final report

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PDSNT004– Helen Springs Bull Breeding PDS

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Executive summary

Currently most properties in the Barkly Tableland region of the NT purchase bulls from interstate and few have objective information on their genetic merit (Estimated Breeding Values - EBVs). This PDS aimed to demonstrate the process of using performance recording and objective selection to set up and run a bull breeding herd under extensive conditions on a large property in the NT. The PDS was run on Helen Springs station (including Brunchilly outstation) on the Barkly Tableland. The producer group for the PDS was the Barkly Research Advisory Committee (BRAC) which had 11 members, 8 of whom were managers of cattle properties in the district and it is estimated that they were collectively responsible for the management of around 288,000 head.

Herd performance data that had been collected crush side (electronically) during pregnancy testing was used to identify 560 cows that had superior fertility (had reared a calf for 5 consecutive years) and were due to calve between September 2012 and January 2013. These cows were segregated in a paddock that would be suitable for conducting calving checks and catching, tagging and weighing calves. The cows had been mated to bulls (Charbray and Brahman) that had been selected on the basis of their EBVs.

Calves were caught and tagged shortly after birth and their birth weight, birth date, gender, colour and dam ID were recorded. The weight of all calves was recorded at weaning. After weaning and branding the male weaners were separated from the females and placed in a paddock where they grazed together as one mob and their performance was recorded. At the end of the post weaning dry season (at about 11 months of age) the young bulls were weight, hip height, body condition score and scrotal size were recorded. In July the following year (at approximately 20 months of age) the bulls were weighed and were visually assessed to determine whether they were suitable to be potential herd bulls. Those that passed this assessment were drafted off for bull breeding soundness examination (BBSE) and semen testing. The main attributes used to assess whether bulls were suitable for further testing were temperament, sheath, deformities, conformation and type. Bulls that passed the BBSE and had >50% normal sperm were selected for potential use as herd bulls.

A selection index specific to the company breeding goals was developed using data for traits recorded in the PDS and the traits given a rating according to their importance in the station's breeding objectives. This selection index was used to rank the bulls and decide where they would be used (which females they would be bred to).

Two year groups of young bulls were bred using this process and in each year group about 24% of the young bulls weaned ended up being selected for use as herd bulls (although about 30% of bulls evaluated at the final selection ended up being selected a number had escaped the paddock between weaning and final selection).

The PDS demonstrated that herd bulls can successfully be bred on property in the NT and it realistically described the challenges and benefits of doing so. Some of the challenges included: Paddock security - multiplier herd animals escaping the paddock during the wet season, other bulls entering the paddock. Collecting birth date and weight is difficult in large herds (560 cows) on extensive properties during the summer months. However challenges can be overcome if staff are committed to the task. The benefits included: Confidence that the herd bulls produced will perform

well in the local environment as they were bred and evaluated in it. Bulls are selected on the basis of objective performance data and not just physical appearance (which is often the result of the nutrition they have received). Good quality bulls can be produced cost effectively on property - the total cost per bull for breeding them on station was around $2,400 each if all the costs (e.g. extra labour, data collection, BBSE, semen collection and steer income forgone) are included. However in this analysis the cost of steer income forgone was not offset by the salvage value of bulls that are culled after selection and not kept for use, which would further reduce the cost of home bred bulls. In comparison a $3,000 bull bought from Queensland costs $3,243 landed on station (including transport, dipping and inspection, spelling etc.). Also bulls bought from interstate are often not semen tested and so are used at a rate of 4%, whereas semen tested home bred bulls can be used at 2% which makes the use of home bred bulls even more attractive as only half as many are required.

A successful field day was run at Helen Springs to communicate the findings of the PDS provide information on using performance recording and objective selection to the local producer group and other interested producers in the area. It was attended by 16 producers representing 8 pastoral properties that cover 4.3 million hectares and manage about 186 000 head. Two cattle veterinarians who service large areas of the Katherine and Barkly regions also attended. Field day participants were able to view and discuss the bulls that had been bred and observe the processes (electronic data collection, semen sample collection etc.) that had been used in data collection and evaluation. There were also talks on the theory of objective genetic selection and bull evaluation and interactive sessions where people could use the knowledge they had gained to rank bulls using objective information.

The PDS met its objectives and was successful in increasing the knowledge of station and company staff, producer group members and field day attendees of what is involved with using performance recording and selection to breed herd bulls under extensive conditions on a large property in the NT.

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1 Background

1.1 Producer Group

The impetus for this Producer Demonstration Site (PDS) came from interaction between NT DPIF staff and the management of Helen Springs station and was supported by the Barkly Research Advisory Committee (BRAC) which is a group made up mainly of cattle producers in the Barkly region (see Appendix 1). BRAC is a Regional Beef Research Committee which functions as a northern beef industry committee and provides advice to DPIF on R&D priorities. BRAC had 11 members at the time of the PDS including 8 managers of cattle stations in the district.

Helen Springs is owned by S. Kidman & Co Ltd which is one of Australia's largest beef producers with a herd of 185,000 cattle run over pastoral leases covering 101,000 square kilometres in three states and the Northern Territory. Helen Springs (and Brunchilly outstation) has an area of 10,198 km^2 and has around 55,000 head of cattle. The average herd size on a Barkly property is around 36,000 (Pastoral Industry Survey (2010) and so the 8 cattle producers in the producer group (BRAC) at the time the PDS started (see Appendix 1) probably represented the management of around 288,000 head.

1.2 Rationale for establishing PDS

The adoption of objective genetic evaluation and selection tools (e.g. EBVs, Breedplan etc.) in the north Australian cattle industry has been low despite genetic improvement being identified as one of the main ways of addressing the low reproductive and growth performance of cattle in northern Australia (McCosker *et al.* 2010). This PDS aimed to demonstrate how an extensive property can breed its own herd bulls on site to achieve genetic improvement in the Barkly Tableland (NT). In doing this the PDS aimed to demonstrate the use of herd performance recording to identify superior females to form a bull breeding herd and the use of objective performance evaluation and genetic tools (eg. EBVs) to select the bulls bred from this herd.

The PDS aimed to demonstrate to the members of the producer group and the wider industry that these genetic evaluation and selection tools can be implemented practically to make genetic improvement on an extensive NT cattle station. This PDS was not about proving that selection works (since it was too short in duration to do this), but rather it was about demonstrating how to do it under extensive conditions on a commercial property and determining the cost benefits.

There are currently few tropically adapted bulls with objective genetic information (EBV’s) available for purchase by NT properties and most properties in the NT end up having to buy bulls with little or no objective genetic information from interstate. Also the stress involved with relocation can reduce the fertility of bulls for months following transportation. Therefore there are large advantages for properties that can breed superior bulls on-farm that have been selected based on objective genetic information and performance in the local environment. Information from the 2004 Primary Industry Survey of the Barkly region indicates that only about 15% of stations breed their own bulls, another 15% get their bulls from their company bull breeding operations while the rest purchase their bulls (Primary Industry Survey 2004).

2 Projective objectives

1. 1: By 30 Feb 2013 to have developed all the project methodologies, protocols and data recording systems for the bull breeding herd.
2. By 30 Sep 2013 to have developed a selection index for use in selecting young bulls from this herd.
3. 3: By 30 Sep 2015 to have evaluated the performance of 2 year groups of young bulls and used the data to select bulls suitable for use.
4. 4: By 30 Nov 2015 to have conducted a field day at Helen Spring/Brunchilly showcasing the work.
5. 5: By 30 Dec 2015 to have submitted the final report to MLA.

3 Methodology

3.1 Setting up bull multiplier herd

Helen Springs Station uses a herd recording program where the performance of cows is recorded electronically using Gallagher TSi data collectors when cattle are processed for pregnancy testing. In 2012 the station used the information that they had collected to identify approximately 510 cows (Brahman and Brahman/Charolais cross) that had reared a calf each year since 2008 and were due to calve again between September 2012 and January 2013. These cows with superior reproductive performance were identified and put together in a paddock to form the base of a bull multiplier herd and were mated to Charbray and Brahman sires selected using EBVs. These cows with "elite" reproductive performance were selected for the bull multiplier herd as bulls born from highly fertile cows are likely to be more fertile and have fertile offspring.

In mid 2012 the multiplier herd was placed in a paddock in which they could be observed during calving and in which it would not be too difficult to find and catch calves. Calves were caught and tagged shortly after birth and their birth weight, birth date, gender, colour and dam ID were recorded. Some cows and calves escaped from the paddock over the wet season and by the weaning muster on 26/4/13 there were 472 cows present that raised 419 calves to weaning (ie. 11% foetal/calf loss from pregnancy test to weaning).

The weight of all calves was recorded at weaning. After weaning and branding the male weaners were separated from the females and placed in a paddock where they grazed together as one mob and their performance was recorded. At the end of the post weaning dry season (on 22/10/13) at about 11 months of age the young bulls were mustered and weight, hip height, body condition score and scrotal size were recorded. At each measurement date the cattle were mustered, kept in the yards overnight with access to water and then measurements (including weight) were recorded the following day.

In July the following year (on 17/7/14) at which time the young bulls were approximately 20 months old, they were weighed and were visually assessed to determine whether they were be suitable to be potential herd bulls. Those that passed this assessment were drafted off for bull breeding soundness examination (BBSE) and semen testing. The main attributes used to assess whether bulls were suitable for further testing were temperament, sheath, deformities, conformation and type.

This resulted in 64 (34% of 183) bulls being selected for BBSE and semen testing (conducted by a veterinarian - Ian Braithwaite). Bulls that passed the BBSE and had >50% normal sperm were selected for potential use as herd bulls. A selection index was used to rank the bulls and decide where they would be used. The development of the selection index is discussed in more detail in section 3.2.

The multiplier herd was again mated to purchased Brahman and Charbray bulls over the 2012/3 wet season and a second crop of calves was produced again the following year. A similar process was used to produce and evaluate young bulls weaned in 2014.

The number of weaners produced in 2014 was less than in 2013 as not all cows had re-conceived and some more cows went missing over the wet season. Calves were born between October 2013 and January 2014 with an average birth date of 18/11/13. A total of 136 male calves were weaned on 29/4/14 with an average weight of 180 kg.

At the end of the post weaning dry season (29/10/14) the young bulls were mustered and weight, body condition score and scrotal size were recorded. Some bulls went missing over the following wet season and 101 were mustered on 17/8/15. Again the bulls were assessed in the round yard and those considered suitable to be potential herd bulls were drafted off for bull breeding soundness examination (BBSE) and semen testing. This resulted in 50 bulls being selected for BBSE and semen testing (conducted by Ian Braithwaite).

3.2 Defining key data for bull selection

The key data used when evaluating the growth and performance of the young bulls bred in this PDS was:

- Birth weight. A lower birth weight was considered to be better.
- Growth over different periods e.g. from weaning to the end of the post weaning dry season and from weaning to approximately 20 months of age. Growth was calculated from weights recorded at birth, weaning, approximately 11 months of age (at the end of the post weaning dry season) and approximately 20 months of age (in July the following year).
- Scrotal size at 11 and 20 months of age.
- Sheath score at 20 months of age. Sheath score 2 was considered to be the optimum score. The station manager did not like bulls tight sheaths and so the order of preference of sheath scores from best to worst was 2,3, 1, 4 and 5.
- Temperament. Temperament was assessed in the round yard at approximately 20 months of age. In some ways temperament was the most important trait as any bulls with bad temperament were excluded from selection.
- BBSE. BBSE was conducted by an accredited veterinarian. Bulls had to pass the BBSE to be selected.
- Semen traits. Semen samples were collected at approximately 20 months of age and density and motility were assessed crush side, while samples were sent to a lab for assessment of morphology.

3.3 Developing selection index

A selection index to rank bulls was developed so that several traits could be included simultaneously in selection. The selection index was developed in consultation with the manager of Helen Springs and the S. Kidman Co. pastoral inspector. Beef genetics experts and consultants were also consulted.

The traits used in the selection index and the rating (out of 100) given to each trait are shown in the table below.

Trait	S. Kidman Co. rating (out of 100)
Birth weight	5
600D Growth rate	15
Scrotal Size percentile	25
% normal sperm	20
Horn poll	25
Sheath score	10

So the selection index was:

SK Index value = (Birth Wt. x 0.05) + (600D Gth x 0.15) + (SS percentile x 0.25) + (% normal sperm x 0.20) + (Horn status x 0.25) + (Sheath Score x 0.10)

Since the traits had different units of measurement (e.g. growth rate was in kg/day, birth weight was in kg, sheath score was a score between 1 and 5, scrotal size was in cm etc.) a method was devised to standardise the units for traits so that each trait had a range of scores between 0 and 1.The way that this was done for each trait is as follows:

Birth weight: The birth weights were given a score between 0 and 1 where the highest birth weight was 0 and the lowest was 1 and there was a linear penalty for each 1 kg increment in birthweight from the lowest to the highest.

600 Day growth rate: The growth rates were given a score between 0 and 1 where the highest growth rate was 1 and the lowest was 0 and there was a linear penalty for each 0.01 kg/day increment in growth rate from the highest to the lowest.

Scrotal size percentile: Each bulls weight and scrotal size at approximately 20 months of age were used to work out what percentile its scrotal size was for that particular weight using the equation for Brahman bulls from Fordyce et al. (2014). The equation was used to make up sheets to use in the yards which showed what percentile each scrotal size was for a particular weight. The percentile was then used in the selection index expressed as a decimal (eg. 76% = 0.76).

Percentage normal sperm: The % normal sperm from the results of morphology testing was expressed as a decimal in the selection index (e.g. 76 % normal sperm = 0.76). However when the % normal sperm was below 50% a larger penalty was imposed by giving a score of -0.25 to samples with 30-50% normal sperm, and -1 for samples with <30% normal sperm.

Horn status: As S. Kidman Co. values polledness quite highly, polled animals were given a score of 0.5 and horned animals were given a score of 0.

Sheath score: The scores (between 0 and 1 for each sheath score are shown in the table below. As the station manager believed that the optimum sheath score for Brahman and Brahman cross bulls was 2 it was given the highest rating and the other ratings were allocated as to how desirable that score was.

Sheath score (1-5 where 1 = tight, 5 is loose and 2 is the best in Bos indicus)	Sheath score value
1	0.6
2	1
3	0.8
4	0.4
5	0.2

This index values fertility quite highly as the fertility traits (scrotal size and percent normal sperm) make up 45% of the index value.

3.4 Communication of results

A field day was held in 2015 at Helen Springs Station to communicate the learnings from the PDS. A field day manual was prepared and handed out to attendees on the day. Several producers who wanted to attend but could not due to circumstances were sent a copy of the field day manual as well.

4 Results

Two year groups of bulls were bred. Of the 203 young bulls weaned in 2013, 48 (24%) ended up being selected as herd bulls, although 21 went missing over the 2013/2014 wet season and so 26% of the bulls actually assessed at 20 months ended up being selected. Not all cows re-conceived and some went missing over the next wet season so less calves were weaned in the following year. Of the 136 male calves that were weaned 32 (24%) were selected as herd bulls. Again some of these went missing and so 32% of the 101 bulls actually assessed ended up being selected.

The results for each year group of bulls are presented separately in the following sections.

4.1 2013 bulls

4.1.1 Birth weight

In mid-2012 the multiplier herd was placed in a paddock in which they could be observed during calving and in which it would not be too difficult to find and catch calves. The calves were caught and tagged shortly after birth and their birth weight, birth date, gender, colour and dam ID were recorded. The average birth weight was 33.8 kg (range = 12 – 52 kg), the average birth date was 9/11/12 (range 11/9/12 to 22/1/13).

Although some cows escaped from the paddock during the wet season and there was some foetal and calf loss, birth date was recorded for 472 calves and birth weight was recorded for 445 calves (not all calves could be caught and weighed close to birth). To catch, tag and weigh this many calves in such a large mob is a very big job and that it was able to be done so well is a testament to the commitment and hard work of the station staff (especially Max Cameron) who carried out the work at a time of year when conditions are very hot on the Barkly Tableland. Some features that helped in carrying out this task were that the paddock was quite flat with relatively few trees so finding cattle was not that difficult. Also, twice during the calving season the wet cows and calves were moved to a separate paddock to reduce the number of calves in the paddock and make finding new calves easier.

4.1.2 Parentage testing results

Tail hair samples were collected from calves at weaning and from the bulls prior to mating and sent to the University of Queensland laboratory for parentage testing. It was intended that a herd Breedplan type analyses would be done. However other bulls must have entered the paddock during mating as parentage could not be established on a sufficient number of calves to make this worthwhile. Therefore this was abandoned and each young bulls own performance was used to assess it with no input from relatives.

4.1.3 Weaning weight/200D weight

Some cows and calves escaped from the paddock over the wet season and by the weaning muster on 26/4/13 there were 482 cows present that raised 419 calves to weaning (i.e. 11% foetal/calf loss from pregnancy test to weaning). Calf loss (after tagging at birth) was a bit higher in male than female calves (13.1% vs 9.3%). The average pre-weaning growth rate of all calves from birth to weaning 0.89 kg/day. Pre-weaning growth rate was higher in males than females, higher in calves with heavier birth weights and higher in calves whose dams were 5-7 years old than in cows that were11-12 years old. Month of birth did not affect pre-weaning growth rate as some other studies have found, but this is likely because all the calves were born at a favourable time of year and within a relatively short spread of calving date.

The average age and weight of calves (male and female) at weaning (on 26/4/13) was 5.6 months and 182 kg. After weaning and branding the male weaners were separated from the females and placed in a paddock where they grazed together as one mob and their performance was recorded.

4.1.4 400 day weight and Scrotal Size

At the end of the post weaning dry season (22/10/13) the young bulls were mustered and weight, hip height, body condition score and scrotal size were recorded. On average the young bulls grew 44 kg over the post weaning dry season (0.25 kg/day between 26/4/13 and 22/10/13). Data recorded for all males up until the end of the post weaning dry season is shown in table 1. The average scrotal size at 11mths of age was 20 cm at an average weight of 227 kg.

Table 1. Data up until 1 year of age for #3 males

Measure	Average	Minimum	Maximum
Birth date	11/11/12	20/9/12	8/1/13
Birth Weight (Kg)	35.0	12.1	52
Weaning Weight 26/4/13 (kg)	189	86	266
Growth rate: birth to wean (kg/day)	0.93	0.33	1.24
Weight 22/10/13 (kg) (avg. age = 345 days)	226.7	131	330
Post weaning Dry Season Growth (kg)	44.1	-2.5	102.5
Scrotal size (cm) 22/10/13 (avg. age = 11 mo.)	20.0	14.2	28.1

*Note – Growth rates could only be calculated for animals that had a weight recorded on each date so some animals were not included in the calculation of growth rate.

4.1.5 600 day weight and BBSE

On 17/7/14 the bulls were re-mustered. Due to paddock movements (some animals escaping over the wet season) only 183 were present for this data collection. Table 2 shows the growth and scrotal size data for the group of bulls.

Table 2: Data at 20mths of age

Measure	Average	Minimum	Maximum
Weight 17/7/14 (kg) (avg. age = 613 days)	376	282	520
Growth Oct 2013 – Jul 2014 (kg)	150	66	299
ADG Oct 2013 – Jul 2014 (kg/day)	0.56	0.27	1.11
Growth Weaning to 20 months (kg)	189	115	277
Scrotal size (cm) 17/7/14 (avg. age = 20 mo.)	30.5	26	37.5

Following this the bulls were assessed in the round yard and those considered suitable as potential herd bulls based on temperament, breed (preference to Charbray) and conformation (muscling, sheath, deformities, size, backline, tail setting) were drafted off to undergo a bull breeding soundness examination (BBSE) by a veterinarian (Ian Braithwaite). This resulted in 62 (34% of 183) bulls being selected for BBSE and semen testing (conducted by Ian Braithwaite). Table 3 shows that bulls selected for further testing were of a similar average age but grew faster than those that were not selected, and so on average were heavier (+18 kg) and had slightly larger (1 cm) scrotal size at 11 months of age. By 20 months of age the selected bulls were on average 40 kg heavier than those that were not selected.

Table 3. Data for #3 bulls that were either selected for BBSE or culled

Measure	**Culled** – Average *(range in brackets)*	**Selected** – Average *(range in brackets)*
Number	118	64
Birth date	11/11/12	9/11/12
Birth Weight (Kg)	34.7 *(12 – 52)*	36.6 *(24 – 49)*
Weight 22/10/13 (kg) (avg. age = 345 days)	220.8 *(132 – 301)*	238.4 *(140 – 330)*
Post weaning Dry Season Growth (kg)	41.7 *(-2.5 to 102.5)*	46.7 *(11 – 95)*
Scrotal size (cm) 22/10/13 (avg. age = 11 mo.)	19.8 *(14.8 – 28.1)*	20.7 *(16.3 – 27)*
Weight 17/7/14 (kg) (avg. age = 613 days)	362.7 *(282 – 451)*	402.8 *(342 – 520)*
Growth Oct 13 – Jul 14 (kg)	142.0 *(66 – 222)*	164.7 *(116 – 299)*
Scrotal size (cm) 17/7/14 (avg. age = 20 mo.)		30.5 *(26 – 37.5)*
Weight (kg) 17/8/15 (avg. age = 2.8 y.o.)		523 *(453 – 722)*
Growth Jul 14 – Aug 15 (kg)		120 *(42 – 202)*

Of the original 203 male calves weaned, 21 went missing over the 2013/2014 wet season, leaving 182 bulls to be assessed at 20 months. Of these, 118 were deemed unsuitable based on visual assessment, leaving 64 for BBSE and semen testing. One bull failed the BBSE and semen could not be collected from another. Of the 62 bulls semen tested, 14 (23%) failed the semen morphology test (having < 50% normal sperm), 18 (29%) had 50-70% normal sperm and 30 (48%) had >70% normal sperm. As a result 48 of the 203 (24%) male calves weaned were selected for use as herd bulls. Table 4 summarises the performance data of the bulls that were either selected or not selected for use as herd bulls. The average growth from weaning to 20 months of age was 208 kg (0.47 kg/day) for selected bulls and 182 kg (0.41 kg/day) for those not selected.

Table 4. Average performance data of young bulls that were or were not selected as herd bulls.

	No. of animals	Birth date	Birth weight (kg)	Weaning weight (kg)	Weight at 20 months (kg)	Scrotal size at 11 months (cm)	Scrotal size at 20 months (cm)
Not selected	134	9/11/2012	34.9	188.9	368.1	19.9	-
Selected	48	13/11/2012	36.6	193.5	400.4	20.5	30.5

Semen samples were collected from the bulls at the same time as a BBSE was conducted. The semen samples were sent to a lab for morphology assessment. As the bulls were younger than 2 years old (the average age at semen test was 20 months but some would have been 18 months old) the figure of 50% normal sperm was used as a threshold to assess fertility. However a higher percent normal sperm is an indicator of higher fertility and so the selection index was set up so that bulls with higher percent normal sperm were favoured.

There was no significant relationship between scrotal size and percent normal sperm (see Figure 1). Figures 2 and 3 also show that the density of the semen sample and motility cannot be used to reliably predict percent normal sperm (e.g. as some semen samples with low density and motility had high percentage normal sperm). Also note the data point in Fig. 1 for bull J00198 who had a very large scrotal size (37.5 cm = 98th percentile) but only 9% normal sperm, again showing that semen testing is important. Therefore it is important to get morphology done on semen samples even though it increases the cost of bull testing (BBSE = $25/head + GST. Semen morphology = $21/head +GST).

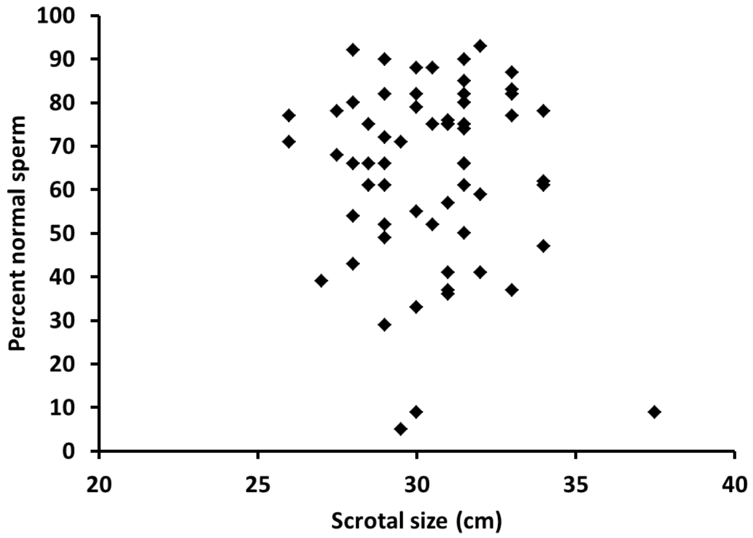

Figure 1. The relationship between scrotal size and percent normal sperm for the 62 #3 bulls semen tested on 17/7/14.

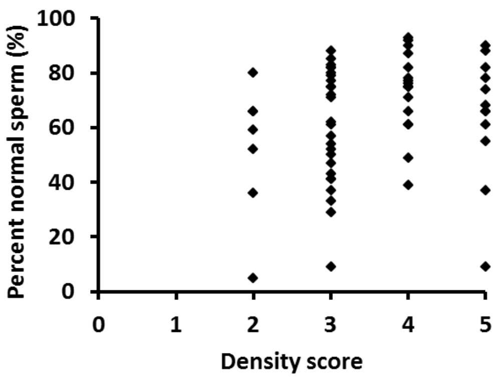

Figure 2. The relationship between semen density and percent normal sperm for the 62 #3 bulls semen tested on 17/7/14.

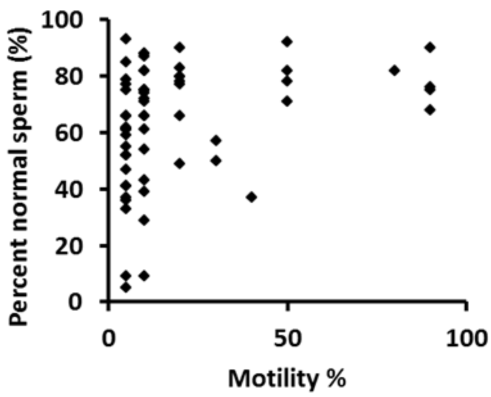

Figure 3. The relationship between semen motility and percent normal sperm for the 62 #3 bulls semen tested on 17/7/14.

It should be noted that semen quality is variable and so it may be worth re-testing young bulls that narrowly failed their semen test if they look like they may grow into a good bull as some may be younger bulls which are still undergoing maturation of testicular function or they could have had a stress (eg. 3 day sickness) prior to semen collection that could have adversely affected semen quality.

4.1.6 Selection index

The performance data of the 62 bulls that were selected by visual appraisal for BBSE and semen testing was used in the selection index to rank the bulls. Kidman Co. intends to use this information to decide how the bulls should be used (i.e. which females they should be mated to).

The index developed in this PDS values fertility quite highly as the fertility traits (scrotal size and percent normal sperm) make up 45% of the index value. Polledness is also valued quite highly, however as there were only 3 animals that were polled (in the #3 bulls), polledness was not actually used in the index for #3 bulls but the polled bulls were highlighted. In this way each the performance of each animal could be compared equally and polledness could be taken into account.

The value of having a selection index is that it takes several different traits into account according to how much they are perceived to influence profitability. Fertility has been found to influence profitability more than growth. So it is important to understand that picking the biggest, best looking bulls is not the best way to go. While growth is important, just selecting for growth will not improve profit as much as a more balanced selection policy as you may end up selecting a herd of large, fast growing animals that have low fertility. A practical example of this looking at the data for #3 bulls is that bull J00072 was by far the best bull for growth but his scrotal size was quite small for his weight (only in the 15th percentile) and as a result he did not rank all that highly (33 out of 62) in the SK selection index ranking which places a high value on fertility traits (e.g. scrotal size and percent normal sperm).

The data for the 62 tested bulls including their index rating is shown in appendix 2. The top 10 bulls based on the Selection Index had an average of 80% normal sperm while the average of the bottom 10 bulls was 29% normal sperm. The bottom 13 bulls all failed the semen morphology (less than 50% NS), showing that the index was putting appropriate weighting on % normal sperm.

4.2 2014 bulls

4.2.1 Birth weight

The 2014 crop of young bulls were produced from the same multiplier herd of cows by a similar process as occurred with the 2013 bulls. However the number of weaners produced was less as not all cows had re-conceived and again more cows went missing from the paddock over the wet season. Calves were born between mid-September 2013 and mid-January 2014 with an average birth date of 18/11/13. Birth date was recorded for 272 calves and birth weight was recorded for 143 calves. The average birth weight was 29.8 kg (range = 20 – 44 kg). Different staff did the calving checks and data recording in the second year and less emphasis was put on trying to collect a birth weight for all calves born (mostly due to trying to reduce the amount of time required for this work).

407 cows were observed calving but after numerous cows and calves escaping the paddock over the wet season and some calf loss, 258 calves were mustered and tagged at the weaning muster.

4.2.2 Weaning/200D weight

For the reasons discussed in the previous section (Birth weight), less calves were weaned in 2014. 258 calves were mustered and tagged at the weaning muster and a total of 136 male calves were weaned on 29/4/14 with an average weight of 180 kg (range = 85 – 248 kg).

4.2.3 400D weight and scrotal size

At the end of the post weaning dry season (29/10/14) the young bulls were mustered and weight, body condition score and scrotal size were recorded. The average scrotal size at 11mths was 20.6 cm at an average weight of 234 kg. On average the young bulls grew 53 kg over the post weaning dry season (0.29 kg/day between 29/4/14 and 29/10/14). Table 5 summarises the data for the 2014 crop of bulls.

Table 5. Data at ~11mths in 2014 males

Measure	Average	Min	Max
Growth post wean dry season	53.4	-21.5	97
Weight 29/10/14 (344 days)	233.9	151	319
Scrotal Size 29/10/14 (11 mo.)	20.6	16	29.3

4.2.4 600D weight and BBSE

Some bulls went missing over the wet season and 101 were mustered on 17/8/15. Again the bulls were assessed in the round yard and those considered suitable to be potential herd bulls were drafted off for bull breeding soundness examination (BBSE). This resulted in 50 bulls being selected for BBSE (conducted by Ian Braithwaite). Seven bulls failed their BBSE and semen samples from 43 bulls (43% of 101) were sent to the laboratory for semen morphology assessment. Table 6 shows a summary of the data for bulls that were either culled or selected for semen testing.

Table 6. Data for 2014 bulls that were either selected for BBSE or culled

	Culled – Average *(range in brackets)*	**Selected – Average** *(range in brackets)*
Number	58	43
Birth date	25/11/2013	16/11/2013
Birth weight (kg)	29.1 *(20 - 36)*	31.5 *(24 - 41)*
Weight 29/10/14 (kg) (avg. age = 344 days)	231 *(157 - 319)*	239 *(161 - 305)*
Post weaning dry season growth (kg)	58.1 *(30 - 97)*	50.6 *(-14 - 86)*
Scrotal size (cm) 29/10/14 (avg. age = 11.1 mo.)	20.1 *(16 – 26)*	21.2 *(16.3 - 29.3)*
Weight 17/8/15 (kg) (avg. age = 636 days)	365.0 *(275 - 455)*	399.9 *(324 - 520)*
Growth Jul 14 - Aug 15	155.4 *(28 - 222)*	174.9 *(112 - 233)*
Scrotal size (cm) 17/8/15 (avg. age = 20.5 mo.)		29.9 *(23.5 - 37.5)*

Results from the semen morphology testing found that 11 of the 43 bulls had less than 50% normal sperm and so these were not selected as herd bulls. Therefore out of 101 bulls, 32 ended up being selected. Again since the semen testing was conducted in mid-August at 20 months of age it may be worth re-testing any of the bulls that narrowly failed their semen test (5 had between 40-49% Normal Sperm) if they look like they may grow into a good bull, as semen quality is variable and has been found to be lower in the dry season especially where bulls have lost body condition. Also some may be younger bulls which are still undergoing maturation of testicular function.

4.2.5 Selection Index

The index ranking included horn status for the 2014 bulls as there were a greater number of polled animals. As polledness has quite a high rating, most of the top bulls in the selection index ranking are polled (11 of the top 15). If polledness is not included in the index then only 4 polled bulls made the top 15. The ranking of bulls by the selection index (including polledness) is shown in Appendix 3. The top ranked bull (K00089) was a good all-round bull. He was polled, had 81% NS, was the 72nd percentile for scrotal size at 11 months of age and was +19.5 kg above average for growth. In this year group the top ranked bull for growth (K00078) also had quite good semen (78% NS) and reasonable scrotal size.

4.3 Cost of breeding bulls on station to Helen Springs

Preliminary economic analysis shows that the total cost per bull for breeding them on station is around $2,400 if all the costs (e.g. extra labour, data collection, BBSE, semen collection and steer income forgone) are included. However in this analysis the cost of steer income forgone was not offset by the salvage value of bulls that are culled after selection and not kept for use, which would further reduce the cost of home bred bulls. In comparison a $3,000 bull bought from Queensland costs $3,243 landed on station (including transport, dipping and inspection, spelling etc.). Also bulls bought from interstate are often not semen tested and used at a rate of 4%, whereas semen tested home bred bulls can be used at 2% which makes the use of home bred bulls even more attractive as only half as many are required.

The other thing to consider is that if the purchased bulls don't have EBVs then there is no indication of how good they will be (in terms of how their offspring will perform) and they may actually be inferior to bulls that have been bred on station and selected on their performance in the local environment.

4.4 Field day

On the 16th September 2015 a field day was held at Helen Springs to present the results of the PDS. It was attended by 16 producers representing eight pastoral properties that cover 4.3 million hectares and manage about 186 000 head. Two veterinarians who service large areas of the Katherine and Barkly regions and who are well respected within the pastoral community also attended.

The program for the field day can be found in Appendix 4. The field day was held in conjunction with a series of field days which all carried the themes of polledness and objective selection in bull breeding and when purchasing bulls.

Participants were asked "Where would you start/continue to change the genetics of your herd?". Properties with several staff attending answered the question as a group. Fertility was a strong theme with three out of three groups listing fertility as their first priority and often specifically mentioning increasing re-conception in lactating cows. Groups also specifically stated selecting bulls on EBVs and BBSE. One group mentioned managing stock numbers to improve nutrition and body condition in breeders.

Participants were asked "What is one thing you could do in the next year?" One property mentioned developing a selection index for use in their bull breeding herd, while another mentioned BBSE testing.

Field day participants were able to view and discuss the bulls that had been bred and observe the processes (electronic data collection, semen sample collection etc.) that had been used in data collection and evaluation. There were also talks on the theory of objective genetic selection and bull evaluation and interactive sessions where people could use the knowledge they had gained to rank bulls using objective information.

Some photos from the field day are presented in Appendix 5.

4.5 Practice change at Helen Springs

Due to changes in company structure, bull breeding for the company will now all be done on another property in Queensland which is dedicated to breeding bulls. Therefore the nucleus bull breeding herd is no longer functioning at Helen Springs. However the PDS was successful in increasing the knowledge of station and company staff (and producer group members) of what is involved with using performance recording and selection to breed herd bulls under extensive conditions on a large property in the NT.

5 Discussion

The discussion of the performance of the bulls in the PDS was incorporated into the previous section (Results). The discussion in this section focusses on the effectiveness of the PDS as an educational process.

PDS Objective	Outcome
1. Developed all the project methodologies, protocols and data recording systems for the bull breeding herd.	Achieved
2. Developed a selection index for use in selecting young bulls from this herd	Achieved
3. Conducted a field day at Helen Spring/Brunchilly showcasing the work	Achieved
4. Submitted a Final Report	Achieved

The learning outcomes of the PDS were that it showed:

- That it is possible to collect intensive data on a large breeding herds when you have the right equipment, staff expertise (that can be taught) and the commitment from management to drive it.
- That the data collected can be used to identify cows with superior fertility to be segregated and used as a bull multiplier herd.
- That running a bull multiplier herd is more intensive than a normal commercial breeding operation, and requires commitment to carry it out.
- That there are challenges in running a bull multiplier herd on a large scale (e.g. 560 cows) under extensive conditions on a large property in the NT (e.g. animals escaping the paddock during the wet season, other bulls entering the paddock, collecting birth date and weight etc.) however these can be overcome if staff are committed to the task.
- That while bulls bred on property may not look as impressive as purchased bulls that have been raised in a more favourable environment and received higher levels of nutrition, that they can be assessed on the basis of how they perform in the environment in which they will have to work in, and that they may be as good or better genetically than purchased bulls.
- Staff turnover often happens on NT properties which needs to be allowed for with training of new staff who take over specialised roles.
- Bulls can be successfully bred on extensive properties in a nucleus bull breeding herd.
- BBSE is an important component of bull management and this was one of the key take home messages which producers took away from the field day. BBSE allows bulls which are not reproductively/structurally sound to be identified and culled.
- Semen testing is also a very important part of assessing bull fertility.
- Fertility was highlighted as a key priority in a bull breeding program.
- Using a selection index allows bulls which perform well on a number of traits to be ranked and selected. The selection index can be designed to meet the station breeding objectives by weighting traits according to their importance.

- The PDS was successful in increasing the knowledge of station and company staff (and producer group members) of what is involved with using performance recording and selection to breed herd bulls under extensive conditions on a large property in the NT.

Also 2 NBRUC conference papers have been published on this work:

Schatz T, McCosker K, McGlynn B and Cameron M (2013).The effect of birth weight and month of birth on pre-weaning growth of calves on the Barkly Tableland, NT. NBRUC 2013 conference proceedings.

Collier C, Schatz T, and Cowley T (2016). Using performance recording to breed herd bulls on an extensive cattle station in the Northern Territory. NBRUC 2016 conference proceedings.

6 Conclusions/recommendations

The Helen Springs Bull Breeding PDS was effective in demonstrating the process of using performance recording data to develop a bull multiplier herd to breed herd bulls on an extensive property in the NT. Participants increased their knowledge of performance recording and objective selection. They were able to view the final product of this process (the bulls bred in the PDS) and gained a honest and realistic understanding of the challenges and benefits of breeding herd bulls on property.

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8 Appendix

8.1 Appendix 1: Barkly Region Advisory Committee (BRAC) Producer Group Members at the commencement of the PDS

Name	Address
Ross Peatling	Alexandria, CMB Mount Isa QLD 4825
Ken Ford	Tennant Creek, Box 445, Tennant Creek NT 0861
Henry Bourke	Brunette Downs, PMB 5, Mount Isa, QLD 4825
Sandy Warby	Phillip Creek, PMB, Tennant Creek, NT 0861
Di Sorely	Lake Nash Station, PMB 16, Mount Isa, QLD 4825
George Scott	Lake Nash Station, PMB 16, Mount Isa, QLD 4825
John Dunnicliff	Beetaloo Station, PO, Elliott, NT 0862
Chris Towne	Helen Springs Station, CMB 8 Tennant Creek NT 0862

8.2 Appendix 2: Data and Selection Index results for 2013 bulls

Tag	Brd	Horn	Bth Wt Kg	SS (cm) 10 mo	SS 10 mo. Percentile (decimal)	SS (cm) 20 mo	% NS (decimal)	20 mo. Growth (kg)	20mo GR rank	GR 2014/15 rank	Wt (kg) Aug15	SK index rank
J00189	Xb.	Horn	23.7	18.8	0.55	30.5	0.88	59	4	43	481	1
J00356	Xb.	Horn	37.8	23	0.77	33	0.87	23.5	22	35	514	2
J00049	Xb.	Horn	31.2	21.1	0.77	33	0.77	28.5	16	11	544	3
J00378	Xb.	Horn	37.5	24	0.75	32	0.93	0	45	12	518	4
J00021	Br.	Horn	32.2	19.3	0.76	31.5	0.9	-9	53	25	486	5
J00297	Xb.	Horn	49	20.7	0.65	33	0.82	51	7	40	534	6
J00203	Xb.	Horn	37	24.2	0.73	34	0.61	43	9	22	572	7
J00067	Xb.	Horn	33	25.7	0.84	34	0.62	4	44	18	542	8
J00433	Br.	Horn	28	18.4	0.83	31.5	0.82	-7	51	9	487	9
J00256	Xb.	Horn	43	27	0.67	34	0.78	16	34		600	10
J00034	Xb.	Poll	29.8	19.3	0.54	31.5	0.74	35.5	13	39	514	11
J00242	Xb.	Horn	40	20.4	0.79	31.5	0.75	-32.5	61	2	534	12
J00041	Br.	Horn	34.5	23.7	0.78	33	0.83	-36	62		M	13
J00013	Xb.	Horn	43.2	19.2	0.46	28	0.92	-3.5	48	32	453	14
J00109	Xb.	Horn	32.9	19	0.57	31	0.75	-32	33		526	15
J00406	Br.	Horn	39.2	22.3	0.48	31.5	0.85	23	25		M	16
J00199	Xb.	Poll		19	0.48	29	0.82	16.5	35	8	502	17
J22214	Br.		16.3	16.3	0.72	31.5	0.5	34	32	21	499	18
J00179	Xb.	Horn		19.5	0.57	29.5	0.71	10.5	40		M	19
J00206	Xb.	Horn		19.2	0.42	31	0.57	52.5	6	7	566	20
J00260	Xb.	Horn	36.5	19.4	0.46	31	0.75	26	19	33	530	21
J00234	Xb.	Horn	33	22.7	0.58	32	0.59	20	29	26	544	22
J00008		Poll	35.4		0.28	29	0.72	68.5	2	5	566	23
J00156	Br.	Horn	36.3	23.1	0.57	31.5	0.61	22.5	26	23	532	24
J00249	Br.	Horn	40	22.5	0.61	31.5	0.8	-19	59	36	506	25
J00307	Xb.	Horn	29	21.3	0.27	30	0.88	9	41	17	564	26
J00285	Br.	Horn	39.2	19	0.54	31.5	0.66	17	30	46	502	27
J00126	Xb.	Horn		20.6	0.36	29	0.9	7.5	42	48	457	28
J00357	Xb.	Horn		19.1	0.36	29	0.61	62	3	34	492	29
J00229	Br.	Horn	37.8	23.3	0.55	30.5	0.75	-12	55	14	522	30
J00437	Br.	Horn	39.4	21.3	0.35	30	0.82	25	20		M	31
J00181	Xb.	Horn	29.2	18.7	0.38	28.5	0.66	28	17	44	460	32
J00072	Xb.	Horn	46.6	23	0.15	31	0.76	88	1	1	722	33
J00088	Br.	Horn	38.4	22	0.44	31.5	0.66	23	24	50	481	34
J00390	Xb.	Horn	34.3	18.3	0.4	28	0.8	-4	49	20	479	35
J00305	Br.	Horn	36.5	18.6	0.36	29	0.66	13	38	16	520	36
J00113	Xb.	Horn		18.4	0.36	28.5	0.61	14.5	37	10	512	37
J00255	Xb.	Horn	39.7	19.5	0.35	30.5	0.52	42	10		M	38

Tag	Brd	Horn	Bth Wt Kg	SS (cm) 10 mo	SS 10 mo. Percentile (decimal)	SS (cm) 20 mo	% NS (decimal)	20 mo. Growth (kg)	20mo GR rank	GR 2014/15 rank	Wt (kg) Aug15	SK index rank
J00223	Xb.	Horn	35.7	21.1	0.54	29	0.52	-8.5	52	6	504	39
J00271	Br.	Horn	41.3	18.2	0.3	30	0.79	37	12	13	564	40
J00244	Xb.	Horn	33.5	19.9	0.27	28	0.66	-2.5	47		M	41
J00333	Xb.	Horn	35.7	20.8	0.22	28.5	0.75	11	39	49	459	42
J00312	Xb.	Horn	33.7	19	0.15	27.5	0.68	24.5	21	42	498	43
J00080	Xb.	Horn	35	20.5	0.08	27.5	0.78	23	23	41	532	44
J00187	Xb.	Horn	39.2	17.5	0.13	26	0.77	-37	31		510	45
J00039	Xb.	Horn	46.7	20.2	0.34	30	0.55	20	28	4	578	46
J00316	Xb.	Horn	34.2	21.1	0.81	34	0.47	6	43	30	532	47
J00219	Xb.	Horn	38.5	18.1	0.08	26	0.71	15	36	19	524	48
J00299	Xb.	Horn	37.5	19.1	0.12	28	0.54	31	15	38	534	49
J00033	Xb.	Horn	29.3	21	0.58	32	0.41	27	18	15	560	50
J00366	Xb.	Horn	32.5	22.9	0.58	31	0.41	-2	46	45	487	51
J00402	Xb.	Horn	42.6	21.4	0.79	33	0.37	-19	58	3	558	52
J00343	Br.	Horn		19.7	0.58	31	0.37	-5	50		M	53
J00198	Xb.	Horn	39.3	23.8	0.98	37.5	0.09	37.5	11	29	534	54
J00268	Br.	Horn	46	22.8	0.38	31	0.36	32	14	24	562	55
J00295	Xb.	Horn	41.7	21.2	0.38	30	0.33	20	27		M	56
J00152	Xb.	Horn	31.9	19.3	0.17	29	0.49	44	8	47	518	57
J00040	Xb.	Horn	29.5	22	0.18	27	0.39	-13.5	56	27	493	58
J00270	Xb.	Horn	39.4	19.7	0.21	28	0.43	-14	57	37	500	59
J00304	Xb.	Horn	30.3	19.5	0.18	29.5	0.05	58	5		M	60
J00350	Br.	Horn		23	0.51	30	0.09	-31	60	28	497	61
J00301	Br.	Horn	42	18.5	0.26	29	0.29	-10	54	31	522	62

8.3 Appendix 3: Data and Selection Index results for 2014 bulls

Tag No.	Horn	Birth Wt. (kg)	SS (cm) 11 mo.	SS 11 mo. Percentile	SS (cm) 20 mo.	SS 20 mo. percentile	% NS	20m Growth (kg)	20m GR rank	Growth Wn- 20 mo. (kg)	Wt (kg) 17/8/15	SK index rank
					33.1	0.7	81	19.5	21	222	427	1
K00165	Poll	26	22.2	0.34	31.1	0.46	75	41	5	243.5	421	2
K00103	Poll		17.1	0.32	28.5	0.55	58	26.5	14	229	333	3
K00139	Poll		19.3	0.17	28.7	0.13	90	63.5	2	266	442	4
K00121	Horn		25.5	0.95	37.5	0.99	65	19	22	221.5	382	5
K00171	Poll		21.1	0.08	31.5	0.48	63	10.5	35	213	430	6
K00096	Poll	29	20.9	0.29	29	0.32	69	17	27	219.5	388	7
K00061	Poll		23.2	0.35	30	0.41	78	-25.5	85	177	K00089	Poll
K00071	Poll				29.6	0.38	74	-9.5	66	193	396	9
K00078	Horn				34	0.49	78	69.5	1	272	520	10
K00064	Horn	24	22.5	0.27	31.5	0.63	80	-6.5	62	196	396	11
K00040	Poll		24.3	0.53	29	0.33	77	-15.5	71	187	389	12
K00199	Horn		23.5	0.95	32	0.75	80	-8.5	64	194	378	13
K00135	Poll	37	20.2	0.17	29.5	0.26	68	9.5	36	212	415	14
K00252	Horn		22.1	0.13	33.8	0.76	67	-11.5	67	191	420	15
K00141	Poll		18.7	0.1	27.2	0.17	50	38.5	6	241	384	16
K00181	Horn		22	0.14	32	0.5	80	15.5	28	218	438	17
K00104	Horn		22.5	0.45	30.5	0.47	84	12.5	32	215	400	18
K00068	Horn				32	0.63	60	0.5	50	203	412	19
K00008	Horn		19.6	0.52	29.2	0.4	88	0.5	52	203	378	20
K00082	Horn		22.2	0.17	30.5	0.43	79	5	39	207.5	407	21
K00223	Horn		24.9	0.57	31	0.58	74	-28.5	86	174	391	22
K00140	Horn		20.7	0.09	30.5	0.35	76	19.5	20	222	429	23
K00123	Horn	30	18.9	0.69	29	0.38	62	2	47	204.5	379	24
K00150	Poll	41	20.7	0.3	30.7	0.44	31	53.5	3	256	413	25
K00162	Horn		21.5	0.25	30	0.38	52	17.5	24	220	407	26
K00034	Horn	32	22.3	0.16	29	0.22	74	12.5	31	215	422	27
K00240	Horn		20.8	0.22	29	0.25	73	0.5	51	203	409	28
K00086	Horn		29.3	0.95	37.4	0.97	46	0.5	49	203	434	29
K00072	Horn	28			27.5	0.28	73	-55.5	92	147	364	30
K00161	Horn	36	17.6	0.04	26.6	0.08	62	30.5	11	233	401	31
K00131	Horn		17.4	0.06	26.6	0.09	55	31	10	233.5	399	32
K00115	Horn	27	20.6	0.26	32.2	0.71	49	27.5	13	230	394	33

Tag No.	Horn	Birth Wt. (kg)	SS (cm) 11 mo.	SS 11 mo. Percentile	SS (cm) 20 mo.	SS 20 mo. percentile	% NS	20m Growth (kg)	20m GR rank	Growth Wn- 20 mo. (kg)	Wt (kg) 17/8/15	SK index rank
K00238	Horn		16.3	0.04	23.5	0.03	61	17.5	25	220	374	34
K00184	Horn	35	19.4	0.13	26.5	0.17	54	-21	79	181.5	369	35
K00105	Horn	28	17.5	0.33	27.8	0.52	40	-6.5	63	196	324	36
K00030	Horn		24.2	0.52	27.8	0.16	48	-3.5	54	199	404	37
K00182	Poll	34	19.8	0.12	29.5	0.38	0	-21.5	81	181	393	38
K00251	Poll	28	18.5	0.05	26.9	0.14	22	4.5	42	207	385	39
K00196	Horn	38	22.7	0.37	27	0.07	44	4.5	40	207	415	40
K00004	Horn		16.6	0.1	29.1	0.47	26	31.5	9	234	363	41
K00237	Horn	31	20.4	0.09	31.4	0.61	16	-15.5	70	187	394	42
K00073	Horn		21.5	0.36	28	0.26	13	6	38	208.5	378	43

8.4 Appendix 4: Field Day Flyer and Program

FutureBeef

Bull Breeding Field Day

Results from the Helen Springs bull breeding PDS – Use performance recording to breed your own bulls.

Field Day featuring speakers John Bertram, Emily Piper and Tim Schatz

Helen Springs Station
Saturday 12th September

RSVP: casey.collier@nt.gov.au

A joint initiative of: Queensland Government | Northern Territory Government | Department of Agriculture and Food | mla

Register now!

Casey Collier
0437 814 678
Casey.collier@nt.gov.au

Helen Springs Station
Saturday 12th September 2015

Speakers: John Bertram and Emily Piper

What's on?

- Overview of the PDS
- BBSE - Selecting structurally and reproductively sound bulls
- Setting breeding objectives to guide herd development
- Breeding for polledness
- Polled gene marker testing
- Identification and selection of superior females for a bull breeding herd

A joint initiative of: Queensland Government | Northern Territory Government | Department of Agriculture and Food | mla Meat & Livestock Australia

FutureBeef

Helen Springs Bull Breeding PDS Field Day

Saturday 12th September 2015

Program

Time:	Session:	Speaker:
9.30am	**REGISTRATION AND MORNING TEA**	
10:15am	Welcome	Chris Towne
10:30am	Auction at House Yards	Whitney Dollemore
12:00pm	Objective Selection/Bull Buying	John Bertram
12.40am	Importance of objective selection (EBVs) to Kidman in their bull buying and breeding	
12:50pm	Overview of PDS	Tim Schatz
1.00pm	**LUNCH**	
1.45pm	Breeding the horns off your herd (Q and A)	Emily Piper
2.15pm	Drive to yards	
2.40pm	Helen Springs PDS Overview • Identification and selection of superior females • Selection of bulls to mate to superior females • Progeny recording • BBSE and semen testing explanation • Bull selection	Tim Schatz, Casey Collier, John Bertram and Chris Towne
4.15pm	Drive back to station	
4.35pm	BBSE Demonstration/discussion	Tim Schatz/ John Bertram
5.00pm	Evaluation	
5.30pm	CONCLUSION. BBQ Dinner for those wanting to stay	

Normal text

Guidelines: Include graphed or summarised data of value to readers (limit the inclusion of raw data**)**.

8.5 Appendix 5: Photos from the Helen Springs Bull Breeding PDS Field Day

8.6 Appendix 6: Acknowledgements

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