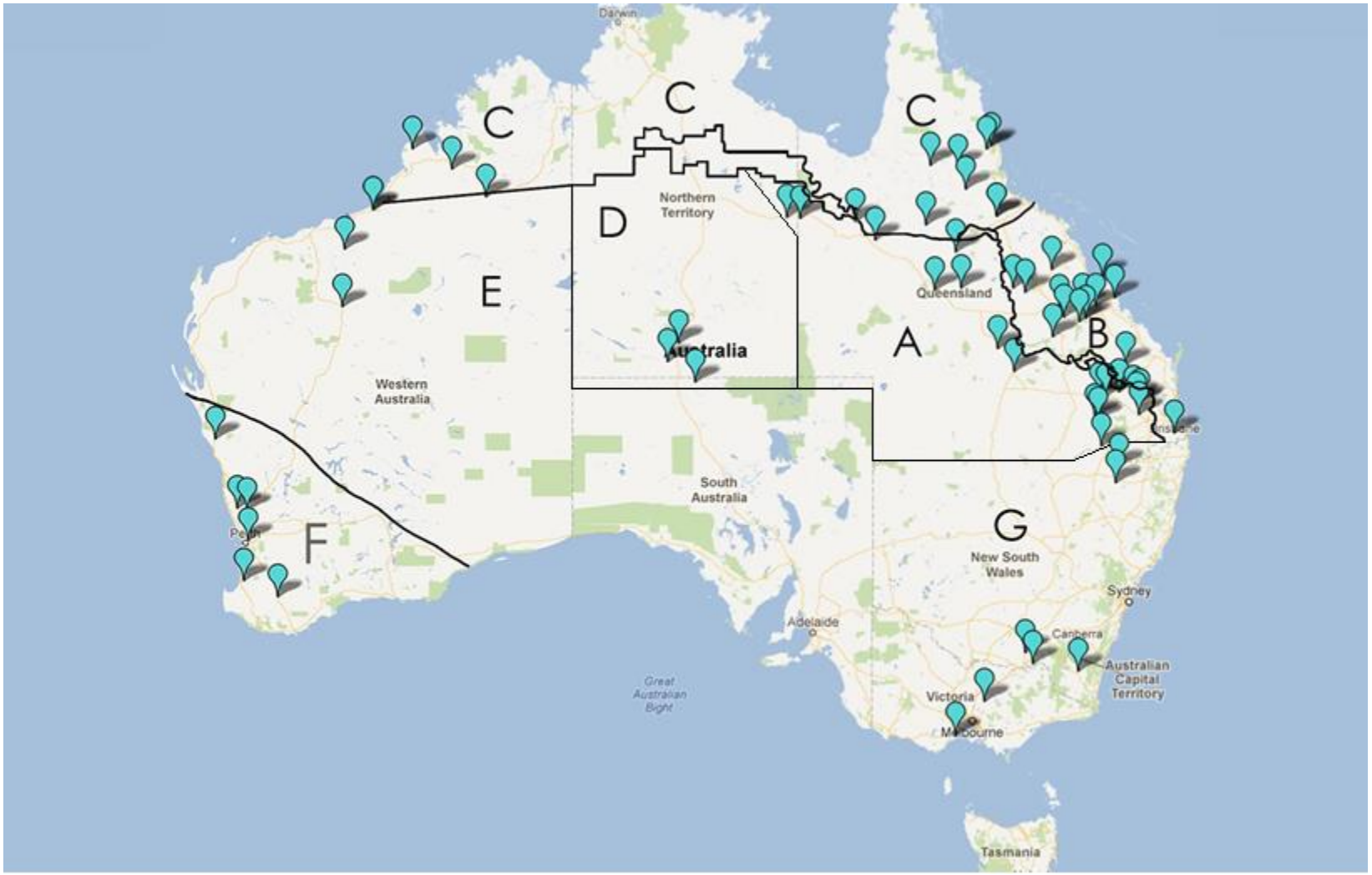

Figure 3.1. Producers interviewed throughout the property visits divided into their production stressor areas. The black line represents the divisions in these areas and the tick line in the north (see pages 6 and 7).

Zone A – The south-western corner of Queensland south-west of the tick line. This area has a reduced number of stressors placed on the animals as there is not the intense humidity during the summer months and there are no ticks. There are areas of good quality country throughout Zone A but also some drier areas in the western parts of the state. Zone A has predominantly summer rainfall with smaller amounts of winter rain that can decrease feed quality.

Zone B – The southern coastal zone in Queensland, south of the Flinders Highway and east of the Great Dividing Range. Zone B has a sub-tropical climate and a higher parasite burden than Zone A.

Zone C – Follows the Flinders Highway to Hughenden and then remains north of the tick line to Broome in Western Australia. The environmental stressors are intense with humidity from high to very high during the summer months. This Zone has patches of highly fertile country which is mainly localised to the Atherton Tablelands. Zone C receives high annual rainfall predominantly in summer and has vast areas of phosphorus deficient country.

Zone D – This Zone encompasses southern Northern Territory, south of the tick line. This area consists of very dry, arid rangelands with average rainfall between 200 and 300mm per annum. Rain tends to fall year-round. Rain during the winter months increases the growth of native herbages in the spring. Summer rainfall increases the growth of perennial grasses. Despite this rainfall, Zone D supports very low stocking densities and is prone to severe droughts.

Zone E – The arid region of Western Australia, south of the tick line and north of the sheep wheat belt in Western Australia. The northern section of this area tends to rely on cyclonic activity for the yearly rainfall. Zone E has extended periods of very hot, dry weather during the summer. The majority of the country in this Zone joins sections of desert and there are vast areas of unfenced rangelands. Zone E is described as marginal, with low average rainfall and vast areas of desert.

Zone F – Comprises temperate south-western Western Australia. This area is better known as the sheep wheat belt of Western Australia. The main producers interviewed in this area were seedstock producers. Zone F tends to be predominantly populated by *Bos taurus* cattle. Some properties in Zone F are utilised as fattening country for cattle bred in the Western Australian sections of Zone C and Zone E.

Zone G – This Zone is the temperate area in New South Wales and Victoria. Many of the seedstock producers who breed bulls for northern, non-temperate Australia occupy this Zone.

3.1.2. Seedstock producers interviewed

Seedstock producers were selected from the Angus Australia database for their experience in selling bulls into northern, non-temperate Australia. Seedstock producers were emailed an initial survey of six questions to identify producers that were willing to discuss their experiences with selling bulls into northern, non-temperate Australia. This survey was emailed on the 10th October 2011 to 52 seedstock producers. From the 52 emails sent there were 28 responses to the initial survey, of which eight were not selling bulls into northern, non-temperate Australia.

Twenty face-to-face semi-structured interviews with seedstock producers were conducted between 12th December 2011 and the 26th July 2012. During this time, the producers were interviewed using the survey in Appendix 8.1. A summary of the interviews in each region is outlined in Table 3.1. Seedstock producers interviewed were producing Angus, Brangus and Santa Gertrudis bulls. The majority of the seedstock producers interviewed were located in temperate regions of Australia.

Table 3.1. Number of producers questioned in each area

Area	Seedstock producers	Commercial producers
A	8	7
B	2	10
C	0	11
D	0	4
E	0	5
F	3	0
G	7	0
TOTAL	**20**	**37**

3.1.3. Commercial producers

The commercial producers interviewed were identified by seedstock producers as running *Bos taurus* bulls in northern, non-temperate Australia. Producers were emailed a brief summary of the project and asked to be involved. Interviews were conducted between the 26th April 2012 and the 14th September 2012. The survey instrument used during the commercial producer interview is listed as Appendix 8.2. The interviews were conducted on-property so visual assessments could be made on the type of animals and body condition score (BCS) of bulls.

Survey data was collated after the interviews. Paper surveys were completed either at the commercial producer's property or directly after the completion of the interview. The surveys were entered into a template and stored in accordance with Section 3.1.4.

3.1.4. Survey development and data collection

Three surveys were developed to collect data to meet the objectives set out for this project (Section 2). The seedstock and commercial producer surveys were developed to obtain similar information but from either perspective. Additionally, the commercial survey included questions in regards to the growth, carcase and sale statistics.

Key stakeholders including Don Nicol (Breedlink), Liz Allen (MLA), Peter Parnell (Angus Australia) and Angus Australia's board of Directors checked the surveys (Appendices 8.1 and 8.2) for relevance.

The information collected during the interviews was used to develop an online decision support tool in order to extend best practice recommendations to producers on a property specific basis.

3.2. Phase 2. Online tool development

The initial research into the development of the online decision support system (ODSS) was conducted by contacting three companies to understand what capabilities and design features were possible. Greenleaf Enterprises demonstrated an understanding the requirements of to the ODSS and were granted the contract to develop the system.

3.2.1. Project scoping

During the final parts of the research phase of this project, meetings were conducted between Angus Australia and Greenleaf Enterprises to increase Angus Australia's understanding of the capabilities that could be incorporated into the ODSS.

The main scoping meeting was conducted on the 2nd October 2012 in Brisbane and the main requirements for the online tool were determined as:

- User friendly (easy and quick to use).
- Map plug in to allow producers to select their property's location.
- Questionnaire to be tailored using three branches of questions.
- Self-managing site.
- Self-registration for users.
- Able to be updated by Angus Australia.
- Incorporate a knowledge base to provide users with additional information on specific areas of interest.

Once Angus Australia set the system functionalities, the time line of development displayed in Table 3.2 ensured the ODSS was developed to meet the Angus Australia annual conference launch deadline of 30th April 2013.

Table 3.2. Time line for the development of the online decision support system

Project development stages	Completion date
1. Project scoping	07/01/2013
2. Defining system functionality	30/01/2013
3. Program final site features	28/3/2013
4. Content Management and site handover	22/04/2013
5. Data extraction functionalities build	22/04/2013

3.2.2. Development of the content of the ODSS

Upon completion of the project scoping (milestone one) the focus switched to the development of the question structure and recommendations. This content was presented to Greenleaf in February 2013 for database upload.

The GPS co-ordinates were provided to define the seven distinct stressor areas, based around the tickline, and changes in environmental ranges. These co-ordinates automatically identify the selected area for each selection on the map.

Questions were set for each stressor area. Once the first tier of questions and answers were developed, the second tier expanded the question based on the answer to the first question. For example, a producer who was located close to the tick line who answered that they did not have ticks would not be asked any additional questions on ticks. The questions were originally developed for the highest stress area and then modified for the additional six areas.

Recommendations were developed for each of the question responses. These recommendations were tailored to the way that both first and second tier questions were answered. This ensured that producers were supplied with recommendations relevant to their current management practices.

4. Results and discussion

Results obtained from interviews with commercial producers indicated that there are a number of producers successfully running *Bos taurus* bulls in northern, non-temperate Australia. The following section presents the findings from the interviews.

The dynamics of the surveyed herds and their locations are displayed in Table 4.1. The variation in the *Bos indicus* content has been displayed to demonstrate the effect of stress levels on the productivity of their female herds.

Table 4.1. Commercial producers' herd dynamics

Stressor zone	Producer areas*	*Bos indicus* content in female breeding herds				
		0–25	25–50	50–75	75–100	Total
Area A	**Total**	**4**	**2**		**1**	**7**
	L	2	2		1	5
	M	2				2
Area B	**Total**		**2**	**8**		**10**
	S			1		1
	M		1	1		2
	L		1	5		6
	VL			1		1
Area C	**Total**	**1**	**2**	**4**	**4**	**11**
	S	1		1	1	3
	M			1		1
	L			1	2	3
	VL		2	1	1	4
Area D	**Total**	**3**	**1**		**1**	**5**
	L	3				3
	VL		1		1	2
Area E	**Total**	**2**			**2**	**4**
	L	1				
	VL	1			2	
All areas	**Total**	**10**	**7**	**12**	**8**	**37**

*S (Small) = 0–500 cows, M (Medium) = 0–1,000 cows, L (Large) = 1,000–5,000 cows and VL (Very large) = 5,000+ cows.

4.1. Benefits of using *Bos taurus* genetics

Increases in productivity from the use of *Bos taurus* genetics in the female herd are through improvements in growth rates, female reproductive rates and polled progeny. In addition to these improvements in productivity, there is a greater demand for the progeny from feedlots and processors.

4.1.1. Growth rates

The increase in growth rates are identified in **Table 4.2. Growth rates of *Bos taurus* and *Bos indicus (BI)* sired calves** demonstrate what can be achieved by incorporating *Bos taurus* genetics into a production system. This data was obtained from a commercial producer in QLD and demonstrates what is possible using the following crosses.

Table 4.2. Growth rates of *Bos taurus* and *Bos indicus (BI)* sired calves

	Bos indicus	**Angus x BI**	**Senepol x BI**	**P value**
Gestation length	288.90	279.53	286.55	<0.001
ADG branding to weaning	0.778	0.862	0.865	<0.001
Branding weight	107.7	119.0	115.4	<0.001
Weaning weight	173.8	195.9	189.9	<0.001

The variation in growth rates between the *Bos indicus* and *Bos taurus* cross calves is caused by hybrid vigour and a gain in the genetic potential of weaners. The growth rates influences the age at sale and the age at which females reach puberty.

The average daily gain (ADG) displayed in Table 4.2 was calculated for the period between branding and weaning, as birth weights were not recorded. Similar increases in growth rates have been observed in temperate areas of the USA where they have seen a 0.09kg increase in ADG post weaning between Brahman x Brahman and Brahman x Angus calves (Ref. 10). Results obtained on individual properties will vary depending on feed availability and management.

The main benefit to producers is the 84g/day increased weight gain without any additional input into the system. If the increased weight gain is maintained during the life of the animals, crossbred animals may be 46kgs heavier at 18 months of age. Reaching heavier weights at earlier ages can reduce the number of animals cutting four teeth prior to sale therefore meeting processors' specifications and Meat Standards Australia (MSA) grading requirements.

Crossbred progeny with greater hybrid vigour can reach carcase specifications at a younger age and therefore, have greater access to premiums associated with MSA compliance.

4.1.2. Polled animal

The percentage of polled progeny from first cross *Bos indicus* x *Bos taurus* calves is variable because *Bos indicus* animals have a sex-linked poll gene. Data obtained from a northern Queensland producer demonstrates this with 80% of the male *Bos taurus* (polled breeds) calves, having horns or scurs when compared to none of the females of the same contemporary group having horns or scurs. Across the *Bos indicus* x *Bos taurus* progeny, 77.9% of the calves were polled, whereas only 16.9% of the *Bos indicus* calves were polled, see Table 4.3.

Table 4.3. Percentage of polled animals between a *Bos indicus* and *Bos taurus* sired calves

Polled status	*Bos indicus*	*Bos indicus* x *Bos taurus*
Horn	71.1%	1.5%
Poll	16.9%	77.9%
Scur	12.0%	20.6%

The main benefit of polled genetics in a herd is the elimination of dehorning. Recent changes to animal welfare guidelines recommend an antiseptic spray be used when dehorning cattle over six or 12 months of age depending on the circumstances (Ref. 11). This will increase the cost of dehorning if animals are missed or are not dehorned before they are 12 months of age.

The stress placed on animals during the process of dehorning may affect their growth rate. A reduction in the number of horned animals will reduce stress level of calves at weaning and reduce possible calf losses at branding due to dehorning.

It may be possible, by selecting a single trait, to increase polled animal production rates without compromising other traits. The time required to reduce the number of horned animals in a herd will vary on the situation. The level of mickey bulls present on the property may affect the rate that a producer's herd can become polled.

4.1.3. Female fertility

Improvements in reproductive rates through the introduction of *Bos taurus* genetics may occur as a result of hybrid vigour through a reduction in milk anoestrus and genetic improvement of the herd. However, the rate of improvement will depend on the quality of the country and management of individual properties.

Producers may need to maintain some *Bos indicus* content in their breeding females, depending on the level of environmental stressors on-property.

The reproductive traits disclosed by producers during interviews varied between 40% and 95% weaning rates. Records kept by producers varied from knowing pregnancy test percentages to calves weaned per number of cows joined. The main factors affecting weaning rate tended to be property size and level of management.

Increases in fertility have occurred through selection for fertility and hybrid vigour resulting in an improvement in calving percentages by up to 10% in three years for one producer (CB8). In another instance, pregnancy test results for *Bos indicus* and *Bos indicus* x *Bos taurus* were 80% and 99% respectively (CB2). It is likely there would have been losses between the pregnancy test and weaning but this demonstrates the positive effects that can be achieved from the first cross heifers.

The increase in growth rates discussed in section 4.1.1. may also affect the age at which females reach puberty as they may reach critical weight at a younger age. The follow on effects of the age and rate at which animals reach puberty may affect the heifers post calving. First cross *Bos indicus x Bos taurus* heifers are likely to cycle earlier than pure bred *Bos indicus* heifers. This may require a change in the management of heifers during better years as heifers may cycle earlier than expected and therefore should be separated from bull calves at a younger age. Some producers that are using *Bos taurus* x *Bos indicus* heifers don't allow them to calve until two years of age to ensure they have grown out and require less inputs post calving.

Improvements in reproductive rates may increase productivity but the implications of *Bos taurus* content in the female herd needs to be considered by producers.

4.1.4. Market availability

Marketability directly affects the bottom line of the business and producers identified that there is substantial variation in the price paid for different types of cattle. There can be up to a 20c/kg carcase weight difference between types of feeder and slaughter cattle and this will vary between seasons.

The markets interviewed producers were targeting varied depending on their location and business structure. The producers located further from an abattoir tended to sell into the live export trade due to costs of transport to other markets. These areas tended to support higher levels of *Bos indicus* content because of market restrictions and country type.

4.1.4.1. Feedlots

There are a number of feedlots throughout Australia finishing high quality *Bos taurus* cattle destined for international markets. Prices for this class of animals tend to be higher according to those interviewed but specific prices should be sought at time of sale.

The level of *Bos taurus* content in steers on feed in the south eastern corner of Queensland tends to affect the class and price paid for the animals on entry to the feedlot. There are premiums available for cull heifers and steers moving into feedlots depending on the *Bos indicus* content. A premium between 10 and 15c/kg over pure *Bos indicus* calves was reported for first cross progeny. As the percentage *Bos indicus* content decreases, price paid increases.

4.1.4.2. Ability to meet carcase specifications

A large proportion of producers throughout Queensland produce bullocks that are sold direct to processors. These producers have incorporated *Bos taurus* genetics into their operation and reported an increase in compliance with processor specifications.

There are guidelines regarding the distance cattle can be transported to slaughter and still meet MSA requirements. Producers selling cattle into MSA certified plants identify main reasons for non-compliance as meat colour and plant specific requirements rather than MSA transport restrictions.

Dark meat colour is the most common non-compliance. In some cases, producers were experiencing up to 11% non-compliance due to meat colour. Meat colour is influenced by stress during transport from the paddock to the abattoir. These stressors include, but are not limited to, mustering and handling prior to transport. Feed regimes can also help improve the meat colour by increasing the gylcogen levels pre-transport.

Processors slaughtering cattle in accordance with the MSA specifications tend to pay higher rates for carcases that meet specifications for MSA boning groups 1 to 11. The premium was greater for carcases in boning groups 1–8 compared with carcases in boning groups 9–11.

Carcase specifications are subject to change without notice. The following specifications were current as of September 2012. There are no prices or value per kilogram included due to natural fluctuations.

- teeth (milk and two, some processors will pay MSA on four teeth but varies according to grid) ,
- fat depth (5 to 23mm),
- meat colour (0 to 3),
- fat colour (0 to 3),
- carcase weights (200 to 340kgs).

Similar information can be obtained from contacting a stock and station agent or a cattle buyer from your preferred processor.

4.1.4.3. Live trade

21% of producers interviewed rely on the live cattle trade. The two major live trades out of northern Australia require moderate to high levels of *Bos indicus* content. Content was determined using pizzle length and coat slickness (CC11, CE2 and CE4) particularly for cattle sold into Indonesia. The heifers and steers sold into the Indonesian market must be below 350kg live weight.

Cattle destined for the Middle East may require a lower percentage of *Bos indicus* but still require a slick coat. The Middle Eastern market predominantly purchase bull weaners.

To ensure that they can meet both markets, producers maintain at least 50% *Bos indicus* content. This allows them to sell heifers into Indonesia and bulls to the Middle East. If additional markets don't emerge producers will be required to maintain at least 50% *Bos indicus* content to ensure they can still sell cull heifers through the Indonesian live trade markets.

Market requirements are a result of the tropical climate the cattle are exported to i.e. *Bos indicus* for the Indonesian market and the sleek coat for the Middle Eastern markets. The live trade into Indonesia has also set the requirement to ensure animals are of a high quality, with minimal "Kimberley shorthorn" content.

4.2. Criteria used to select *Bos taurus* bulls

Buyers select bulls prior to purchase based on physical attributes and estimated breeding value (EBV). The EBVs considered vary depending on their availability. In addition, the physical attributes used for selection are structural confirmation and frame size.

4.2.1. Breeding soundness

The structural soundness of bulls was demonstrated to be the most important factor when purchasing bulls iwth 89% of producers including it in their selection criteria. The 11% not selecting for structural soundness expected sellers would not sell any animals that are not structurally sound.

Producers interviewed during this research expressed an increasing push for full semen morphology testing prior to sale. Producers in northern Queensland were particularly vocal about this and believed all bulls should be tested prior to purchase.

The use of EBVs to select *Bos taurus* bulls for fertility traits tended to be relatively low when compared to the use of EBVs to select for growth patterns and the fat depth of animals. The main fertility trait used by producers is scrotal circumference, which is also included in the bull breeding soundness evaluation (BBSE)

Bull breakdowns can cause significant losses in production depending on the time of year and price paid per animal. Many producers raised the issue of *Bos taurus* bulls breaking down a number of times during interviews, indicating it was an important issue to them. The main causes of breakdowns discussed were structural or reproductive failure once the bulls have adapted to the environment.

The main structural issues identified were the hind legs and feet. A number of producers said they use independent assessment of structural soundness and find this very valuable.

Hind leg injuries as the result of bulls falling off cows when serving have been identified as a major cause of breakdowns (Refer to: Age of bulls in a contemporary group). This leaves the bulls unable to walk between watering points. Commercial producers identified the inclusion of independent structural assessment information in sale catalogues as beneficial. This is important as independent assessors assess animals on a regular basis and are experts in the field (CA3).

Producers indicated they select very strongly for feet soundness to reduce the chance of infections post relocation. Some producers said they would not purchase an animal with the slightest crack in its hoof (CB8).

Vets and producers in northern, non-temperate Australia have requested semen morphology testing to increase the certainty for commercial producers that bulls are highly fertile at time of purchase. Only some seedstock producers were testing all bulls for sale at the time of this research. Many factors can affect semen morphology post-sale. These will be discussed during subsequent sections of this report.

Recommendations:

The important risk management tools identified by commercial producers are:

- Semen morphology testing prior to sale.
- Independent structural assessment included in sale catalogues.

4.2.2. Female fertility/herd history

Selection for fertility was the second most important factor discussed by producers during interviews. The pregnancy test results reported varied from 60 to 99%. The largest losses were seen between pregnancy testing and weaning, with losses of up to 15% experienced on some places.

The main selection procedure used by the interviewed producers was culling cows that do not present a calf every year at weaning and inspecting the reproductive rates of the

maternal side of bulls' pedigrees. The main physical selection method used for bull fertility was using the BBSE and/or EBVs.

The selection pressure producers place on their female herd is affected by the country quality and female reproduction rates. Producers in tougher country cull cows if they fail to present a calf every two out of three years, which involves identifying cows that have not calved (CC4). The selection pressures used on individual properties should be calculated on a case-by-case basis to ensure they improve their reproduction rates but not cull too many females (which could result in female herd numbers that are unsustainable).

The ability of a producer to sell cull cows, particularly in Western Australia, has been identified by some producers as an issue due to limited cull cow markets. It may be better to keep them and hope they get in calf next year rather than selling at low prices. This is mostly due to processors in Western Australia not accepting pregnant cows.

Introduction of *Bos taurus* genetics can reduce the age of heifers when they first calve, but in some regions this is not desirable. Early calving females may require an increased amount of supplement to ensure they return to calf. Some producers explained that first cross heifers could be six to 12 months in front of their *Bos indicus* progeny (CC2). This is mainly due to the reduced age at puberty. These younger animals may require some supplement to ensure they maintain their body condition (CC1, CB3).

Recommendations:

To increase female reproductive rates producers may:

- Cull any cows that do not calve every year, where possible.
- Select the proven cows to breed with the best quality bulls.
- Ensure that the bulls' dam and grand-dam have a proven reproductive recorded when purchasing bulls.
- Ensure the female herd maintains enough adapted content to survive environmental stressors, particularly in tougher years.

4.2.3. Selection for carcase attributes

Carcase attributes were the third most important factor for selection. This was particularly the case for producers supplying their own beef brands and producers looking to meet MSA.

In some cases, producers have increased their compliance with MSA specifications through the introduction of *Bos taurus* genetics. In one instance, MSA compliance improved from 50% to 95% into Boning groups 1 to 8 (Note: there were management practice changes involved with this compliance rate improvement also).

The main change is a reduced turn off age while meeting the fat specification. 36% of interviewed producers who were using EBVs to help with selection decisions selected only bulls with above breed average fat depth for both rib and rump fat. These producers were located in drier environments where fat depth of animals can affect their body condition during dry times.

Producers who were not selecting bulls for carcase traits saw the *Bos taurus* bulls as a way to improve the saleability of progeny.

4.2.4. Temperament

Temperament is heritable so a bull's temperament may affect a herd for the next seven years. Quiet cattle are important to reduce the risk of staff being injured.

66% of the producers interviewed were using temperament as part of their selection criteria across their herd, with temperament being ranked 4/10 for selection importance.

Temperament was considered more important in remote areas. In these areas, any animals classed as wild are culled. One commercial producer said, "There is more selection for docility in the larger places as the cattle only get seen about twice a per year and in some cases then will only be drafted and let go again" (CE10).

The consensus from producers was there is no place for wild cattle in the industry anymore and any bulls sold into non-temperate Australia should be of a good nature. One producer suggested that there has been an issue in the past with cheap wild bulls being sold into open rangelands country. He said, "The bulls just get to the point you can't handle them which can cause a poor reputation for the breed" (SG1).

Recommendation:

Producers should not sell or purchase bulls that have a poor temperament.

4.2.5. EBV use

The use of EBVs in northern, non-temperate Australia varies between producers. Interview responses indicated 95% of seedstock producers supply data to BREEDPLAN and only 70% of commercial producers use EBVs as part of their selection criteria. Further analysis of this 70% of producers indicated 10% of producers utilise set EBVs required by a pastoral company. The producers not using EBVs either were purchasing bulls on physical attributes or had a third party purchasing bulls on their behalf. DAFWA's producer survey found that 33% of producers were not using EBVs in the Kimberley and Pilbara regions (Ref. 1).

EBV use by producers was influenced by the type of bull being purchased and their understanding of EBVs. The location, production systems and size of their female herd also influenced EBV use.

Producers purchasing elite bulls with higher sale prices were using EBVs to aid selection. A majority of these bulls were being used in multiplier herd situations. In these situations, the bulls were being placed in elite female herds and the male progeny used as replacement bulls for the rest of the operation. This is done to increase the genetics within the herd whilst reducing the cost of bulls.

Some of the producers interviewed were purchasing elite bulls for their own use to increase the genetic gain of their female herd. This was occurring mainly in smaller operations that are able to pull bulls out during the dry season.

Producers who were not using EBVs tended to purchase bulls of lower value, i.e. those of lower quality registered animals or unregistered paddock bulls. These paddock bulls are commonly the excess bulls from producers who purchase registered sires and keep the male progeny entire.

It seemed that the main reason producers weren't using EBVs as a tool for selection was a simple lack of understanding. When discussing this issue with producers they said they were willing to learn if the information was provided (CB5, CA4). This is in agreement with Moreland and Hyland (Ref. 11) who suggested that the high complexity of BREEDPLAN has a negative effect on its adoption.

4.2.6. Growth patterns

Growth patterns of animals was identified as the fifth most important attribute of the animal. It is mainly selected for using EBVs or raw data depending on what is available. 57% of producers said that 600 day growth is of moderate to high importance and 53% of producers said they require breed average and above.

The main reason producers were selecting animals whose growth rate plateaus at 600 days are so females have an earlier maturity pattern. This ensures the female progeny are not raising a calf while still growing themselves. This, in turn, maintains a moderate framed animal with enough weight to allow for income from cull cows.

The selection for growth patterns by commercial producers was determined by the target market. Producers in more arid areas with higher levels of *Bos taurus* genetics placed more emphasis on mature cow weight.

The selection for earlier maturity patterns may ensure the steer progeny will achieve the carcase specifications prior to cutting four teeth. Given this, producers supplying bullocks to

the abattoirs identified that turn off age affects their selection for 400 or 600-day weights. This however, needs to be monitored as emphasis on growth pattern may increase the mature cow weight.

4.2.7. Frame size

The selection of bulls for frame size by producers was one of the less important traits with 57% of producers using it in their selection criteria. Producers selecting heavily for fertility said they don't mind a moderate framed animal as long as they produce a calf every year.

The frame size of bulls and cows produced varied between regions but the consensus was that frame size should not be too extreme. The biggest concern with frame size is how it affects the ability to finish bullocks with adequate fat and the ability of females to return to calf every year.

The frame score of the bulls being used by the interviewed producers varied depending on the size of the female herd. Frame score is moderately to highly heritable. Producers selecting moderate framed bulls tended to be using these bulls over large framed Brahman, Droughtmaster and Santa Gertrudis cows.

Producers suggested that bulls need enough frame to walk between waters. The *Bos taurus* bulls used in cross breeding operations have been identified as bringing thickness and meat quality to the equation rather than more frame. The male proportion of the first cross progeny may have a smaller frame but finished at an earlier age when marketed as grass fed bullocks. This is due to the difference in maturity pattern enabling crossbred animals to lay down fat earlier than their *Bos indicus* counterparts.

Recommendations:

Frame size considerations in bulls are:

- The frame of the cows and how will they maintain their body condition during dry times.
- The ability to finish steers as bullocks, prior to them cutting four teeth.

4.2.8. Coat and hide characteristics

Producers select on coat type depending on their location. Interviewed producers in tick country said they selected more heavily for coat type because they thought ticks did not have as many places to hide in smooth coated cattle (also see Section 4.4.3.1).

The colour and brightness of the coat was also considered an indicator of the animal's nutrition and health status. Producers in tick free areas suggested that hairy cows tend to cull themselves out, as they don't return to calf (SA4, CA1). The coat's appearance was

attributed to the animal's lack of adaptability to the environment, or seen as the result of an underlying health condition.

Bos taurus cattle destined for northern, non-temperate areas of Australia require coats that are as slick as possible. This increases the animal's ability to maintain normal body function. Coat type is evaluated at the time when an animal losses its winter coat. The animal's "normal" coat is classified post shedding as either slick or normal. The slick coat gene is a dominant gene displayed in *Bos indicus* and *Bos taurus* composite breeds.

Brahman cattle have finer, shorter hair with a higher concentration of hairs per unit area than Angus, however the extent of this difference varies between individuals within each breed. *Bos taurus* cattle have the ability to shed their winter coats as required when moved into hotter areas. The time that *Bos taurus* cattle shed their coats is affected by genetics and environmental factors.

The black woolly coats of Angus cattle mean they absorb a higher amount of solar radiation than slick coated animals. Individual Angus cattle tend to shed at different rates, causing different responses to heat stress during hotter parts of the year. Gray et al., (Ref. 12) ranked animal's coats on a scale from 1 to 7 with a coat score of 1 resulting in less effects of heat. The Northern Development Project comprised by Breedlink Pty Ltd found that 60% of producers were not sure if they selected bulls on coat type.

Recommendation:

Selection for slick coated animals may affect their adaptability and performance post relocation. In areas where there are tick burdens or very high heat load there may be an increased requirement for animals with slicker hair. Bulls for sale into non-temperate Australia should have slicker finer hairs to reduce tick burdens and increase heat tolerance.

4.2.9. Genetic conditions

During the interviews, it was identified that a number of producers were purchasing bulls that are carriers for recessive genetic conditions. There are recessive genetic conditions present in all breeds of cattle however this is not an issue in terminal crosses because by definition, no replacements are kept.

If crossbred replacement females are kept, then they can be managed by the following methods:

- Understand if the bulls purchased are carriers for any genetic condition:
    - This information can be identified from the pedigree of registered animals in the database or catalogue.

- Understand the heritability of genetic conditions:
    - Carriers of genetic conditions have a 50% chance of producing progeny that are carriers. If these progeny are crossed with another carrier there is a 25% chance of giving birth to an affected animal and 50% chance of these animals being carriers of the condition.

Recommendation:

If producers are planning to keep progeny, they should only purchase sires that have been tested free or calculated to be free of any genetic conditions.

4.3. Management practices to minimise stress on *Bos taurus* bulls in northern, non-temperate Australia

To realise the benefits of incorporating *Bos taurus* genetics into a northern production system the successful adaptation of *Bos taurus* bulls is required. The following information details the management practices that should be considered when introducing new bulls into a herd. The successful adaptation of a new bull may mean the difference between the bull surviving and passing the genetics onto his progeny or performing badly.

The considerations for successful adaptation include:

- Nutritional intake pre and post relocation.
- Grazing behaviours of cattle.
- Sale type.
- Time of year when bulls are relocated.
- Age of bulls when purchased.
- Removal of bulls during the year.
- Age of bulls running in the same group.
- Control of mickey and scrub/feral bulls.
- Heat tolerance.
- Mustering methods.

4.3.1. Adaptation period

The adaptation period given to bulls to acclimatise to their new environment may affect their survivability and longevity. The adjustment period commercial producers said they allowed bulls to adapt for varied between one week and 12 months, with 61% of commercial producers giving bulls a minimum of three months prior to introducing them into the cow herd. 65% of seedstock producers interviewed said some adaptation process is required.

The recommended adaptation period used by producers across Australia varies depending on the variation in environment between locations and the age of bulls when relocated. The suggested ideal minimum adaptation period was between eight and 12 weeks where secure infrastructure was available.

The breeding location of bulls was identified as a factor affecting successful bull adaptation. Bulls bred in tougher country may have an increased ability to deal with harsh environments when sold. The best-case scenario is where bulls are bred in a tough environment and required to work in such an environment prior to sale but this is very rarely the case.

The majority of bulls sold into northern, non-temperate Australia have been bred in a less stressful environment. The animals therefore require time to adapt to the new environmental stressors post relocation prior to being placed with the cow herd.

Male mammals who experience a spike in temperature can have decreased sperm quality (Ref. 13). Such a spike in temperature can be caused by infection. The main two infections present in northern, non-temperate Australia which may cause a spike in body temperature are tick fever and bovine ephemeral fever. The occurrence of these two infections can be reduced by vaccination but bulls may react to the tick fever vaccination (discussed in detail in section 4.3.8.1).

Recommendations:

The younger the bull is when relocated into northern Australia the better it will adapt to the environment. Equally, the usage and expectations for younger bulls should not be equivalent to that of older/more mature bulls. When purchasing bulls the following general adaptation periods should be adhered to before putting them with the cow herd:

- A minimum of three months for all 18–24 month old bulls.
- A minimum of six months for 12–18 month old bulls.
- Bulls 12 months and under will adapt better to the environment but should be allowed 6–12 months adaptation period or a very light cow load in the first 12 months.

Note: These ages may differ between breeds depending on their maturity patterns.

4.3.2. Nutritional intake pre and post transport

The effects of grain feeding prior to sale across both *Bos taurus* and *Bos indicus* cattle breeds, tend to be dictated by sale method. 70% of commercial producers interviewed specifically stated they do not like purchasing bulls that have been grown out on high concentrate diets. The main reasons for this is the variation in nutrient levels between

purchase and use on property, the time required for the rumen micro flora to adjust and the effect of feeding regimes on the animal's ability to adapt to the new environment.

The nutritional intake of bulls pre relocation into northern, non-temperate Australia varies from high levels of grain supplementation to native pastures with some mineral supplementation. The feeding of bull's pre relocation can have substantial effects on the animal's adaptation because of the rumen micro-environment adjustment to a new feed type. The rumen micro-environment requires a minimum of 14 days to adjust to any changes in diet (Ref. 14) and the greater the variation the more adverse effects it can have on animal's post relocation.

Commercial producers reported that bulls which have received high levels of supplementation prior to sale, irrespective of whether they are *Bos indicus*, *Bos taurus* or a composite, will lose their condition after sale. In some cases, bulls have lost up to 150kgs post relocation, prior to putting the bulls out with the cows (CC4).

Bulls purchased from multiple vendor sales usually come from a high level of supplementation and tend to lose condition during the first breeding season. Whereas the bulls which have grown out on native pastures, tend to maintain their body weight throughout the breeding season (CB2). This has caused some producers to gauge the success of their bulls on the animals that lost the least weight during the first year (CB9).

Seedstock and commercial producers using Leucaena as a feed source (*Leucaena leucocephala* subspecies glabrata) reported an increase growth rates of cattle during the drier times of the year. This will therefore increase the ability of animals to grow out to their genetic potential. Producer's putting bulls onto plantations of Leucaena need to ensure they have been appropriately drenched with the leucaena inoculum.

Due to the feedback provided by producers throughout the interviews it can be concluded the feeding regime of bull's pre relocation can have considerable effects on an animal during the first-year.

Recommendations

Rumen micro-organisms require time post relocation to adapt to changes in nutritional intake. A minimum of 14 days is therefore required for rumen microorganisms to adapt to the northern pastures.

It is best if bulls receive a minimal level of grain supplemented in their diets prior to purchase.

- Bulls that have received large amounts of grain supplementation prior to relocation should be provided with an energy and protein supplement for at least three months.

- Bulls purchased from an auction generally will have received supplementation or high quality forage pre-sale. These bulls should be monitored carefully to ensure that their body condition does not drop too rapidly, and if it does, buyers should offer supplement.

4.3.3. Grazing behaviours of cattle

There were a small number of producers (13%) who identified that the grazing behaviours of cattle have a major effect on a bull's adaptation. The ability of an animal to consume all the nutrients available is affected by their knowledge of grazing areas and their ability to browse rather than grazing. The natural grazing behaviour of cattle is for them to graze rather than browse (consume dry matter from trees and shrubs). The animal's ability to adapt to browsing in northern, non-temperate Australia is critical to ensuring it consumes all the available nutrients (Ref. 15). Naïve animals, such as bulls post relocation, have a tendency to eat less and walk less during grazing (Ref. 16).

Animals finished on monocultures or fed high levels of supplements may have a reduced ability to learn how to browse. Research has shown animals have a greater ability to learn to browse whilst still on their mother. Although all animals have the ability to develop motor skills later in life, older animals take longer to learn than younger animals.

The first 18 months is the most critical time for bulls post relocation as they have a limited knowledge of the grazing area or the ability to browse. This may have negative effects on an animal's body condition whether they are working or not. Losses in body conditions caused by inexperience need to be monitored to ensure the welfare of all animals during this period.

4.3.4. Sale type

Seedstock producers mainly sell bulls through auctions or private treaty sales.

4.3.4.1. Contract sales

Producers who buy bulls through contract sales typically purchase larger numbers of bulls (22 plus per year to one property). The seedstock producers who are selling bulls via contract usually have a long-term relationship with the commercial producers and are selling bulls on a yearly basis.

As part of the arrangement, contracted bulls generally receive very low amounts of grain supplementation. This is in the best interest of both parties involved as the seedstock producer can keep their input costs down and the sale price is negotiated.

The commercial producers involved tend to be well educated and experienced in the use of EBVs. These figures tend to form the basis of the selection process and the bulls, which satisfy the EBV specifications, are then physically inspected prior to purchase.

4.3.4.2. Paddock sales

The sale of bulls in the paddock can occur at any time during the year and involve bulls of varying ages. The main difference between the contract and paddock sales is that paddock sales tend to be for smaller numbers of bulls.

Paddock sales occur on-property and animals receive minimal levels of grain feeding. The number of animals sold in each lot varies but is generally in lots of less than a deck of bulls.

4.3.4.3. Single vendor auctions

Single vendor auctions sell the best bulls that vendors have produced. Feeding in preparation for auction ranges from a high level of supplementary feeding to bulls fed native pastures and legumes.

The advantage bull buyers gain from buying bulls through on-property single vendor sales is that all the animals have been grazing on a similar nutritional plain. This allows the bulls to display their genetic potential within a contemporary group at time of sale.

4.3.4.4. Multivendor auctions

Bulls sold through multivendor auctions receive the highest level of supplementary feeding prior to sale compared to other sale methods. One seedstock producer commented that bulls all need to be in good condition because human nature takes over and the most finished bulls will top the sale (SF5). Smaller stud breeders selling bulls through this type of sale feel they need to feed the bulls to ensure success at the sale.

4.3.5. Time of year at relocation

The majority of interviewed producers, both commercial and seedstock, agreed that the best time to relocate bulls is when there is minimal variation in climatic conditions. The ability of animals to adapt is affected by the feed availability and temperature post relocation. Results from the interviews with commercial producers indicated that 43% of bulls are relocated in the spring and 34% relocated in the winter. The other 33% of producers interviewed said they have been relocating bulls in either autumn or summer depending on the season.

The biggest factor involved in deciding when to relocate bulls was the feed availability when the animals were relocated. Bulls shifted during the winter and the spring tended to be purchased from auctions.

Producers in northern Queensland said that relocating bulls later in the summer months and particularly around the time of the first storm would allow for an increase in feed availability so “the poor buggers have something to eat” (CC9). However, there is a contradiction between the feed availability and the heat experienced when bulls are relocated.

The results indicate that most of the bulls relocated in the spring tended to move onto poorer quality feed than if they were relocated during the autumn months. This may cause a drop in condition, particularly if they have come off some form of supplementary feeding (section 4.3.7.1). This affects the ability of animals to adapt to the change in environment and can affect their ability to perform post relocation.

Some of the seedstock producers were selling bulls bred in New South Wales and Victoria at sales in Queensland. The vendors relocated the bulls to Queensland six months prior to sale so bulls are not moving over winter. Relocating these bulls may reduce the stress imposed on animals due to climatic changes.

Recommendation:

The climatic conditions vary substantially between temperate, tropical and sub-tropical Australia. The main factors to consider when relocating animals include temperature, humidity and nutrient availability. Where possible, animals should be relocated before the end of the wet season when pastures are still of reasonable quality and temperatures are dropping.

If there is any question over feed quality and availability after arrival, bulls should be provided with some supplementation until they are placed into the breeding herd.

4.3.6. Age of bulls at sale

The age of bulls sold into northern, non-temperate Australia ranges from eight to 24 months of age. 75% of *Bos taurus* bulls sold through the auction system are rising two-year-olds. The bulls sold out of the paddock or by contract are sold between the ages from eight to 32 months of age, with 95% of these bulls being sold between 12 and 24 months.

The variation in age at sale is due to the expectations the commercial producer has on the bull post purchase. Most producers purchasing bulls at auctions require them to be used within six months of purchase. Whereas producers who are purchasing animals from private treaty sales and, contract sales do not expect the bull to be working so soon after sale.

Bulls rising two-year-old when sold into areas of northern, non-temperate Australia have the advantage of being closer to fully-grown. These grown-out bulls require less energy than a bull that is still growing; therefore, fully-grown bulls are not as stressed when serving cows.

Interviewees commented that the phenotype of bulls which are two years of age or older is a result of the environment he was bred in and not the environment he is expected to work.

Producers explained that bulls relocated to tougher areas will never grow (CD1, CD2, CD3, CD4 and CC2). Animals need to be of a reasonable frame and maturity when they are relocated to ensure they can cover the country and serve cows during the hotter parts of the year. The requirements of these animals are greater than smaller framed animals.

Producers indicated the younger the bull the better they adapt to the environment. However, younger bulls can't be used heavily as a two-year-old animal. Bull buyers need to be willing to let them grow out for a period of time post relocation before putting them out with cows.

Recommendation:

Producers should consider purchasing younger bulls but not use them for six to 12 months. Producers who purchase bulls to use within six months after relocation should be looking to purchase older bulls who have finished growing.

4.3.7. Bull management to reduce breakdowns

The management of *Bos taurus* bulls during the first 12 to 18 months after relocation will effect bull fertility and health. The methods used by producers to assess the success or failure of bulls in different environments varies between interview respondents from visual appearance of the bull, to number and quality of the progeny. This variation in people's perspective of the success of bulls varies according to the amount of management they are willing to provide to bulls. The scale of production systems affects the ability of producers to manage bulls post purchase.

The negative perception of commercial producers located in sub-tropical regions is that Bos *taurus* bulls are not particularly well suited to the environmental challenges of the region. Commercial producers think that bulls do not grow out to their genetic potential due to environmental stressors post re-location. This is a major concern to some producers. However, the true value of a bull should be measured in the productivity of progeny.

The following section contains considerations for producers once the bull has been acclimatised for three months. The following management considerations may influence bull longevity depending on the environmental stressors.

4.3.7.1. Supplementation

The survey results indicated that 57% of producers were using some form of supplement during the dry season. The producers that were not using supplement during the year of the interviews did use them during drier seasons. 60% of producers indicated phosphorus was

the most limiting factor in the animal's diet during the wet season and protein during the dry season.

The supplements used by producers mainly contained a phosphorus source during the wet season and a protein supplement during the dry. Producers supplementing all females used urea based licks with between 15 and 30% urea and phosphorus at varying concentrations.

The supplementation of bulls during the dry season varied depending on the ability of producers to remove bulls from the paddock because of variations in property size. The supplements used for bulls included a source of energy and protein, in the form of a protein meal such as copra meal or cracked corn (CC2, CB8, CB7 and CC4). The use of supplementation can aid in increasing an animal's chance of survival during the dry season.

To conclude, the supplementation of bulls post relocation may be affected by the distances bulls are relocated and the available nutrients in the pastures. The type of supplement should maintain the animal's body condition prior to mating and increase bull body weight during the dry season, if they can be removed from the female herd.

Recommendations:

- Where possible, bulls should be supplementary fed post relocation and during the dry season.
- The amount of supplementation required will vary depending on the season and pasture availability on the property.
- The two distinct periods that bulls should be supplemented are post relocation and during the dry season.
- Post relocation supplements should consist of good quality hay and/or a protein and energy supplement to ensure the microorganisms in the rumen can adapt to the pastures present on the property. The hay may reduce loss in body condition as it assists the rumens micro flora in adapting to the pastures.
- Supplementation of bulls during the dry season will depend on the producer's ability to remove bulls from the female herd. Where possible bulls should be supplementary fed during the dry season to increase their body condition for the following breeding season.
- The type and amount of supplement fed should be selected through consultation with a nutritionist or local Department of Primary Industries.

4.3.7.2. Removal of bulls during the year

Management of bulls in the first year post relocation can effect a bull's adaptation. During the interviews, there appeared to be three distinct groups concerning the removal of bulls. 35%

of producers removed bulls after three months, 25% of bulls were in with the cows for between five and seven months and 40% of producers did not remove bulls from the female herd at all.

Major factors effecting the management of bulls was size of property, the environment and the amount paid for the bulls. Smaller holdings tended to have the ability to remove bulls and did not have large bull numbers. Producers on smaller properties were leaving bulls in with the cow herd for only three months. Producers on larger properties located in central and southern Queensland were removing bulls during the dry season.

Producers purchasing bulls of higher value to be used in multiplier herds were removing bulls from the female herd during the first dry season (CC9). The opposite also occurred for cheaper bulls with the producers tending to leave the bulls in all year (CB10).

Bulls left in with cows for five to seven months were usually removed for a period between musters or were left in to add value to the less fertile cows. Seasonal variations, which occur in tropical climates, forced most producers to remove bulls between musters and return them on the second muster to ensure they are out with the cows prior to the first rain. Removing the bulls between musters allows them to recover during the dry season and in some circumstances be fed to increase body condition prior to being returned to the cow herd.

Producers in northern, non-temperate Australia rely on cull cows and heifers as a major source of income. This has caused an increase in “age of foetus” pregnancy testing which allows the producer to sell PTIC heifers or cows at a higher value than empty cows. There is some increased value if the cow is in calf to a *Bos taurus* bull. The cows that have a younger foetus are removed for lower fertility and sold on, as they will calve outside the optimal calving period.

Producers not removing bulls during the year tended to be large producers or producers who have opportunistic breeding periods. The main constraint very large producers face is the extensive number of bulls on the property. Some of the interviewed producers were leaving bulls in all year but pregnancy testing cows at the second round of mustering.

The producers who are opportunistic breeders, tended to be located in arid regions and experience a highly variable rainfall pattern. The bulls were left in all year so when it rains and cows’ cycle there will be bulls to cover them (CD3).

The removal of bulls during the year may also be effected by the level of infrastructure on the property and the ability to control feral bulls. Producers from properties that have a large number of feral bulls indicated there could be adverse effects on the genetic progress if bulls

are removed, caused by the feral bulls serving the cycling cows rather than bulls of preferred genetics.

In conclusion, the producers interviewed tended to be running bulls in different ways due to the property size and management structure. A number of the producers commented that the year that this project was conducted was a good season (CC1, CB2).

Recommendation:

The removal of new bulls from the cow herd after the wet and during the first winter is particularly important as the bulls can still be adapting to the environment. Where possible, it is recommended that *Bos taurus* bulls be removed between musters and supplementary fed to increase their body condition. The following factors have been identified to limit the ability of producers to remove bulls from the breeding herd:

- The availability of supplement to feed and costs associated with its transportation.
- The number of bulls that need to be removed from the breeding herd.
- The following issues related to the ability to remove bulls:
    - Practical aspects of removing large numbers of bulls (150+) from cows.
    - Increased fighting and subsequent breakdowns due to large numbers of bulls in the bull paddock.
    - Logistics of mustering and shifting large numbers of bulls in excess of 50kms.
    - Missing the opportunity to put bulls back in with the cows if the wet season starts early and roads become impassable.

4.3.7.3. Age of bulls in a contemporary group

The interviewed producers said they were running young bulls together, particularly for the first year, to reduce injuries due to fighting. 74% of producers were running bulls in similar age groups and a majority of these younger bulls were used with heifers. The remaining 26% of producers were either single-sire mating or did not have enough bulls to age segregate.

Putting bulls into mixed aged groups may cause an increase in the number of breakdowns, particularly in younger bulls. The main cause of these breakdowns was younger bulls being knocked off cows when serving (CD1). This has the potential to injure or break hind legs.

Commercial producers that were purchasing large numbers of bulls (22 and above) from one vendor have identified that running these bulls in the same contemporary group for their lifespan decreases the numbers of injuries in the first year (CD4). The social hierarchy of these bull groups has already been established before they get to the new property.

Watering points have been identified as a high-risk area when younger bulls are running with older bulls. The older bulls have a tendency to become lazy and do not travel as far from watering points. When bulls are mixed in the same paddock, the older bull will fight or chase the younger animals from the water. Where spear traps were used for mustering this has been a larger problem as the older bulls will not let the younger bulls drink (CD4).

To conclude, segregating younger bulls in a contemporary group for 12 months may reduce losses during the first 12 months on the new property.

Recommendations:

Injuries to younger bulls due to fighting either with feral bulls or with older herd bulls can cause losses. Running bulls of similar ages together can substantially increase the success of younger bulls in their first breeding season.

4.3.7.4. Control of feral bulls

A small proportion of producers indicated they have a problem with feral bull populations affecting the success of young bulls post relocation. The majority of these producers were located in open rangeland country.

The environmental pressure of the last 100 years has reduced the feral bull's frame and increased the bull's robustness through "survival of the fittest" on open rangeland areas. However, most of these bulls are of an undesirable genetic base for production.

The main areas where feral bull populations are high is through the Pilbara, Kimberley, NT Gulf country and far north-west Queensland. These areas have vast sections of unfenced country that allows bulls to breed up in native reserves and move into private leasehold land. The ability of these bulls to move into the herd reduces genetic gain offered by the *Bos taurus* bulls. This is because a proportion of the cows will be mated to the feral bulls rather than the *Bos taurus* bulls.

Feral bulls can effect young bulls in a similar way to older bulls. For example, one producer reported that in areas with high levels of feral bulls, bull losses of up to 20% occurred during their first year post relocation (CB3).

Recommendations:

In open rangeland country, where there are large numbers of feral bulls present the following techniques can be employed:

- Feral bulls should be removed from the property or humanely destroyed.
- If feral bulls cannot be controlled, younger bulls should be grown out and only well adapted bulls over two years of age should be used.

4.3.7.5. Heat tolerance

There were mixed responses when discussing the adaptation of *Bos taurus* bulls to hot and humid environments. Producers located in areas that experience extreme heat and humidity explained that animals tend to be less active during the hotter parts of the day.

Slick coat type (section 4.2.8) and mustering animals during the cooler times of the year (Section 4.3.7.6) can positively influence an animal's ability to survive extreme conditions. If management procedures and selection pressures for adaptation have been applied, cattle tend to be doing reasonably well in the hot environments when the nutritional and management adversities have been removed.

The northern Pilbara, southern Northern Territory (which doesn't experience the high humidity) and the Atherton Tablelands have adequate nutrition and have extreme temperatures during the year. These areas all reach well over 45^{o}C during the summer months and producers report that *Bos taurus* cattle seem to do reasonably well. The adaptation period and time of the adaptation of these animals appears to be the most important factor in allowing bulls to perform.

The producers in hotter dryer environment such as the Pilbara and Central Australia have indicated that the cattle do okay as long as they do not have too much hair on them during the summer months (CF1).

Recommendations:

To ensure bulls tolerate the heat:

- Apply selection preferences to slick coated animals.
- Conduct mustering in the coolers parts of the day.
- Apply adaptation periods and practices.
- Ensure bulls have adequate nutrition (and supplementary feed if necessary).

4.3.7.6. Mustering methods

The majority of mustering methods used by interviewed producers incorporated air and ground personnel. The producers that were not using any air support when mustering were smaller operations or had spear traps in use.

Producers indicated that during mustering *Bos taurus* animals are slower walkers than *Bos indicus* cattle. This slows the process down slightly.

Mustering during the hotter periods of the year may place unnecessary stress on cattle with Bos *taurus* genetics. Producers have indicated this has detrimental effects on the animal. An example was given where cattle were shifted to the yards during the wet season and when

personnel came back after lunch a bull had died after the walk home due to heat stress. The only symptom was that the animal had been foaming at the mouth on the walk home (CC8).

Where possible it would be best to reduce mustering during the hottest parts of the year. In the cases where producers are conducting rotational grazing systems, it may be necessary to shift the animals very early in the morning or modify the rotations to reduce the distance cattle are shifted during the summer.

The use of spear traps throughout northern, non-temperate Australia has been minimal but where this form of mustering is used the animals must be taught how to use them prior to setting the traps. To train an animal to use a spear trap the spear is opened right up and as the season progresses it is closed to just spikes in the spear at the start of mustering. This can happen reasonably quickly as the bulls tend to follow the cows in (CD4).

Recommendations:

When mustering *Bos taurus* bulls the following considerations need to be made:

- During periods of extremely hot weather, it is preferable to minimise mustering of *Bos taurus* bulls.
- If spear traps are used, bulls need training to use the equipment prior to setting the traps.

4.3.8. External parasites endemic in non-temperate Australia

4.3.8.1. Ticks

Interviewed producers who were running *Bos taurus* animals and located in a tick area were treating for ticks. Some producers said that they dip their female herd up to four times per year when their female herd is less than 50% *Bos indicus* content. The pure bred *Bos taurus* bulls being run in areas of high tick infestation need to be treated for ticks at least twice a year.

Animals with a slick coat have a greater ability to resist ticks than animals with hairy, woolly coats. Ticks are able to hide in the thicker coats and the cattle cannot remove the ticks by licking and tail movements. Crossbred/composite cattle with the slick gene have 10 fold the resistance of purebred *Bos taurus* cattle but have less resistance than purebred *Bos indicus* cattle (Ref.17).

Ticks can cause debilitation, anaemia, weight loss and death when in large numbers on the animal (Ref.18). Throughout northern Australia north of the tick line, this presents an issue for *Bos taurus* bulls as it may result in weight loss. Ticks have the ability to reduce weight gains by up to 0.06g/day/tick (Ref.18) for *Bos indicus* x *Bos taurus* steers. This may be higher for purebred *Bos taurus* cattle.

Due to the negative effects of ticks on *Bos taurus* animals it is necessary to use some form of tick control to ensure ticks do not affect the animal to a detrimental level. The producers using *Bos taurus* bulls in ticky areas have explained that they either dip or back line the bulls every time they are in the yards or every six to 10 weeks depending on the time of year and chemical being used. This varies depending on the producer's environment and the ability to get the bulls into the yards. The biggest issue is during the wet season when bulls are working and ticks are at their highest level.

The use of dips and sprays can be used in conjunction with paddock rotation to control the tick population.

Recommendation:

Producers in endemic tick areas should treat *Bos taurus* bulls on a regular basis. Bulls that are removed during the dry season should be treated as required. Bulls that are in with the cows all year round should be treated when the female herd is processed. Tick treatment should be on hand at the yards to treat bulls when possible.

4.3.8.2. Buffalo flies

The majority of producers interviewed have fly burden on their properties during the wet season with some properties having large numbers of flies all year round. The properties in the southern Northern Territory do not have buffalo fly, as the country is too dry.

Treatments used to control flies on bulls are back rubbers, fly tags and spraying the animals as required. Producers used some type of buffalo fly control to reduce the irritation and disease in animals. On producers said, "If you control the insects you can control the transmission of disease between cattle in particular arboviruses" (CA3).

The extent to which treatment as used depended on the producer's location and the ability to control the flies. The use of fly tags was generally restricted to smaller operations or specifically on bulls to reduce the fly burden for the first season.

The variation in the number of sores on each animal noted by producers indicates a difference in susceptibility in individual animals. A producer conducting a three way cross between Charolais, Angus, and Brahman cows indicated Angus cows tended to have less sores (CB2). There appears to be as much variation within breed as between breeds. One seedstock producer had noticed a small number of cows carried fly "marks" (SA4).

Recommendations:

Buffalo flies affect production in northern, non-temperate Australia, through irritation to the animal and as vectors for disease. One or more of the following control methods should be used to reduce these burdens:

- Non-chemical control:
    - buffalo fly traps,
    - dung beetles,
    - culling allergic cattle.
- Chemical control:
    - ear tags,
    - sprays,
    - pour-ons,
    - plunge dips,
    - back rubbers.

4.3.9. Vaccination requirements for bulls moving into non-temperate Australia

The three main vaccinations required for bulls being relocated into northern, non-temperate Australia are tick fever (red water), bovine ephemeral fever and *Clostridial botulism*. These three vaccines were identified as important depending on a commercial producer's location.

4.3.9.1. Tick fever

Tick fever vaccinations were administered by all the Queensland seedstock producers and 57% of the New South Wales and Victorian producers. The two main reasons for this variation is the location at which bulls are sold and the requirements to use three germ blood vaccination in New South Wales, Victoria and Tasmania.

49% of commercial producers interviewed indicated they did not require bulls to be vaccinated, but they were all located in the tick free areas of northern, non-temperate Australia. The corresponding 51% of producers all required bulls to be vaccinated prior to purchase. Bulls not vaccinated before moving into a tick endemic area can die if they contract the disease. Because of this, seedstock producers selling bulls into northern, non-temperate Australia must vaccinate bulls prior to sale.

The producers interviewed in zones B and C all required bulls to be vaccinated for tick fever prior to purchase. The immune system requires eight weeks to develop adequate protection against the three strains of tick fever (red water) and the side effects of the disease. Bulls that have not been vaccinated prior to shifting into tick endemic areas should be treated for

ticks with a tick-a-cide that will kill all stages of the tick to reduce the chance of the animal contracting the disease.

The current recommendation for bulls is that they should receive one tick fever vaccination between six and 12 months to reduce the chance of bulls having a reaction to the vaccine. The recommendation from Biosecurity Queensland is to vaccinate bulls twice due to their high nominal value.

Producers in tick areas discussed the necessity of vaccinating animals moving into tick areas prior to shipment. The tick fever vaccination is so paramount that some producers will not purchase bulls if they have not been vaccinated. Bulls are best to be vaccinated as weaners but if the stud is not vaccinating, than the animals should be vaccinated prior to being introduced to the new property.

Recommendations:

The current vaccination recommendations for bulls to ensure they are protected against tick fever are:

- One shot of the vaccine between six and 12 months of age;
- It is preferred that bulls be vaccinated with a second shot prior to relocation but this can be conducted post relocation.

The first month after bulls have been delivered all bulls, including those that were vaccinated, should be monitored for signs of tick fever.

Seedstock producers looking to purchase the tick fever vaccination outside Queensland should contact the tick fever centre or local district veterinarian to confirm protocols for the particular state.

4.3.9.2. Clostridial botulism

Botulism sickness is caused when the bacteria *Clostridial Botulism* is consumed by the animal. The bacteria release a toxin that causes the animal to get sick very rapidly. The biggest issue with this disease is it can lay dormant in bones or organic matter for years. Phosphorus deficiency during the wet season and protein deficiency in the winter months is associated with botulism outbreak. In these conditions, animals start looking for foreign objects such as bones to satisfy their cravings for phosphorus or protein. The *Clostridium botulism* bacteria are in the bones and when ingested, the animal's tongue, throat and stomach go into paralysis. Vaccinations are required in areas that are naturally deficient in phosphorus or proteins as the cattle chew on bones to increase their phosphorus intake.

35% of seedstock producers interviewed were vaccinating animals against *Clostridial botulism* prior to sale. 64% of commercial producers were vaccinating their entire herd for botulism between every one and three years depending on the type of vaccination used. The 36% of commercial producers not administering the botulism vaccination were mostly located in temperate country not deficient in phosphorus.

Producers were asked whether they would like to have botulism vaccination administered to *Bos taurus* bulls pre-sale and responded by saying it would be good but is not crucial as long as the vaccination status of the animal is known.

Recommendations:

In areas that experience deficiencies in phosphorus or protein, bulls should be vaccinated against botulism.

4.3.9.3. Bovine ephemeral fever

Bovine ephemeral fever (BEF), also known as three day sickness, is predominantly found in tropical areas during the summer when insect vectors are present. Mosquitoes that have consumed blood from another infected animal transfer the BEF virus. It is more prevalent in sub-tropical and tropical areas of Australia, because of the preferable conditions for the mosquito vector. The distribution of this disease depends on the moisture available for mosquitoes to breed.

During an outbreak there can be close to 100% morbidity but very low mortality. If animals die from BEF it is usually caused by a secondary infection. Bulls that become infected with the disease become temporarily sterile, therefore vaccination for bulls is advisable to ensure their reproductive performance.

Bulls are more susceptible to the disease than females. The increased susceptibility of bulls and the effect on semen quality may have detrimental effects if an outbreak was to occur directly prior to the start of the breeding season.

Recommendations:

To reduce the risk of bulls contracting bovine ephemeral fever they should be vaccinated before relocation.

4.3.10. Transportation of bulls

Bulls may be transported large distances after sale. In this study, bulls were transported up to 3,200km. Relocation of bulls is necessary but it can have some effects on their semen morphology and structural soundness.

There were mixed responses from producers regarding the management of bulls prior and post transportation. All transportation should be conducted within the new legislation for land transport of livestock (detailed at http://www.animalwelfarestandards.net.au/land-transport/). Different procedures are put in place to minimise the stress of transporting animals long distances such as placing different materials on the floor of the truck to reduce jarring on legs and the use of electrolytes to reduce dehydration. Truck floor materials producers were using to reduce the effects of transport included rice hulls, wood shaving, carpet or rubber flooring (SH2, CD1 and CD4). The inclusion of these types of additions to a truck floor has appeared to have a positive impact in the animal's stifle joints post relocation.

Truck travel over rough roads may exacerbate existing weaknesses with an animal's conformation. Discussions with a former breed development officer revealed his opinion that the best thing for transporting bulls long distances was the introduction of airbag suspension as it reduced the jarring on the animal's legs.

The use of electrolytes directly prior to transportation has been used extensively amongst the producers interviewed. Electrolytes are used to reduce dehydration during the period of transport. Published data has reported inconclusive results on the effects of electrolytes on bulls trucked for long periods.

Recommendation:

All animal transportation should be conducted in accordance with the state and federal legislation for biosecurity and transportation of livestock. A maximum of 48 hours off water for cattle over six months of age, with additional considerations for animals after 36 hours off water.

During transportation, the truck's flooring and suspension can have a major effect on how bulls travel. To reduce the amounts of physical stress on bulls during relocation the following techniques may be applied:

- Well maintained air bag suspension systems.
- Flooring covering such as rubber matting, wood shavings, rice hulls or carpet.

4.3.11. Bull mating percentages

The number of bulls used per 100 cows varied between one and 10. The majority of producers were running two to three bulls per 100 cows. The smaller producers and producers who were semen testing bulls on a regular basis tended to be running a lower percentage of bulls in their female herd. This equated to 2% for two-year-old bulls and 3% to 4% for younger bulls. Larger producers that were conducting regular semen testing on a yearly basis only used bulls with above 50% normal semen.

The producers running at more than 5% bulls in the herd were located in extensive rangeland areas. These producers were breeding their own bulls from high quality heifers. In most of these cases, there were a large population of feral bulls on the property. For these reasons, there may be a higher requirement for bulls of preferred genetics to be used to increase the probability that the desired bulls are mating cows and thus increasing the genetic potential of the herd.

Recommendations:

A minimum of 2.5 bulls per 100 cows should be adhered to for two-year-old bulls and older if they are being semen tested regularly.

To maximise the calving percentage of a herd, the number of bulls per 100 cows should be increased when:

- High numbers of feral bulls are on the property.
- Semen testing is not regularly conducted.

5. Extension of results

The second phase of this project was the development of an online decision support system (ODSS) for producers purchasing *Bos taurus* bulls in northern, non-temperate Australia. The results obtained during the first phase of research have been used to provide recommendations to producers customised to their production system and enterprises. The ODSS can be accessed from www.angusaustralia.org.au. This system has been developed as a portal for the extension of management recommendations and can be updated as new information becomes available.

5.1. Website design and functionality

The website was designed to be easy to use and provide tailored information to producers based on their responses to the questionnaire. Users can save previous results and use the tool for multiple properties. The following section briefly describes the pages in the tool.

The welcome page was designed to draw people into the ODSS and supply users with detailed results from the research prior to logging into the website. Users are able to access the questionnaire in the secure site and this provides tailored information.

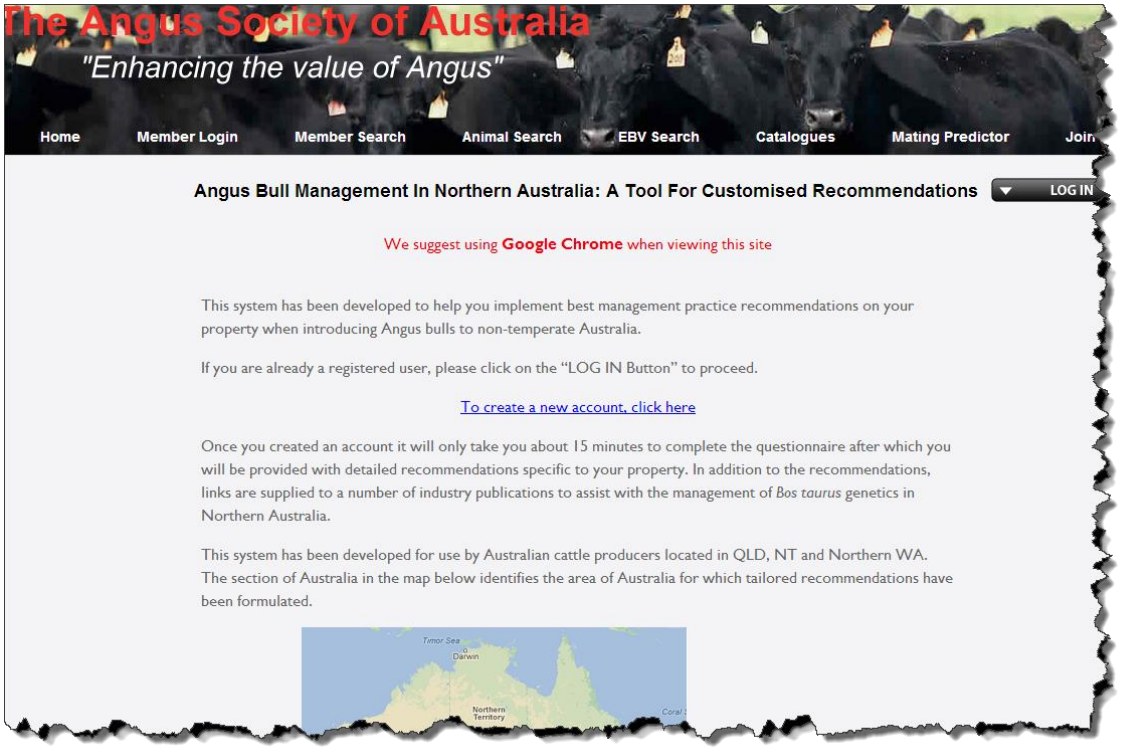

Figure 5.1 Welcome page

The features on the 'questionnaire list' page allows producers to start a new questionnaire, modify/view an already completed questionnaire and view the recommendations of previously completed questionnaires.

The 'start new questionnaire' section of the tool takes producers to the 'identify property page' and asks them to complete information regarding their location. The area where producers are located will determine the recommendations that are provided to them.

Figure 5.2 Identify property location page

The ‘property address’ field allows producers to save locations, questionnaires, and identify the corresponding recommendations for the next time they visit the website. This facility has been developed to allow producers with a number of properties to complete the questionnaire for each scenario.

The text box labelled “town” allows producers to enter their nearest town to their property and identify their exact property’s location. This text box is directly linked to the Google maps plug-in below. The map allows producers to identify their exact location, then the system identifies the questionnaire, and therefore information, most relevant to their location.

The ‘selected area’ box automatically fills when there is a location selected on the map, these areas relate to Figure 3.1. The GPS coordinates of this line select the questions from the database.

Figures 5.3 and 5.4 are screen shots of the questionnaire pages of the ODSS. These pages are directly linked. The way that the benchmarking questions are answered on the screen shown in Figure 5.3 will affect the capability questions asked on the screen shown in Figure 5.4.

Figure 5.3 Benchmarking questions

The questions on the screen shown in Figure 5.3 are the first tier of questions that determine the questions to be asked in the screen shown in Figure 5.4 which are only relevant to the producers location. For example, if the producer is in a tick free zone then they will not be asked any questions on ticks in the second set of questions.

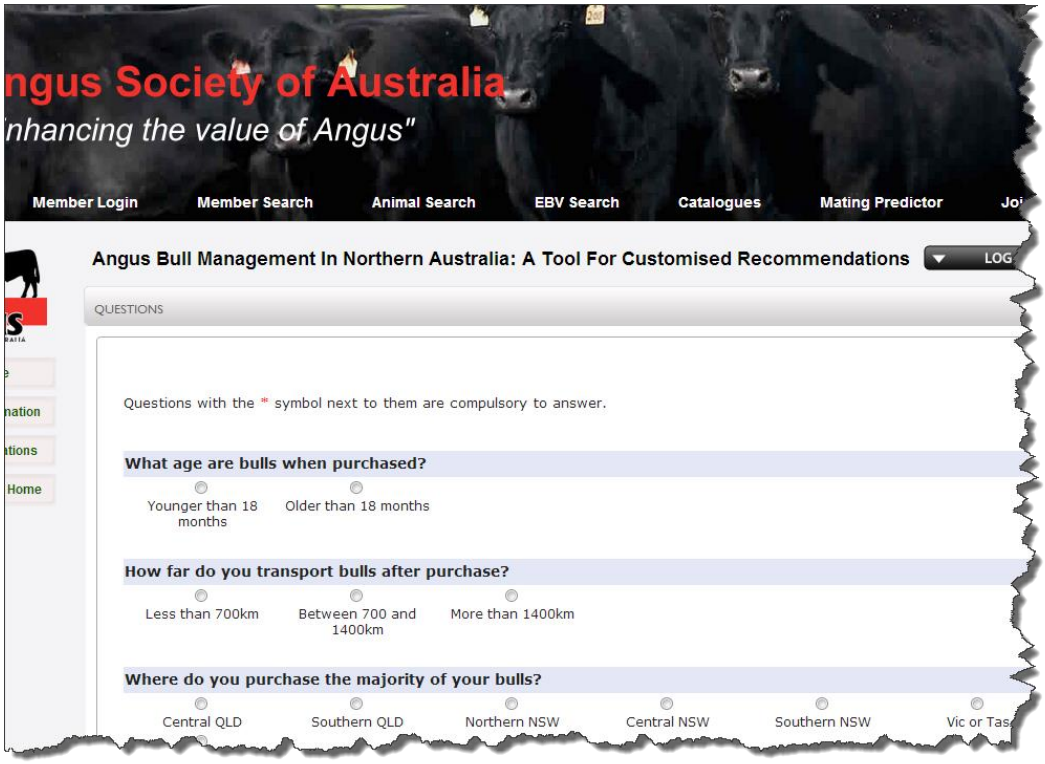

Figure 5.4 Capability questions

The 'recommendations page', shown in Figure 5.5 is the main information page of the website and provides producers with the recommendations based on the way they answered the two sets of questions.

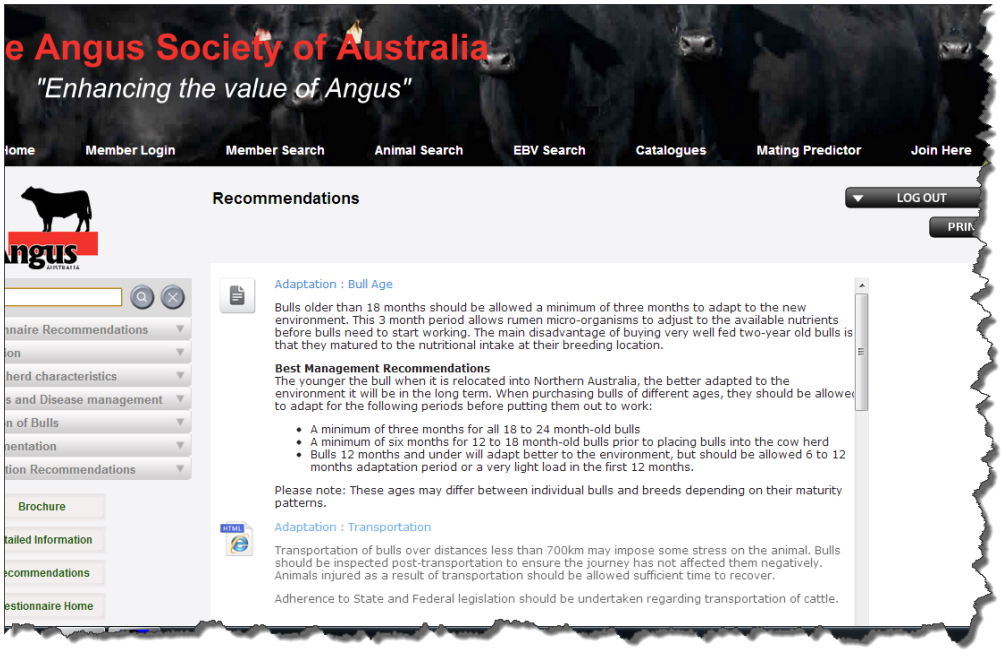

Figure 5.5 Recommendations page

The important functionalities of this page are:

- The search facility on the top left hand side allows users to search all the content of the database for additional material.
- The tabs down the left hand side of the page allows users to select additional references from areas of interest.
- The tailored recommendations in the middle section of the page.
- The HTML sign indicates there is additional reading material associated with the recommendation.
- The print button allows producers to print the recommendations for future reading.

To conclude, the online tool was developed as a user-friendly interface to give producers access to relevant information in regards to the adaptation of Angus bulls to northern Australia. If this system is utilised to its full potential it can help producers improve management of *Bos taurus* bulls relocated to northern Australia.

6. Conclusion

Bos taurus bulls can adequately adapt to most areas in northern, non-temperate Australia, through the incorporation of the following management practices within a production system.

6.1. Adaptation

The method by which northern producers manage the adaptation of bulls to new environments strongly affects their subsequent mating ability and longevity. An absolute minimum of three months adaptation is required to eliminate any reductions in semen quality that results from transportation and post relocation environmental stressors. Longer periods of adaptation are recommended for best results. The following factors are key considerations and management practices that may affect the successful adaptation of bulls to their new environment.

6.2. Age of bulls when relocated

The younger the bull is when relocated into northern Australia the better adapted to the environment it will become. Equally, the usage and expectations for younger bulls should not be equivalent to that of older/more mature bulls. When purchasing bulls of different ages the following general adaptation periods should be adhered to before putting them out to work:

- A minimum of three months for all 18–24 month old bulls;

- A minimum of six months for 12–18 month old bulls;
- Bulls 12 months and under will adapt better to the environment but should be allowed 6–12 months adaptation period or a very light load in the first 12 months.

Please note that these ages may differ between breeds depending on their maturity patterns.

6.3. Time of year at relocation

The climatic conditions that animals are exposed to vary substantially between temperate, tropical and sub-tropical Australia. The main factors to consider when relocating animals include temperature, humidity and nutrient availability. When possible animals should be relocated before the end of the wet season when pastures are still of reasonable quality and temperatures are dropping to the coolest part of the year.

If there is any question over feed quality and availability after arrival, bulls should be provided with some supplementation until they are placed into the breeding herd.

6.4. Transportation

The transportation of bulls can have multiple negative effects on the animal if not managed appropriately. All animal transportation should be conducted in accordance with the state and federal legislation for biosecurity and transportation of livestock – a maximum of 48 hours off water for cattle over six months of age, with additional considerations for animals after 36 hours off water.

During transportation, the trucks flooring and suspension can cause injuries to limbs. To reduce the level of physical stress on bulls, producers should use trucks with well-maintained air bag suspension systems and use floor covering such as rubber matting, wood shavings, rice hulls or carpet.

6.5. Nutritional intake

Rumen micro-organisms require time during post relocation to adapt to changes in nutritional intake and feedstuffs. A minimum of 14 days should be provided to allow rumen microorganisms to adapt to the northern pastures with some supplementary feeding where necessary.

It is best if minimal grain is supplemented in the bull's diet prior to purchase and relocation.

Bulls that have received grain supplementation prior to sale should be let down on a protein and energy supplement for at least three months and be monitored carefully to ensure that their body condition does not drop too rapidly. If it does, provide supplement.

6.6. External parasite control

Producers in endemic tick areas should treat *Bos taurus* bulls with tick control treatments on a regular basis. *Bos taurus* bulls have a potential to lose weight and die due to higher tick burdens because of their lower resistance when compared to their *Bos indicus* counterparts. The ability to treat bulls for ticks may be based on whether they are being removed from the breeding herd. Bulls that are removed during the dry season should be treated as required. Bulls that are in with the cows all year round should be treated when the female herd is processed. Have a tick-a-cide on hand at the yards to treat bulls when possible.

Buffalo flies and mosquitoes affect production in northern, non-temperate Australia, causing irritation to the animal and acting as vectors for disease. Non-chemical and chemical control methods should be used to reduce insect burdens.

6.7. Vaccinations requirements

Before relocating bulls into the ticky areas of northern Australia, it is necessary to ensure that animals have been pre-vaccinated. Bulls should be vaccinated in accordance with the following:

- The ideal time for bulls to be vaccinated for tick fever is between six and 12 months of age. Due to their high value, bulls should be vaccinated with a second shot post relocation to ensure coverage for the three strains of tick fever. Bulls vaccinated when older than nine months of age may react to the vaccine and should be monitored for a month for signs of fever.

- If bulls have not been vaccinated prior to relocation into a tick zone they should be vaccinated on arrival and treated with a tick-a-cide that kills nymph ticks. Where possible this should be avoided as bulls can become affected by tick fever prior to the vaccine taking affect.

- Three-day sickness (bovine ephemeral fever) can cause fevers and reduction in semen quality and can render the bull infertile for over three months. To reduce the risk of bulls contracting bovine ephemeral fever they should be vaccinated prior to relocation.

- Producers relocating bulls to areas endemic with botulism should ensure bulls are vaccinated either pre or post relocation.

- The above vaccinations are in addition to the standard vaccination protocols against the clostridial diseases (5-in-1 or 7-in-1), pestivirus and vibriosis.

6.8. Management of bulls during the first 18 months after relocation

The management of *Bos taurus* bulls during the first 12 to 18 months on a property will affect the bull's fertility and health for the rest of its life. The following management practices can aid in the success of *Bos taurus* bulls in northern Australia.

6.9. Removal of bulls from the breeding herd

The removal of new bulls from the cow herd after the wet and during the first winter is particularly important as they can still be adapting to the environment. Where possible it is recommended that *Bos taurus* bulls be removed between musters and supplementary fed to increase their body condition. The following factors have been identified to limit the ability of producers to remove bulls from the breeding herd.

- The availability of feed supplement, and costs associated with its transportation.
- The number of bulls that need to be removed from the breeding herd. The following issues relate to the ability to remove bulls:
    - Practical aspects of removing large numbers of bulls (150+) from cows.
    - Increased fighting and subsequent breakdowns due to large numbers of bulls in the bull paddock.
    - Logistics of mustering and shifting large numbers of bulls in excess of 50kms.
    - Missing the opportunity to put bulls back in with the cows if the wet season starts early and roads become unpassable by trucks.

In cases where one or more of the above issues affect producers, any bulls that are in poor condition should be removed and supplementary fed.

6.10. Supplementation

Where possible supplementary feeding of bulls should be conducted post relocation and during the dry season. The amount of supplementation required will vary depending on the season and pasture availability on the property. The two distinct periods that bulls should be supplemented are post relocation and during the dry season.

Post relocation supplements should consist of good quality hay and/or a protein and energy supplement to ensure the microorganisms in the rumen can adapt to the pastures present on the property. Hay may reduce the loss of body condition as it assists the rumens micro flora to adapt to the new pastures.

Supplementation of bulls during the dry season will depend on the producer's ability to remove bulls. Where possible, bulls should be supplementary fed during the dry season to increase their body condition for the following breeding season.

The type and amount of supplement fed should be selected through consultation with a nutritionist or with the local rural produce store.

6.11. Types of bulls in contemporary groups

Injuries to younger bulls due to fighting either with feral bulls or with older herd bulls can cause losses. The success of younger bulls in their first breeding season can be substantially increased by only running bulls of similar ages together.

6.12. Feral bull problems

In cases where young bulls have been put into areas with high numbers of 'mickeys' there have been losses of over 20% due to fighting. In open rangeland country, feral bulls should be removed from the property, or humanely destroyed during daily operations. If feral bulls cannot be controlled, younger bulls should be grown out and only well adapted bulls over two years of age should be used.

The genetic progress of breeding herds can be dramatically slowed in areas that have a high population of feral bulls. Thus to increase the genetic progress of the herd, it is in the producers best interest to run younger bulls in one paddock to increase survival rates.

6.13. Mustering *Bos taurus* animals

When mustering *Bos taurus* bulls the following considerations need to be made:

- During periods of extremely hot weather, it may be preferable to minimise mustering of *Bos taurus* bulls. Heat influences all animals but will have a greater effect on the *Bos taurus* animals.
- Mustering duration may be increased in herds with *Bos taurus* cows when compared to *Bos indicus* cows as *Bos taurus* animals walking slower than their *Bos indicus* counterparts.

- If spear traps are used on a property, bulls need to be trained to use this equipment prior to setting the traps.

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8. Appendices

8.1. Seedstock producers survey

Bos taurus bull breeders survey

1. Breeder details

Trading name	
Members ident	
Stud prefix	
Owners	
Family members	
Manager	
Partners name	
Family members	
Property's address	
Postal address	
Phone number	
Location description	
Location (latitude and longitude)	
Property size	
Bull sale month	

Notes:

2. Bull selection

2.1. What are your key breeding goals?

2.2. What markets do you target with your bulls?

2.3. What is your primary calving season?

Notes:

2.4. What selection criteria do you think is the most valuable for the sale of bulls into northern/non-temperate Australia?

Selection criteria for bulls to be used in northern/non-temperate areas (rank).

	Rank	Why	Tools
Structural soundness			
Temperament			
Coat type			
Hide thickness			
Carcase			
Growth			
Fertility			
Herd history			
Breed			
Other 1			
Other 2			

Notes:

3. EBV use

3.1. What EBVs do you think there are most relevant for the selection of *Bos taurus* bulls for the use in northern/non-temperate Australia?

EBV	**Importance**			**EBV value for selection**		
	Low	Moderate	High	Below breed average	Breed average	Above breed average
Calving ease						
Gestation length						
Birth weight						
200-day weight						
400-day weight						
600-day weight						
Mature cow weight						
Milk (kg)						
Scrotal size						
Days to calving						
Carcase weight						
EMA						
Rib fat						
Rump fat						
Retail beef yield						
Intra-muscular fat						

Notes:

4. Breeding

4.1. Purebred *Bos taurus* (Angus) bulls

4.1.1. What areas in northern/non-temperate Australia do you sell *Bos taurus* bulls (Please mark on map)?

4.1.2. Have you ever had any experience or feedback from clients on bulls that were more successful or unsuccessful than others in northern/non-temperate environments?

4.1.3. What key factors do you think have affected the success of these animals in their adaptation to northern/non-temperate areas?

4.1.4. What key factors do you think have affected the failure of these animals?

4.2. Crossbred/composite bulls (if applicable)

4.2.1. Are you producing any crossbred/composite bulls for sale into northern/non-temperate areas?

4.2.2. What crossbred/composite bulls are you producing for the northern/non-temperate markets?

Dam (Breed)	**Sire (Breed)**	**Targeted area (to be marked on map)**
		1
		2
		3
		4
		5
		6
		7
		8

4.2.3. Have you ever had feedback on which crossbred/composite bulls were more successful or unsuccessful than others?

4.2.4. What do you think has affected the success of particular crossbred/composite bulls?

4.2.5. What do you think has affected the failure of particular crossbred/composite bulls?

5. Bull management

5.1. How important do you think it is to have an adaptation period prior to sale of your bulls to the north?

5.2. If considered important, how do you manage the adaptation of your bulls prior to sale?

5.2.1. How long should the adaptation period be?

5.2.2. What age have you found to be the most practical/suitable for your northern clients?

5.2.3. What time of year do you move bulls into northern/non-temperate Australia?

5.2.4. What nutritional regime do you feed your bulls on during an adaptation period?

5.2.5. Is there anything else that you believe is important for the management of *Bos taurus*/Angus bulls destined for use in northern/non-temperate Australia?

5.3. What are the bulls fed post-weaning through to sale into northern/non-temperate Australia?

		Age of bulls ADG (kg/day fed)		
Pasture type	Supplementation	Weaning	>1 year	>Sale
Native pasture	Non			
	Lick			
	Grain sup.			
Improved pasture	Non			
	Lick			
	Grain sup.			
Crops	Non			
	Lick			
	Grain sup.			

5.3.1. If feeding lick supplementation: What is the composition of the lick (component percentages would be preferred)?

5.3.2. If feeding grain supplementation: What are the ingredients of the grain supplement and how much is fed/day?

5.3.3. If known, what is the energy concentration and protein concentration of the ration (MJ ME/kg DM)?

5.3.4. What vaccinations are administered to bulls for sale into northern/non-temperate Australia?

Vaccination	<3 months	3–6 months	6–12 months	>12 months	Annual booster?
5 in 1/7 in 1					
Tick fever					
Bovine pestivirus					
BEF*					
Botulism					
Pinkeye					

*BEF – Bovine ephemeral fever (three-day sickness)

Other _____

5.3.5. Do you recommend what follow up treatments be used for your bulls post sale?

5.3.6. Are there any other bull management practices that you use prior to shipment into northern/non-temperate Australia?

5.3.7. Do you conduct bull soundness examinations prior to sale into non-temperate/northern Australia?

5.3.8. If, so what point/age is this conducted?

6. Sale of bulls

6.1. Approximately how many bulls have you sold into northern/non-temperate Australia in the past four years? (Table to be filled out for the answers)

	Number of bulls sold per year into northern Australia			Total number sold in that year
	Auction	Paddock	Contract	
2008				
2009				
2010				
2011				

6.2. Does your selection criteria differ between sale methods?

6.3. Auction

6.3.1. Age at sale?

6.3.2. Number of purebred bulls sold.

6.3.3. Number of crossbred/composite sold.

6.3.4. What percentage of your clients are repeat buyers?

6.3.5. Time of year at sale?

6.4. Paddock

6.4.1. Age at sale?

6.4.2. Number of purebred bulls sold.

6.4.3. Number of crossbred/composite sold.

6.4.4. What percentage of your clients are repeat buyers?

6.4.5. Time of year at sale?

6.5. Contract

6.5.1. Age at sale?

6.5.2. Number of purebred bulls sold.

6.5.3. Number of crossbred/composite sold.

6.5.4. What percentage of your clients are repeat buyers?

6.5.5. Time of year at sale?

Notes:

7. Feedback

7.1. Is there any specific information that you believe we should ask northern/non-temperate commercial bull buyers about when conducting that phase of the project?

7.2. Is there any particular feedback that you would like from this research?

Notes:

8.2. Commercial producers survey

1. Property details:

Trading name	
Angus Australia member	
Owner	
Family members	
Manager	
Family members	
Property's address	
Postal address	
Phone number	
Location description	
Location (latitude and longitude)	
Number of Properties	
Property size/s	
Number of cows	

1.1. How long have you been managing or own this property?

Notes:

2. Operation information

2.1. What markets are you targeting?

2.2. What are your key breeding goals?

2.3. How long do you join females for?

2.4. What is your primary calving season?

2.5. What is your average calving percentage?

2.6. What is the main breed makeup of your female herd?

2.7. What heifers do you breed and what percentages do you keep as replacements?

	Purebreds	First cross	Second cross
Breed			
Percentage used for breeding			
Percentage sold on			

3. Mustering operations

3.1. Do you seasonal muster?

3.2. How many musters do you do per year?

3.3. What methods do you use to muster your cattle?

3.4. What percentage of cattle on your place would move through you cattle yards per year?

3.5. How many mickey bulls (male animals that have never been mustered or castrated) over the age of two years would you find per year?

4. Bull purchasing

4.1. What breeds of bulls have you used in the past?

4.2. What methods do you use to purchase your bulls (auction, paddock or contract)?

4.3. How many bulls of each breed have you purchased in the last four years?

4.4. What years have you purchased these bulls?

	Paddock		Contracts		Auction	
Breed	Number purchased	Year	Number purchased	Year	Number purchased	Year

4.5. If only *Bos indicus* bulls purchased what are your reasons for purchasing these?

Notes:

5. Bull selection

5.1. What selection criteria do you use when selecting bulls to be used on your place? (Selection criteria)

	Rank	Why	Tools
Structural soundness			
Temperament			
Coat type			
Hide thickness			
Carcase			
Growth			
Fertility			
Herd history			
Breed			
Frame score			
Other specifications			

5.2. Do you purchases bulls of any particular breeders?

5.3. Do you use EBV's?

5.4. If not: Is there any reason why you don't?

5.5. If, so which ones?

EBV	Importance			EBV value for selection		
	Low	Moderate	High	Below breed average	Breed average	Above breed average
Calving ease						
Gestation length						
Birth weight						
200-day weight						
400-day weight						
600-day weight						
Mature cow weight						
Milk (kg)						
Scrotal size						
Days to calving						
Carcase weight						
EMA						
Rib fat						
Rump fat						
Retail beef yield						
Intra-muscular fat						

Notes:

6. Success of bulls

6.1. How would you measure the success or failure of a bull?

6.2. Which breeds of bulls do you think have been the most successful in your herd in the past?

6.2.1. What do you think made these breeds most successful?

6.2.2. Have you had any stand out bulls within this breed (traits, performance)?

6.2.3. What year did you purchase these bulls?

6.2.4. Where did you get these bulls from (either a location or a producer's name)?

6.2.5. What do you think made these bulls perform better than the others?

6.3. Were there any breeds of bulls that performed unsuccessfully?

6.3.1. What do you think caused these bulls to fail?

6.3.2. Have you had any stand out bulls within this breed?

6.3.3. What year did you purchase these bulls?

6.3.4. Where did you get these bulls from?

6.3.5. What do you think it was that made these bulls perform less successfully than the others?

6.3.6. Would you consider using this breed again if you could overcome the problems?

6.3.7. Do you think that the distance that bulls are transported affects their performance?

6.3.8. If so, what distances have your bulls been transported?

6.3.9. Did these bulls get any special treatments?

Notes:

7. Bull management

7.1. What are your expectations of the seller in relation to the adaption of bulls going into non-temperate/northern Australia?

7.2. What is the preferred age that you purchase your bulls?

7.3. Why?

7.4. What time of year is ideal for you to introduce them to your place?

7.5. What vaccinations do you like bulls to have had prior to purchase?

Vaccination	< 6 months	6–12 months	Annual booster	Number of dosses
5-in-1/7-in1				
Tick fever				
Bovine pestivirus				
BEF				
Botulism				
Pinkeye				
Vibrosis				
Leptospirosis				
Other				

7.6. What vaccinations do you use and when would you administer them?

Vaccination program

Vaccination	< 6 months	6–12 months	Annual booster	Number of dosses
5 in 1/7 in 1				
Tick fever				
Bovine pestivirus				
BEF				
Botulism				
Pinkeye				
Vibrosis				
Leptospirosis				
Other				

Notes:

7.7. Do you run your bulls in like age groups?

7.8. How do you think this affects their performance?

7.9. How many bulls do you run per 100 cows?

7.9.1. Does this differ between breed of bulls?

7.10. Do you remove bulls from cows at any point during the year?

8. Production rates

8.1. Have you ever had weaning weights that noticeably differed between the bulls that you were using?

Breed of cows	Breed of bull	Weaning percentage	Weaning weights (if known)

Notes:

8.2. Do you use HGPs?

If yes, please complete the following table.

HGP type	Sex	Age at administration

Notes:

9. Environmental effects

9.1. What is your average rainfall?

9.1.1. What months does this rainfall dominate?

9.2. What is your average temperature?

9.3. What is the average humidity for this area?

9.4. What are the main mineral deficiencies in this area?

9.4.1. To what degree do these deficiencies affect your cattle?

9.5. What is the main water source on your place?

9.6. What would be the average distance between water sources?

Season	Trough	Dam	River
Wet			
Dry			

9.7. What parasites or diseases do you have issues with in this area?

Parasite or disease	Management practices	Other notes
Buffalo fly		
Cattle ticks		

Notes:

10. Nutrition

10.1. Do you plant any crops during the year?

10.1.1. If so, what crops are you producing for fodder?

10.1.2. Do you bale any of these crops for use during the dry season?

10.1.3. Are any crops of pasture irrigated on the property?

10.2. Do you supplement feed or provide licks to any animals during the dry season?

Please specify the pasture type that the different categories of animals are fed on during the dry season.

		Animal (ADG or kg/animal/day)				
Pasture type	**Supplementation**	**Weaners**	**Steers**	**Heifers**	**Cows**	**Bulls**
Native pasture	None					
	Lick					
	Grain sup.					
Improved pasture	None					
	Lick					
	Grain sup.					
Crops	None					
	Lick					
	Grain sup.					

10.2.1. If feeding lick, what is the composition of the lick (percentages would be preferred)?

10.2.2. If feeding grain supplement what are the ingredients of the grain supplement?

10.2.3. What is the energy compensation of the ration (ME, protein and dry matter)?

10.3. Do you feed animal during the wet season?

10.3.1. What do you feed them?

Please specify the pasture type that the different categories of animals are fed during the wet season.

		Animal (ADG or kg/animal/day)				
Pasture type	**Supplementation**	**Weaners**	**Steers**	**Heifers**	**Cows**	**Bulls**
Native pasture	None					
	Lick					
	Grain sup.					
Improved pasture	None					
	Lick					
	Grain sup.					
Crops	None					
	Lick					
	Grain sup.					

10.3.2. If feeding licks, what is the composition of the lick (percentages would be preferred)?

10.3.3. If feeding grain supplementation, what are the ingredients of the grain supplement?

10.3.4. What is the energy composition of the ration (ME, protein and dry matter)?

11. Sale methods

What method of sale do you use for the majority of your steers?

	Class animals sold and weight range	**Location/port/ destination**	**Purchaser, if known**
Sale yards			
Feedlot			
Abattoirs			
Live trade			
Other			

11.1. Would you be willing to share sales statistics (carcase data, feedlot data, or sale live weights of the animals at sale, any record of the purchaser)?

11.2. Would you mind being contacted in regards to future research that may arise from this investigation?

11.3. Do you see your markets changing in the next 5–10 years?

11.3.1. If so how long and what do you believe you will do to combat this?

12. Feedback

12.1. Is there anything else that I haven't covered that you think is important to the success of *Bos taurus* bulls in this area?

12.2. Is there any particular feedback that you would like from our investigations?

12.3. Would you be willing to be contacted by Angus Australia's marketing team in regards to press releases?

Notes:

8.3. Feedlot producers survey

1. Feedlot details

Trading name	
Owner	
Family members	
Manager	
Property's address	
Postal address	
Phone number	
Location description	
Location (latitude and longitude)	
Number of properties	
Number of properties in the company	

1.1. Notes:

1.2. What is your registered feedlot capacity (SCU)?

1.3. Is this feedlot apart of a vertically integrated supply chain?

1.3.1. If yes, what is also included?

2. What experiences have you had with Angus in the past?

2.1. How many years have you been feeding Angus at this feedlot?

2.2. What Angus brands are you suppling?

2.3. Is there anything that causes different animals to cope better with the environment then other?

3. Environmental effects

3.1. What is your average temperature?

3.2. What is the average humidity for this area?

3.3. Do you experience long periods of hot weather during the summer?

4. Where do you source most of your cattle from?

4.1. Have you experienced any differences in performance from the scores locations?

5. Performance on feed

5.1. What is the ADG across the feedlot?

5.2. Have you experienced variations between the types of cattle that you are feeding?

5.3. What is the average FCR across the feedlot?

5.4. Does this vary dramatically between the types of cattle on feed?

6. Cattle types on feed

6.1. Do you feed any heifers?

6.2. Does the induction weight change between sexes?

6.3. Is there a c/kg premium for black over red?

6.4. Do you feed cattle for different

7. Feeder specifications

7.1. What beef brands are you currently feeding to supply (class)?

7.2. Induction specification for different classes of cattle

Specification	**Class**					
Entry weight*						
Age						
Breed						
Sex						
Temperament						
Bos indicus content						
CAAB certified						
JAS standards						
Yard weaned						
c/kg payed						

* Full or shrink

7.3. Would you be willing to supply me with the carcass specifications for each brand and the discounts or premium involved with each?

Carcass specifications

Specification		**Class**							
Days on feed			+						
			-						
Carcase weight									
P8 fat depth									
Rib fat depth									
Marbling score									
Ossification									
Base price c/kg									
Sex	Male								
	Female								

7.4. What percentage of cattle would meet the specification?

8. Carcase data

8.1. Do you have any data comparing carcase composition between breeds? In particular variations in *Bos indicus* content?

8.2. Would you be willing to share some of this data?

9. Rations in use

9.1. How many rations are in use?

9.2. Ration changes between the grades of cattle

9.3. What is the energy level of the ration?

9.4. What is the protein level in the ration?

9.5. What is the average finishing ration cost per ton?