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Barriers to adoption of genetic improvement technologies in northern Australia beef herds

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Abstract

Despite considerable research investment into the development of breeding and genetic technologies, the perceived levels of adoption by both the stud and non-stud sectors of the northern beef industry are low. This survey was designed to ascertain current bull selection criteria, what BREEDPLAN and genetic technologies are working well and what should be changed for greater adoption.

The study involved a phone survey of 293 commercial and stud breeders across northern Australia and an additional email survey of 233 stud breeders Australia wide. The results indicate that breeders' selection decisions continue to be based on the 'clearly visible' phenotypic traits that have been used for many years rather than the Estimated Breeding Values and fertility measures that require data on performance and analysis to estimate the genetic component of observed differences. The lack of emphasis on fertility data was particularly evident. There was lack of association, amongst breeders between improved financial returns and use of $Indexes. As an opportunity for the industry to overcome the increasing costs of production, there needs to be a shift in focus towards a more objective business approach integrating the latest genetic tools available. These include:

- A range of existing Breedplan EBVs,
- $Indexes for appropriate target markets,
- Bull Breeding Soundness Evaluation measures including scrotal size and percent normal spermatozoa, and
- Genomic profiles supporting the current genetic differences.

With a declining number of service providers there is an acute need to crystallise the current stakeholders and assist beef producers' understanding of current and developing breeding and genetic messages from basic fertility measures to genetic and then genomic information relative to herd profitability.

Executive Summary

The perceived low level of adoption of genetic technologies, by both the stud and commercial beef industries of the northern beef, was the stimulus for this project.

The project objectives were to identify and report (via survey):

- The current and future selection criteria for bulls by producers in northern Australia;
- What is currently working well with BREEDPLAN and other related genetic technologies; and
- What is not working well and could be changed for greater adoption across both the seed stock and commercial breeding sectors.

This study involved a phone survey of 293 commercial and stud breeders across northern Australia and an additional email survey of 233 stud breeders Australia wide. The phone survey employed open questions rather than multiple choice questions. There are many similarities between the data derived from 1992 surveys and the current one. Major findings of the current state of play were:-

- 95% of phone survey respondents were owner operators of the beef enterprise indicating their level of personal responsibility for the breeding and genetic selection decisions
- The majority (72%) of stud breeders are solely straight breeding i.e. within breed.
- About 62% of stud breeders identified their budgeted average price for investing in replacement bulls is greater than $8,000/bull, compared with 37% of commercial breeders that have an average budgeted price of $2,500-5,000/ bull.
- 89% of stud breeders purchase either one or 2-5 bulls per year, compared with commercial breeders where 71% purchase 1-5 bulls per year. Amongst the stud breeders, the majority (32%) mated bulls at 2.5% with 27% and 30% mating bulls at two and three percent respectively. Bulls are generally being purchased as 2-year-olds and retained in herds to five to eight years old.

Stud breeders make culling decisions based on structural breakdown (94% of respondents) followed by poor performance (45% of respondents) and increased inbreeding and age (39% of respondents). Failure of a bull in a BBSE and the opportunity to access superior animals with better genetic information each rated lowly in the stud sector in northern Australia

In contrast, in the commercial sector of the industry, 85% of respondents identified culling decisions based on structural breakdown, increased inbreeding and age (27% of respondents), poor temperament (19.6% of respondents) followed by poor performance of progeny (15%).

Commercial industry most frequently identified temperament/docility, structural soundness and conformation as the major traits in their selection criteria in 67% of responses. Use of Breedplan EBVs was identified in greater than 50% of responses. Degree of visual muscling, poll status, scrotal circumference, physical measures, the animal appearance (conformation) and % normal spermatozoa all were identified as important. Breed of the bull and stud name were important criteria as used by breeders in the commercial sector of the industry.

In northern Australia, 57% of stud breeder respondents either have never recorded and submitted data or ceased recording data for Breedplan genetic analyses. The main reasons being that Breedplan does not work (42%) and insufficient time to collect the data (37%). Meanwhile a total of 22 and 23 percent of stud and commercial breeders, respectively, indicated they have a high dependence on Breedplan information (8 and 9 score). The main reasons given by those still in Breedplan were that it ranks animals better than raw data measures, it stacks genetics effectively and there is opportunity for herds with poor recording practices to improve.

58% of stud breeders and 57 % of commercial breeders indicated genomic information was not applicable or of minimal value.

24% of stud breeders and 30% of commercial breeders use $Indexes in their selection criteria.

Electronic survey: Of the 227 stud breeders in the electronic survey which had a response rate of 8%, the majority (55%) were between 45 and 64 years old, followed by 19% in the 65 to 75 year old age group. 54% identified Breedplan EBVs as how they arrive at a selection decision for each bull entering their breeding program. 52% rated $Indexes as "Use them sometimes" to "depend on them" which is the same scale as EBVs. The importance of genomic information as part of their selection criteria averaged 3.8 (scale 1-9).

Of the 104 studs that don't use BREEDPLAN, in the electronic survey, the major concern was the perceived lack of financial rewards for the sale of animals with EBVs (46% of respondents) followed by the perceived cost being too high (34%)

New Traits and Improvements: Suggested improvements of the 88 respondents who use Breedplan include:- Breedplan EBVs that allow comparison across breeds rather than within breed (57%), recording practices of herds (51%), shorten the time it takes to implement new technology into Breedplan e.g. use of genomics (33%) and improve selection based on $Indices (30%).

The stud sector indicated that the traits they would like to include in selection if suitable bulls were available include Breedplan EBV traits as well as Polled bulls. In contrast, the commercial sector identified temperament and the breeder cow's herd background data with similar emphasis closely followed by Breedplan EBVs and percent normal spermatozoa information.

The respondents failed to identify any new traits that are of real interest. There is a continued focus on the traditional traits such as structural soundness of feet, legs and joints as the major trait. Temperament, conformation and Breedplan EBV traits are the next most important traits. Then followed by physical measures, scrotal circumference, polledness and degree of muscling. In contrast, the commercial industry identified temperament, structural soundness and conformation as the three major selection criteria going forward. Breeder cow fertility traits are conspicuous by their absence.

Despite considerable Australian research investment into the development of breeding and genetic technologies, the level of adoption by the stud industry is still much lower than achievable. The northern commercial beef industry is not effectively utilising the available objective genetic technologies to overcome the escalating costs of production. The 'clearly visible' phenotypic traits that have been used by breeders for many years continue to be the focus of selection decisions rather than the measured traits of Estimated Breeding Values and BBSE fertility measures that require a more clinical examination.

For the industry to overcome the increasing costs of production, there needs to be a shift in focus towards a more objective business approach using:

- A range of existing Breedplan EBVs,
- $Indexes for appropriate target markets,
- Bull Breeding Soundness Evaluation measures including Scrotal size and percent normal spermatozoa, and
- Genomic profiles supporting the current genetic differences.

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1 Background

1.1 Purpose of the study and description

A range of genetic technologies and tools have been available for beef producers in the northern half of Australia for more than 20 years, to assist with both the breeding of animals of superior productivity and the purchase or selection of animals, especially bulls, that will improve the productivity of commercial herds. These technologies and tools are generally packaged within BREEDPLAN, the national genetic evaluation system for beef cattle. BREEDPLAN produces Estimated Breeding Values (EBVs) for beef cattle for a range of important production traits. The accuracy of these EBVs improves with the quantity and quality of performance data being recorded. Additionally, BreedObject Selection Indexes describe genetic differences of animals as the value of their genetic package ($) for specific production systems and market end-points.

Despite a) the availability of such tools, b) the capacity of these tools to cost-effectively improve productivity by about 2% per year (Holmes, Personal communication), and c) the need for producers to continually increase productivity to combat the cost-price squeeze, the rate of genetic progress in northern Australia is perceived to be less than half that of leading Angus herds in southern Australia (Banks 2005). Also, the level of BREEDPLAN use has plateaued or decreased in recent years particularly with regard to “new” stud breeders and the recording levels of traits by existing users (McDonald, Breedplan *Pers. Comm*.).

Furthermore, some stud breeders using BREEDPLAN report limited demand from commercial producers for BREEDPLAN EBVs or Selection Indexes. Consequently, performance recording for BREEDPLAN genetic evaluation may not be producing for them additional revenue via increased sales and/or increased prices relative to bulls sold without EBVs (Eenennaam, 2012 and Williams, TBTS *Pers comm*.). In southern sales targeting the long fed target market, Eenennaam (2012) reported a clearer association between long fed $Index and bull sale price compared to northern commercial bull market sales. Additionally, in northern Australia, it is recognised that there is a large multiplier herd bull layer to the bull breeding sector. Generally, bulls produced in this system will not have basic information recorded such as sire, dam and date of birth, let alone performance traits for genetic evaluation. There are also some producers that, due to cost or convenience, simply keep the “tops” of their weaner male calves as entire to make up a percentage of their herd bull replacements. All the selection happens in the weaner yards with limited information.

Acknowledging the above issues (both documented and anecdotal), this project aims to identify the barriers to adoption of genetic improvement technologies in both the seedstock and commercial beef breeding sectors located in the northern half of Australia.

1.2 Previously published data

In recent years there has been an increase in both the amount of genomic information available and the additional service providers of this information to the beef industry. Several surveys have been conducted with a focus on herd production and selection decisions by producers in the beef industry.

In a survey of north Australian beef producers, O’Rourke *et al* (1992) reported that producers gave strong signals that selection for breeding stock rated highly in ensuring their future profitability: 93% of producers rated superior bull selection as important and 87% rated selection of breeders on fertility as important, but selection methods were generally free of objective measures and genetic differences. Only 43% of producers valued performance recording as important. Only 24% of their respondents culled more than 20% of bulls annually, indicating that genetic progress was slow with extended generation intervals. Producers reported an average branding percentage of 63 % and a high percentage of

respondents left bulls in the herd all year round. Even restricted joining periods were relatively long, averaging 6.7 months.

A north Australian report edited by Blakeley for MLA (2002) was compiled to ascertain how to better package R&D information to increase the understanding of producers on reproduction and genetics and assist them to use appropriate technologies to improve their business performance. This report segmented the market by enterprise zone, gender, age, and management position for various breeding and genetic decisions made on the beef enterprise. Technology use rated low at 23% which was complimented by the respondent's lowest confidence ratings of 7.4 for Bull fertility(scale 1- 10) , 6.6 for Bull breeding and 6.9 for Genetics. Producers gave highest ranking/importance to traits pertaining to selecting for temperament and physical and reproductive soundness of bulls. That survey also showed that 35% of respondents bred bulls for their own use, with 23% also indicating that they used EBVs.

This report provided extensive profiling of the northern industry and was a precursor to the development of 'Breeding and Genetics' training packages for northern Australian producers.

Oxley *et al* (2004) surveyed the Northern Territory (NT) pastoral industry following earlier independent regional surveys in the 1980's. This survey reported that NT producers use year-round mating utilising about 4.3% of bulls in the herd. The Barkly and Alice Springs region producers more frequently indicated they used EBVs but the extent of dependence upon EBVs was not identified by each respondent. A subsequent NT beef industry survey by Cowley *et al* (2010) reported that the average percentage of bulls dropped to 3.6%. Generally, these bulls are sourced from Queensland stud breeders. 38% of producers indicated they used EBVs as a selection tool for potential bull purchases, thereby representing 29% of NT bulls purchased. 71% of NT producers using EBVs, considered fertility followed by growth as their highest priority genetic selection traits. Temperament, structural conformation and polledness were the phenotypic traits of greatest importance.

Bortolussi *et al* (2005a) surveyed 375 north Australian beef producers during 1996-97. These respondents were recruited through a direct approach, local networks, advertisements and the individuals were selected on the basis of being a commercial entity with sufficient detailed records to meet the information requirements of the survey. This implies that it was not a truly random sampling process. These authors reported that highly ranked selection traits were bull temperament, structural soundness (greater than 90% of respondents in all regions) and conformation. 52 % of all producers across the north of Australia (north Queensland, north Northern Territory and north Western Australia) indicated they used Breedplan as part of their selection criteria.

Bortolussi et al (2005b) found that use of Breedplan as the only bull selection criterion was used by <5% of producers (mainly stud breeders) and was negatively correlated with selection for colour and conformation. Those breeders identifying scrotal circumference as part of their selection criteria maintained they did not have a corresponding benefit in increased branding rate, but that their use of Breedplan was related to increased branding percentages. The study found that producers used four to five selection criteria with structural soundness and temperament ranking highest, followed by conformation, weight for age, Breedplan and color. Beef producers did not readily associate the use of high genetic merit bulls with improvements in live weight performance and improved turnoff weight. Instead they were more readily able to accept crossbreeding as the means to increase turnoff weight.

Across all regions surveyed, Bortolussi *et al* (2005b) found that bull age, physical defects / conformation, poor quality or poor performance calves, reproductive problems and temperament were the main culling criteria used by beef producers. In most Queensland regions, bull culling age peaked at 6 to 8 years-old.

In a survey of beef producers in the Burdekin and Suttor Catchments, Moravek *et al* (2013) found that 64% of producers used a continuous mating program and, of the 48% of producers that use Bull Breeding Soundness Evaluation data in their selection of bulls for fertility traits, 85% of these used the technology prior to purchase, and 15% of producers routinely use it on an annual basis. 48% of respondents said they used EBVs in their selection of bulls with greatest emphasis on birth weight, followed by 600, 400 and 200 day weight EBVs. Scrotal size followed by Days to Calving were the major fertility traits used. Some respondents clearly had a poor understanding of currently available genetic differences such as polled status and sperm morphology and thought they were included in the EBV traits.

The study found that less than 50% of producers appeared to be recording adequate herd information that would provide them with objective data in order to be able to make targeted management and breeding selection decisions in bulls purchased eg EBVs.

Burns and Ruvie (1996) identified a number of issues faced by members of the tropical breed societies. These included communication between all sectors, effective use of reliable genetic evaluation data, better utilization of the opportunities in new technologies and many other marketing and environment issues.

Freer *et al* (2003) in a report to Meat and Livestock Australia used an extension group to focus on a National Beef Genetics Foresight Plan for the current and future beef industry. The extension team reported on barriers to adoption of genetic technologies in the beef industry and methods for overcoming these barriers. Four major barriers were identified:

- ✓ Lack of 'Proof of Profit'
- ✓ Lack of follow up (assistance with adoption) after initial exposure to awareness programs
- ✓ Extension in a diverse and fragmented industry
- ✓ Decline of traditional extension resources

Banks (2005) put forward the view that in recent years, the rate of genetic progress in Australia's extensive livestock industries is lower than is possible and there are challenges to improve this situation as it is in part due to a lack of coordination in the diverse interests of the industries.

Upton *et al* (2007) went on to suggest that given the above limitations, a component of 'coaching' target opinion leaders or 'key players' should be implemented across the wider beef industry to diffuse the good messages on beef genetics.

Genetics has played an important part in the profitability of the beef industry with particular gains stemming from improved growth rates with EBVs since 1985. An evaluation of historical investment in beef cattle genetics research and development in Australia showed that investment in genetic selection and crossbreeding realized a net present value (NPV) of $861 million, a benefit cost ration of 3.6 and an internal rate of return (IRR) of 19% (Farquharson *et.al*., 2002).

Hammond (2006) identified that there needs to be an encouragement for the beef industry as a whole to take more responsibility for its genetic improvement including a more appropriate program of capacity building.

In a situation analyses report of the northern beef industry (McCosker *et al*, 2010), the authors cited a critical decline in profitability of beef enterprises and amongst a number of critical key influencing factors identified a renewed focus on heifer management, breeder performance and bull selection based on objective measurement. They cited the need to continue to develop skills and capacity of business managers and ensure bull selection is

appropriate in order to account for the pressure likely to be incurred within a given breeding system. Concern was expressed for the extensive breeder herd where extremely poor performance is an alarming contributor to unprofitable business performance. Specifically, very poor reproduction rates e.g. wet cow re-conception rates of less than 10%, 1st calf heifer re-conception rates below 20%, and low dry cow conception rates. They specifically cited that “Poor quality genetics, especially in reproduction” was a limiting factor to increased profitability.

These recommendations are consistent with the more recent report of Lee and Pitchford (2014) which has supported the development of ‘Proof of Profit’ messages, the opportunities in creating a value chain pull-through effect and working with northern commercial beef producers to increase the demand for Breedplan and BBSE information. They highlighted that communication is a key factor and this included development of effective networks and engagement of the beef industry.

The initial BullPower research outcomes (Holroyd, *et al* 2000) have been implemented in the national Bull Breeding Soundness Evaluation (BBSE) standards managed by the Australian Veterinary Association - Cattle Vets (Beggs, 2013). The BBSE provides opportunity for beef producers to set minimal bull fertility standards when purchasing their bulls and thereby minimising the incorporation of sub fertility into their herd (Burns, *et al* 2013 and Johnston *et al*, 2013) with a resultant decline in profitability (McCosker *et al*, 2010).

1.3 Index of Terms

ABRI	Agricultural Business Research Institute
BBSE	Bull Breeding Soundness Evaluation as standardised by the Australian Veterinary Association, Australian Cattle Veterinarians chapter.
BLUP	Best Linear Unbiased Prediction model used for the genetic analyses.
BREEDPLAN	The title used to refer to the Australian genetic analyses using the BLUP analyses.
B. wt.	Birth Weight Estimated Breeding Value
CSIRO	Commonwealth Scientific Industrial Research Organisation
EBV	Estimated Breeding Value
200 day (weaner weight) EBV	Estimated Breeding Value measured 81 to 300 days of age
400 day (yearling weight) EBV	Estimated Breeding Value measured at 301 to 500 days of age.
600 day (Final weight) EBV	Estimated Breeding Value measured at 501 to 700 days of age
$Index	$ Index derived from Estimated Breeding Values and weighted economic traits.
%Normal	A morphological assessment of percentage normal spermatozoa
Mass Activity	A crush side assessment of a fresh sample of semen using a microscope
MLA	Meat and Livestock Australia
MVP	Molecular Value Prediction; Genomic suite of single nucleotide polymorphisms (SNPs) indicating variation in traits identified on the chromosome.
Progressive motility	A crush side assessment recording the percentage of spermatozoa that are progressively motile in a fresh semen sample
SS	Scrotal size/circumference measurement in centimetres
TBTS	Tropical Beef Technology Services

2 Project objectives

The Research Organisation will achieve the following objective(s) to MLA's reasonable satisfaction:

To identify and report:

1. The current and perceived future selection criteria for bulls by producers in northern Australia;

2. What is currently working well with BREEDPLAN and other related genetic technologies; and

3. What is not working well and could be changed for greater adoption across both the seed stock and commercial breeding sectors.

3 Methodology

3.1 Survey design

A standardised telephone survey was employed with several target groups located in (or providing genetics to) northern Australia (defined as Queensland, the Northern Territory and the northern rangelands of Western Australia). The target groups included:

1. Stud/seedstock producers that are current active members of BREEDPLAN.
2. Stud/seedstock producers that were previously BREEDPLAN members but have since resigned.
3. Stud/seedstock producers that have never been a BREEDPLAN member or recorder.
4. Commercial beef breeding producers. This was further broken into 3 sub-target groups being:

    a) Pastoral Companies
    b) Large family operations
    c) Small/medium family operations with minimum numbers of 200 commercial cows or 50 stud cows.

The survey format was developed with the assistance of a market research specialist and statistician including input from industry stakeholders such as Breed Societies, MLA, ABRI and TBTS to capture the bounds for the survey questions and potential responses for coding and more effective analyses.

The telephone survey population within each of the target groups was defined with the assistance of the MLA member data base covering northern Australia. This was complemented by an email survey of a sample drawn from the ABRI breed society member database and endorsed by the executive of these societies. The telephone survey was conducted between August 2013 and March 2014. The one-on-one individual surveys were conducted at a time convenient to the respondent.

The industry phone survey comprised eight general questions relevant to all respondents and included general questions addressing location, general herd profile and herd dynamics which were followed by two general questions seeking subjective attitudinal responses describing the respondents selection decisions. The survey was separated into nine questions that were targeted towards **stud breeders only** and subsequently a similar group of five questions that were focussed on the **commercial breeders only** (Appendix Ia). Breeders whose beef enterprise had both categories could answer both stud and commercial sections.

- Phase 1 - Before the full survey was rolled out, a pilot group of producers across each of the target producer groups was interviewed, with the experience used to formulate the final questions.

- Phase 2 - The survey and surveying process used eight independent interviewers with about 300 producers identified across each of the target groups. The interviewers initially contacted the respondent by phone or email and then sent a copy of the survey (Appendix I) to the respondent who was phoned at a pre-arranged time, to progress through the survey while the interviewer recorded coded answers established from phase 1.

- Phase 3. Approval was sought from all breed societies, by Tropical Beef Technology Services staff, to use their member email lists for the purpose of an electronic survey (Appendix 1b). This survey was emailed to about 3,000 breed society members across Australia using 'Survey Monkey' as the medium. This was emailed from ABRI in June/July 2014. No stud breeder completed both surveys. Response to this survey was voluntary and open to both Breedplan and non-Breedplan members from all breed societies. The questions were similar to the personalised phone interviews, but the respondents had categorical responses from which to select. These categories were the same as those used by the phone interviewers.

3.2 Statistical Analyses

The results from the phone survey were analysed by a Queensland Department of Agriculture Forestry and Fisheries statistician using the following methodology.

Minimum herd size requirements (50 and 200 females for stud and commercial, respectively) as specified on the survey were not rigidly enforced when numbers were very close to minimums required. As many questions where specific to either stud or commercial breeders, and with many of the remaining questions clearly influenced by whether the respondent was a stud or commercial breeder, the data for stud and commercial breeders were analysed separately.

Relationships among variables were limited to two-way interactions due to the limited number of responses within breeder enterprise (stud or commercial), so data were analysed using chi-squared tests for contingency tables. It was necessary to amalgamate categories for many variables to ensure sufficient cell numbers within the tables. In cases where expected numbers for some cells were less than 5, permutation tests were performed to verify the results of the chi-squared test. Values have been presented as $P<0.001$ is considered highly significant, $P<0.10$ is significant and $P>0.10$ is not statistically significant.

The following category amalgamations were applied.

- Herd size (**Q1**) was collapsed from 4 categories to 3 (<200, 200-500, >500 females) for stud enterprises and remained at 4 categories (<200, 200-500, 500-1000, >1000 females) for commercial enterprises

- Region as based on postcode (**Q2**) was grouped into 4 categories –

    1. north (NQ/NT/WA) with postcodes >=4800 and 0850-0899;

    2. central (CQ) with postcodes 4670-4799;

    3. south/south east (SE) with postcodes 4000-4387 and 4500-4660; and

    4. south-west (SW) with postcodes 4388-4499 and various codes (see appendix IV).

- Respondent age (**Q3b**) was collapsed from 5 categories to 4 (20 to 35-years-old, 36 to 50-years-old, 51 to 65-years-old, and >65-years-old)

- Breeding program (**Q4a**) was collapsed from 3 categories to 2 (straight breeding and other (composite & cross breeding))

- Price for replacement bulls (**Q6**) was collapsed from 7 categories to 3 categories (<$5000 (A-E), $5000-8000 (F) and >$8000 (G)) for stud enterprises and to 4

categories (minimal cost <$2500 (A-D), $2500-5000 (E), $5000-8000 (F) and >$8000 (G)) for commercial enterprises

- Number of purchase bulls per year (**Q7a**) was collapsed from 5 categories to 3 (1, 2-5 and >5 bulls)
- Bull % (**Q7b**) was collapsed from 7 categories to 4 (<=2%, 2.5%, 3% and >3%)
- Bull purchase age (**Q8a**) was collapsed from 4 categories to 2 (<2 and >=2-years-old)
- Bull cull age (**Q8b**) was collapsed from 4 categories to 3 (3-4, 5-8 and >9-years-old)
- Rating scales (0-9; **Q12**/**Q20**, **Q13**/**Q21** and **Q18**/**Q23**) – '0' (N/A) was excluded and 1-9 collapsed to 3 categories (little (1-3), some/fairly (4-6) and considerable/extremely (7-9))
- Reasons for not using $EBVs (**Q17**/**Q22**) was collapsed from 7 categories to 3 (doesn't work (A), accuracy (B-D) and relevancy (E-G))
- Options B & C of **Q24a** were combined as 'No', the target market specifications haven't changed.

4 Results

Surveys were conducted during a period of extreme drought conditions across the majority of northern Australia which made interviewer/respondent connections difficult with beef producers placing priority on available time for cattle management

4.1 Phone survey responses

Two hundred and ninety three (293) responses were recorded by the interview team from stud and commercial breeders identified by the following categories:

Table 1. Percentage and [number] of stud and commercial breeder respondents by herd size.

Stud Breeders # Note: 2 respondents did not indicate herd size	**Breeders**	**Number of respondents [n=109] #**
	Less than 200 head	44% [48]
	200-500 head	32% [35]
	Greater than 500 head	22% [24]
Commercial Breeders # Note: 1 respondent did not indicate herd size		**[n=230] #**
	Less than 200 head	15% [34]
	200-500 head	35% [81]
	500-1,000 head	23% [52]
	Greater than 1,000 head	27% [62]

Forty (46) breeders completed their responses as having both stud and commercial cattle; hence they responded to all questions.

Demographics

For the comparative analyses all postcodes were grouped into four broad regions: South East (SE), South West (SW), Central Queensland (CQ) and North Queensland, Northern Territory and West Australia (NQ/NT/WA) regions (Appendix IV). The groupings were made due to smaller response numbers in some regions, similarities of production system and herd size.

The distribution of the 293 respondents across these four grouped regions were as follows and using the postcode by pooled regions (Table 2) and depicted in Appendix IV.

Table 2. Percentage and [number] of stud and commercial respondents by pooled region categories.

Pooled Regions	Stud	Commercial
SE	25% [27]	22% [50]
SW	36% [39]	50% [115]
CQ	30% [33]	17% [39]
NQ/NT/WA	9% [10]	11% [26]

Of the 330 individuals contributing to the 293 responding businesses recorded (some had both partners contributing information) there were 86 males and 23 females involved in stud breeding, and 182 males and 45 females involved in commercial enterprises (three respondents were not recorded). 50% of stud breeders and 58% of commercial breeders were older than 51 years old (Table 3). Almost 95 % of respondents were owner operators of the beef enterprise implying a high level of direct responsibility for breeding and genetic selection decisions. The relative differences for those involved in stud breeding were managers (8) and owners (101), whilst in commercial breeding it was managers (10) and owners (220).

Table 3. Percentage and [number] of stud and commercial enterprises respondents according to Age categories.

Age categories	Stud	Commercial
20-35 years old	13% [14]	14% [30]
36-50 years old	38% [41]	29% [62]
51-65 years old	32% [35]	40% [86]
66-75 years old	17% [18]	15% [32]
>76 years old	1% [1]	3% [7]

Bull selection and culling practices

The majority (72%) of stud breeders are solely straight breeding ie within breed. The majority of commercial herds (64%) are using crossbreeding/composite breeding systems in at least part of their enterprise (Table 4).

Table 4. Percentage and [number] of respondents by stud and commercial focus according to their breeding system.

Breeding system	Stud	Commercial
Straight-breeding	72% [78]	36% [83]
Crossbreeding/composite	5% [5]	51% [117]
Mixture of both	24% [2]	13% [30]

About 66% of the stud breeders identified their budgeted average price for spending on replacement bulls was greater than $8,000 / bull in contrast with 25% of commercial breeders. Most commercial breeders (46%) have an average budgeted price of $2,500-5,000/ bull with a further 18% spending $5,000 - $8000 / bull. Only 6% of stud breeders and 3% of commercial breeders keep their own bulls to be future herd sires.

No significant relationships could be found between age or gender of the breeder and price they paid for replacement bulls in either the stud or commercial sectors or if sectors were pooled. Price paid for replacement bulls was not related to breed group (straight breeding or cross breeding / composites) for stud breeders. However, there was a significant relationship ($P>0.01$) between breed group (straight breeding and others (cross breeding and composite breeding)) and the price paid in the commercial industry A greater proportion of straight breeders (35%) and fewer 'other' breeders (18%) paid more than $8,000 / bull. In contrast, a greater proportion of the 'other' breeders (67%) and fewer of the straight breeders (43%) paid $2,500 to $5,000 / bull. 6% of stud breeders and 3.8% of commercial breeders either keep their own male calves or buy another property's uncastrated male calves to ultimately use as replacement bulls.

Within the stud sector of the industry, 89% of breeders purchase either one to 5 bulls per year. For the commercial industry, about 71% of breeders purchase 1-5 bulls per year and an additional 20% of breeders purchase between 6 and 20 bulls per year.

Amongst the stud breeders, 27%, 32% and 30% mated bulls at 2, 2.5% and 3% respectively (Table 5). Some stud breeders are mating bulls at 5% and greater, but this may be a reflection of breeder group, herd and paddock sizes. In contrast, in the commercial component of the beef industry, 21%, 24% and 40% mate bulls at 2, 2.5% and 3% respectively. There were no significant differences between herd size and mating percentage of bulls in the stud sector. 10% of commercial breeders are mating bulls at 4% and a further 4% of breeders were using mating loads of 5% and greater. There was a significant ($P<0.001$) relationship between herd size and mating load in the commercial industry - 57% of beef producers are mating with 2% or less bulls and 13% of producers are mating at less than 3% bulls in herds with fewer than 200 head while in herds greater than 1000 head 13% of commercial breeders were mating with 2% or less bulls and 46% were mating with 3% bulls. Across both sectors of the industry, 86% of breeders indicated they were mating their sires at between 2 and 3% bull to female mating ratios (Table 5). The greater the number of bulls:females, the poorer the selection intensity. The majority of producers are using bull percentages close to that recommended by the Australian Cattle Veterinarians which is a 2.5% mating ratio.

Table 5. Percentage and [number] of respondents from stud and commercial enterprises reporting bull percentages used.

Bull percentage used	Stud	Commercial
1%	3% [3]	3% [5]
2%	27% [27]	20% [38]
2.5%	32% [32]	25% [46]
3%	30% [30]	38% [72]
4%	6% [6]	10% [18]
5%	1% [1]	2% [4]
>5%	1% [1]	2% [3]

There was no significant relationship between percentage of bulls used in the herd and bull purchase age for either, stud, commercial or the pooled groups.

Bulls were generally purchased as 2-year-olds and retained in herds until five to eight years old (Table 6). However, commercial breeders tended to buy younger bulls and cull earlier - 20% of commercial breeders were purchasing bulls at 12-18 months-old with 72% culling at 5-8 years-old compared with 8% of stud breeders purchasing bulls at 12-18 months-old and 64% culling at 5-8-years-old.

Table 6. Percentage and [number] of respondents by bull purchase and disposal age according to stud and commercial enterprises.

	Purchase age (years)				Disposal age (years)			
Industry sector	**1**	**1.5**	**2**	**>2**	**2**	**3-4**	**5-8**	**>9**
Stud	1% [1]	7% [7]	86% [87]	6% [6]		7% [7]	64% [61]	29% [27]
Commercial	9% [18]	11% [20]	71% [135]	9% [17]	1% [2]	3% [5]	72% [129]	24% [44]

There was a trend (P=0.086) in a relationship between bull purchase age eg less than 2-year-old, and price in the stud sector; but a much stronger relationship (P<0.001) applied to those age group purchased bulls in the commercial sector.

There was no relationship (P>0.10) between age of culling and price paid for replacement bulls in either the stud or commercial sectors. However, when data for the sectors were combined, there was a significant relationship (P<0.05) with breeders prepared to spend $5000-$8000 on replacement bulls were less likely to keep bulls for 9 or more years.

There was no relationship (P>0.10) between age of culling and % of bulls used in the stud sector while there was weak evidence (P=0.071) of a relationship in the commercial sector with breeders more likely to use 2.5% bulls if keeping bulls for 9 or more years than if culling as 2-8 year olds (36% vs 24%).

Irrespective of herd size, across both stud and commercial industries, there was a significant relationship (P<0.05) between age of culling bulls and % of bulls used. The younger the culling age of bulls, the more likely the breeders are to mate at less than or equal to 2 % bulls.

The reasons indicated by respondents for culling bulls identified that stud breeders make culling decisions based on structural breakdown (47% of respondents) followed by poor performance (45% of respondents) and increased inbreeding and age (39% of respondents). Failure of a bull in a BBSE and the opportunity to access superior animals with better genetic

information each rated lowly in the stud sector in northern Australia (Table 7). In contrast, in the commercial sector of the industry respondents identified culling decisions based on structural breakdown (42%), increased inbreeding and age (27% of respondents), poor temperament (20% of respondents) followed by poor performance of a bull's calves (15%). The lesser importance of culling for poor performance in the commercial sector is possibly not surprising as pedigree information and linkage between sire and progeny is less frequently identified.

A similar percentage of respondents in both the stud and commercial sectors identified failure of a bull in a BBSE as the reason for culling (10% and 11%, respectively). These figures are not too dissimilar to the percentage of respondents who identified the 'number of calves sired in matings' as the reason for culling (5% and 7% for stud and commercial sectors, respectively).

Table 7. Percentage and [number] of respondents by the stud and commercial sectors providing reasons for culling bulls.

Reasons for culling bulls	Stud	Commercial
Breakdown in legs and joints	50% [55]	45% [103]
Breakdown in sheath and prepuce	43% [47]	38% [88]
Poor performance / quality of calves	45% [49]	15% [35]
Number of calves sired	5% [5]	7% [15]
Poor temperament	21% [23]	20% [45]
Failure in a BBSE	4% [11]	11% [26]
Too old / being mated to daughters (increased inbreeding)	39% [42]	27% [62]
Opportunity to access superior animals/better genetic data	16% [17]	10% [23]
Total number of respondents	**109**	**230**

Apart from the reason of "Breakdown in legs and joints" in the commercial sector, there was no relationship between age of culling and reason for culling in either the stud or commercial sector.

Bull selection

Respondents were asked to identify reasons for making selection decisions in their herds. These reasons were divided into current decisions, potential traits for selection if available, and possible selection decisions in the future eg. 10 years later.

Stud breeders identified the following traits as part of their current bull selection decisions (percentage of respondents in parentheses): structural soundness of legs, feet and joints (75%), Conformation eg backline (64%), Temperament / docility (62%), Breedplan EBVs (53%), Physical measures eg. Ultra sound scan data, birth weight etc (43%) and Scrotal circumference (39%). Poll status and the degree of muscling were both identified by 34% of respondents while semen % normal spermatozoa was only identified by 27% of respondents. The commercial industry most frequently identified temperament / docility, structural soundness and conformation as the major traits in their selection criteria (identified by more than 77% of respondents). The use of Breedplan EBVs was identified by more than 52% of respondents. The degree of visual muscling, poll status, scrotal circumference, physical measures, animal appearance and % normal spermatozoa were also identified as important. Further, the breed of the bull and the stud name and cost / price of replacement bulls were important criteria as used by breeders in the commercial sector of the industry.

The stud sector indicated that the traits they would like to include in selection decisions if suitable bulls were available included Breedplan EBVs and polledness in bulls. Although the commercial sector also identified these traits, temperament and the breeder cow's herd

background data were identified by more respondents. To a lesser degree, % normal spermatozoa information and Intramuscular fat % were also identified.

Future selection criteria in the stud sector included a focus on structural soundness of feet, legs and joints as the major trait. Temperament, conformation and Breedplan EBVs were the next most important traits followed by physical measures, scrotal circumference, polledness and degree of muscling. A very few respondents identified an increase in the use of genomic breeding values and $Index EBVs. Similarly the commercial industry identified temperament, structural soundness and conformation as the three major selection criteria for the future (which similarly were identified as the most important immediate selection criteria). . These were followed by Breedplan EBVs, the stud name, degree of muscling, breed, physical measures of traits and polledness. Only a few commercial breeders identified the use of DNA trait markers / SNPs as potential new selection tools.

Use of Breedplan by stud breeders to generate EBVs

The 108 stud breeders were initially asked to indicate their involvement with Breedplan but eight gave no response. 57% of stud breeder respondents have either never recorded and submitted data or ceased recording data for Breedplan genetic analyses (Table 8). Eleven % of studs have some ambivalence towards the use of EBVs whilst 28% have a substantial interest by recording all EBVs and/or apply them in their selection decisions.

Table 8. Stud breeder involvement with Breedplan and EBVs as a genetic analyses.

Stud involvement	**% of studs**
Never have recorded and submitted Breedplan data	43
Originally a member, but subsequently ceased recording / resigned	14
Currently record limited EBVs	11
Currently record all EBVs available in my breed	4
Only use EBVs as a marketing tool to sell bulls	4
Totally committed, recording and applying EBVs in my herd	24

In the stud industry, excluding the ‘not applicable’ response, there was a significant ($P<0.001$) relationship between the respondent’s level of involvement and importance assigned to Breedplan. Of those not involved in Breedplan, (42%) rated it as little use and 42% as some use. Of those with limited involvement, almost 75% indicated Breedplan was of some use and similarly about 75% of those with substantial involvement rated it highly through to ‘depend on it’.

Use of Breedplan to assist with bull selection

All breeders were asked to rate “How important do you rate Breedplan information as part of your selection criteria (scale 0-9)”

There was no relationship ($P>0.10$) between industry sector and assigned importance of Breedplan with 28 and 36% of stud and commercial breeders, respectively, indicating they had a high dependence on Breedplan information (scores 7-9) and 21 and 18%, respectively, indicating it was of little value (scores 1-3) (Table 9). The average importance rating was 4.3 for stud breeders and 4.6 for commercial breeders. Further, there was no relationship ($P>0.10$) between the age of the respondent and importance assigned to Breedplan for either the stud or commercial sectors.

Of particular concern are the stud and commercial breeders (22 and 19%, respectively), that indicated Breedplan was not applicable. In contrast, there are about 31% of studs and 26% of commercial breeders that use Breedplan information as additional selection information or when the data is available on bulls at the time of purchasing replacement sires.

Table 9. Percentage and [number] of respondents by the stud and commercial sectors allocating level of importance to Breedplan information in selection decisions.

Importance of Breedplan	Stud [n=102]	Commercial [n=191]
0 = Not applicable	22% [22]	19% [36]
1 = little dependence	7% [7]	8% [16]
2	4% [4]	3% [5]
3	10% [10]	7% [13]
4	2% [2]	6% [12]
5 = Use it sometimes	22% [22]	10% [20]
6	7% [7]	10% [20]
7 = great dependence	6% [6]	13% [25]
8	11% [11]	9% [18]
9 = Depend on it for selection	11% [11]	14% [26]

There was no relationship found between any of the age groupings of respondents for both stud and commercial breeders and their value assigned to Breedplan.

To gain an indication of the stud and commercial industry attitudes to emphasis being placed by breeders on genomic information eg DNA markers or Molecular Value Prediction (MVPs), they were asked to rank their dependence on a 0-9 scale of “not applicable” to “depend on it” (Table 10).

There was no relationship (P>0.10) between industry sector and dependence on genomic information with only 15% of each stud and commercial breeders indicating they had a high dependence (scores 7-9) on genomic information. In contrast, 36 and 29%, respectively, indicated it was not applicable and 27% and 36% respectively, that it was of little value (scores 1-3) (Table 10). This would suggest that both the stud and commercial sectors of the beef industry presently place little emphasis on genomic information.

Table 10. Percentage and [number] of respondents by the stud and commercial sectors allocating emphasis on genomic information in selection decisions.

Importance of Genomic data	Stud [n= 102]	Commercial [n= 177]
0 = not applicable	36% [37]	29% [51]
1 = little dependence	14% [14]	19% [34]
2	8% [8]	10% [17]
3	5% [5]	7% [13]
4	8% [8]	7% [13]
5 = Use it sometimes	7% [7]	7% [12]
6	8% [8]	6% [10]
7 = great dependence	6% [6]	6% [11]
8	8% [8]	6% [10]
9 = Depend on it for selection	1% [1]	3% [6]

In total 37% of stud breeders indicated that genomic information was 'not applicable'. Of these 62% were not involved in Breedplan as a selection tool. There was no relationship between how great their dependence on genomic information and if they were involved in Breedplan.

Stud and commercial breeders rate their dependence on genomic information very similarly. There was no relationship between straight breeding and cross breeding and their dependence on genomic data.

The 44 stud breeders who indicated they have never recorded data in Breedplan indicated that Breedplan does not work (41%) and they have insufficient time to collect the data (37%) (Table 11).

Table 11. Percentage and [number] of studs that have never been in Breedplan and identified their concerns.

Stud involvement	**Studs [n=41]**
I don't think it works -taking physical data to EBVs	41% [17]
Insufficient bulls available with data	-
I don't understand EBVs	2% [1]
I'm not interested/I'm too old	5% [2]
Time/resource limitations to collect and submit data	37% [15]
Turnaround time from submitting data to analyses is too long	2% [1]
Does not rank our bulls in the correct order of merit	-
Does not work for 100% of animals	5% [2]
# Breedplan stacks genetics and may not translate to physical gains	2% [1]
No/minimal financial rewards for sale animals	5% [2]

Breedplan uses animal pedigrees and the associated animal Estimated Breeding Values to predict the genetic values of relatives.

Of the 14 stud breeders that have ceased recording in Breedplan, their main reasons for ceasing were the belief that Breedplan does not work (converting physical measures to EBVs) and that there was little or no financial reward from sale animals (Table 12).

Table 12. Percentage and [number] of studs identifying reasons for ceasing to record performance data with Breedplan

Stud involvement	**Studs [n=14]**
I don't think it works -taking physical data to EBVs	43% [6]
Insufficient bulls available with data	-
I don't understand EBVs	-
I'm not interested/I'm too old	-
I have insufficient time to collect and submit data	14% [2]
Turnaround time from submitting data to analyses is too long	-
Does not rank our bulls in the correct order of merit	14% [2]
Does not work for 100% of animals	7% [1]
Breedplan stacks genetics and may not translate to physical gains	-
No /minimal financial rewards for sale animals	36% [5]

Twenty three (23) stud breeders responded with reasons why they were still recording and submitting Breedplan data, and the opportunities for improvement. The main reasons given were that it ranks animals better than raw data measures (48% of respondents) and that it stacks genetics effectively (43% of respondents). However there is a need to improve herds

with poor recording practices and some would like to see an increased range of economically important traits available for analyses and a more rapid inclusion of genomic information into Breedplan (Table 13).

Table 13. Percentage and [number] of stud breeders providing reasons for continuing to submit data into Breedplan and opportunities to improve the system.

Stud involvement	**Studs [n=23]**
Actually ranks animals far better than raw data	48% [11]
Breedplan stacks genetics effectively	43% [10]
Monthly 'runs' are timely/analyses superior to the annual 'run'	-
Need a common EBV base across breeds	-
Need a standardised availability of traits across breeds	13% [3]
Need to improve herds with poor recording practices	43% [10]
Need more rapid inclusion of genomic information into EBVs	22% [5]
Need an improved range of traits in $Index EBVs	4% [1]
Need to increase the range of economically important traits	30% [7]

The Breedplan traits used by stud breeders to assist in selection decisions were, in order of frequency of response:

Weight traits – weaner weight (200 day), yearling weight (400 day) and final weight (600 day), Date of birth, Scrotal size at yearling age and Poll / Horn status. The fertility trait of semen crush side assessment was of higher importance than percent normal spermatozoa. The carcase traits identified were eye muscle area, rib fat, rump fat and intra muscular fat (Appendix III a). Days to Calving as a separate fertility trait was not specifically identified by any of the respondents.

Stud breeders believe that their customers wish to purchase docile bulls as the most important trait (Appendix III b). Carcase traits such as eye muscle area and intra muscular fat %, fertility traits such as scrotal circumference measurements and semen morphology measures, limited EBVs and poll / horn status were traits also believed to be required by the buyers.

Stud and commercial breeders rated the use of $Indexes similarly ($P>0.10$) with 24% of stud breeders and 31% of commercial breeders indicating they used $Indexes in their selection criteria. About 30% of stud breeders not using $Indexes either "do not think they work" or "are not interested" (Table 14). Reasons identified by commercial breeders for not-using $Indexes were equally distributed (about 23% each) between "I am not interested", "I don't know the weightings of the various traits in the $Index", "I place emphasis on other traits not included in the Index" and "Insufficient bulls are available with the data". When the reasons were grouped into three broad categories (don't work, poor accuracy and not relevant), a significant relationship ($P<0.001$) between the categories and enterprise type was evident with a greater proportion of stud than commercial breeders indicating that $Indexes do not work (30% versus 2%, respectively).

Table 14. Percentage and [number] of respondents by the stud and commercial enterprises who provided reasons for lack of use of $Indexes .

Reasons for not using $Indexes	**Studs (n=109)**	**Commercial (n=230)**
No response	[63]	[187]
Don't work		
I don't think they work	30% [14]	2% [1]
Poor accuracy		
Insufficient bulls are available with the data	17% [8]	19% [8]
Breeders I know only guess submitted data	2% [1]	2% [1]
I don't know the weighting on the various traits	2% [1]	23% [10]
Not relevant		
I don't think they are relevant	11% [5]	5% [2]
I'm not interested	28% [13]	26% [11]
I place emphasis on other traits not included in $Indexes	9% [4]	23% [10]

Breeders were asked to rate their confidence in using available selection tools in setting the herds breeding objectives to achieve progressive financial improvement in the enterprise. The average confidence score on a scale of 0 to 9 of stud and commercial breeders was 6.8 and 5.2 respectively. Confidence in the use of selection tools was related ($P<0.001$) to sector. The majority of stud breeders (69%) considered they were very to extremely confident (scores 7-9) in the use of selection tools (Table 15). In contrast, the commercial breeders were more evenly distributed across the confidence levels with 45% very to extremely confident and 26% with little or no confidence. This confidence in available selection tools (potentially perceived by the producers in a broad sense) and therefore may well be interpreted by breeders to include many more aspects other than just Breedplan, $Indexes, EBVs, genomic data and semen morphology information. Furthermore, the respondents were not asked to specify their herd's breeding objectives relative to target markets. These objectives may be very different to those defined as part of $Indexes and therefore very different levels of confidence identified than potentially anticipated relative to the selection criteria used in selection.

Confidence in using the various selection tools was not related to the age, herd size or gender of respondents for both stud and commercial enterprises.

Table 15. Percentage and [number] of respondents by the stud and commercial enterprises who indicated their level of confidence in the use of available selection tools to set their herd breeding objectives for financial improvement.

Confidence in the use of available tools	**Stud [n=101** ex. No response]	**Commercial [n=153** ex.No response **]**
No response	[8]	[76]
0 = No confidence	1% [1]	7% [10]
1	1% [1]	6% [9]
2 = Little confidence	2% [2]	7% [10]
3	3% [3]	7% [11]
4	2% [2]	7% [10]
5 = Fairly confident	11% [11]	14% [21]
6	11% [11]	8% [13]
7	29% [29]	29% [44]
8	26% [26]	12% [19]
9 = Extremely confident	15% [15]	4% [6]

The high percentage (33%) of the commercial breeders “not responding” is possibly an indication of their lack of understanding and business commitment thereby an inability to indicate a confidence level in selection tools and the establishment of breeding objectives relative to financial improvement in the herd. Within stud breeders, there is a slight relationship (P=0.070) between level of confidence expressed by respondents and their use of selection tools for setting the herd’s breeding objectives relative to those having limited confidence. Stud breeders were more confident in their use than commercial breeders with more stud breeders 'extremely confident' and fewer with 'little confidence'. The mean confidence score was significantly higher for stud (6.9 +/- 0.17) than for commercial breeders (5.6 +/- 0.19) (from t-test).

There was no relationship between stud and commercial sectors and reported change in their target market specifications. 45% and 56% of stud breeders and commercial producers respectively, believe they have changed their target market therefore affecting their breeding selection criteria. Thirty-three percent of the commercial breeders compared with 6% of stud breeders chose not to respond to this question.

Eighty-four percent of the stud breeders sold bulls into northern Australia (6% no response).

There was a significant relationship (P<0.001) between stud and commercial breeders and their ability to demonstrate their use of the selection tools. Over 89% of the stud breeders and only 61% of the commercial breeders indicated they could demonstrate increased profitability as a result of their selection decisions (Table 16).

There was no relationship) between the stud breeders perceived ability to demonstrate the impact of their bull selection decisions and their assigned importance to Breedplan. However, there was a relationship (P<0.05) between the stud breeder’s perceived ability to demonstrate the impact of their bull selection decisions and their confidence in using selection tools. The more limited the stud breeders confidence in using the selection tools, the less their perceived ability to demonstrate the benefits in their herd.

Commercial breeders who were able to demonstrate profitability were more likely to have confidence in using selection tools compared with those who could not demonstrate profitability (17% compared with 41%, respectively), and had little or no confidence in using selection tools.

Table 16. Percentage and [number] of respondents by the stud and commercial enterprises who indicated they believed their selection criteria decisions result in making their herd more profitable.

Selection criteria increasing profitability	Stud [n= 94]	Commercial [n= 151]
No response	15	79
No	11% [10]	39% [59]
Yes	89% [84]	61% [92]

4.2 Electronic survey of stud breeders

In addition to the 293 personal interviews, about 3,000 surveys were emailed to stud breeders following approval from breed societies. These studs were independent of those contacted in the phone survey. ‘Survey Monkey’ was used as the platform to disseminate and process these electronic surveys (Appendix Ib) that attracted 233 responses from stud

breeders across Australia. This 8% response rate is markedly less than the 33% achieved following a mailed survey by O'Rourke *et al* (1992). However, the number of respondents are considerably more than those used in the survey conducted by Blakeley (2002) (142 respondents) who focussed on reproduction, genetics and animal health issues for beef producers in northern Australia. The respondents compliment the northern stud breeder's attitudes and perceptions regarding breeding and genetics decisions being made from a much wider geographically dispersed sample population. Not all respondents completed every question in the electronic survey. Of the 233 responses, 70% were male and 42% were Breedplan members.

Of the 227 stud breeders identifying their age, the majority (55%) were between 45 and 64 - years-old, followed by 19% in the 65 to 74-year-old age group and 9% were less than 34-years-old. Sixty five percent (65%) of the survey respondents have herds that comprise less than 200 head as shown in table 17.

Table 17. Percentage and [number] of stud breeders by herd size

Herd size range	Number of respondents [n=222]
Less than 50 head	27.9% [62]
51-200 head	36.9% [82]
200-500 head	19.4% [43]
Greater than 500 head	15.8% [35]

Of these respondents, about 21.6% of breeders send eleven or more bulls into northern Australia each year (Table 18). Northern Australia was defined as Queensland, the Northern Territory and the top half of Western Australia

Table 18. Percentage and [number] of stud breeders selling bulls into northern Australia each year.

Breed society members sending bulls into northern Australia	Total responses [n=222]
No bulls sent to Northern Australia	46.0% [102]
A small number (1-5) sent very occasionally and not every year	17.1% [38]
Between 1 and 10 bulls	15.3% [34]
11 to 50 bulls	11.3% [25]
50 to 200 bulls	7.7% [17]
Greater than 200 bulls	2.7% [6]

Of the 195 respondents that rated the importance of BREEDPLAN EBVs as part of their selection criteria, the average response was 5.4 with 70% of respondents rating EBVs between 5 and 9 (Table19). However, only 54% of respondents identified Breedplan EBVs as how they arrive at a selection decision for each bull entering their breeding program. There are an additional 18% of respondents that identified $Index EBVs as their selection criteria which may indicate why 70% allocated them a rating of "some value to highly important".

Table 19. Percentage and [number] of stud breeders rating the importance of EBVs in their selection criteria.

Rating identified by respondents	% and No. respondents (n= 195)
0= not applicable	3.6% [7]
1 = little value, not used	19.0% [37]
2	1.5% [3]
3	3.6% [7]
4	2.1% [4]
5 = Some value ie use some of the information or occasionally	14.9% [29]
6	12.3% [24]
7	13.3% [26]
8	10.8% [21]
9 = Highly important	19.0% [37]

When asked to rate the importance of $Index EBVs as part of their selection criteria, the 195 respondents in the electronic survey averaged 4.13 with 32% rating the Indexes as 'not applicable or not used'. 52% rated $Indexes between 5 and 9.

Table 20. Percentage and [number] of stud breeders rating the importance of $Indexes in their selection criteria.

their selection criteria.**Rating identified by respondents**	% and No. respondents (n=195)
0= not applicable	5.1% [10]
1 = little value, not used	27.2% [53]
2	5.1% [10]
3	3.1% [6]
4	7.7% [15]
5 = Some value ie use some of the information or occasionally	18.5% [36]
6	10.8% [21]
7	9.7% [19]
8	5.1% [10]
9 = Highly important	7.7% [15]

Of the 194 respondents rating the importance of genomic information as part of their selection criteria (using a 0 [not applicable], to 9 [highly important]), the average was 3.8 with 44% of respondents rating genomic information between 5 and 9 (Table 21). 38% of breeders place little dependence (1-3 ratings) on genomic information.

Table 21. Percentage and [number] of stud breeders rating the importance of DNA and genomic information (DNA marker or MVP) in their selection criteria.

Rating identified by respondents	% and No. respondents (n=194)
0= not applicable	6.2% [12]
1 = little value, not used	27.3% [53]
2	4.6% [9]
3	9.3% [18]
4	8.8% [17]
5 = Some value ie use some of the information or occasionally	17.5% [34]
6	9.3% [18]
7	6.7% [13]
8	5.2% [10]
9 = Highly important	5.2% [10]

Those studs that have either not recorded or ceased recording with Breedplan, were asked to indicate their attitude to this technology in their cattle breeding. Of the 104 that answered this question, the major concern was the perceived lack of financial rewards for the sale of animals with EBVs (46% of respondents) followed by the perceived cost being too high (34%). The lack of time for breeders to collect and submit data and lack of confidence that Breedplan works and does not translate into actual production gains were the next major concerns (Table 22).

Table 22. Percentage and [number] of stud breeders who have not recorded or ceased recording data for Breedplan and have concerns about the role of Breedplan in their selection criteria.

Attitudes to the value of Breedplan	% and No. respondents (n=104)
I don't think Breedplan works ie taking physical data to EBVs	27.9% [29]
Insufficient bulls available with EBVs in my breed	20.2% [21]
I don't understand EBVs	7.7% [8]
I'm not interested	12.5% [13]
I'm too old	3.9% [4]
I have insufficient time to collect and submit data	29.8% [31]
Turnaround time from submitting data to analyses is too long	3.9% [4]
Does not rank bulls in the correct order of genetic merit	11.5% [12]
Does not work for 100% of animals	19.2% [20]
BREEDPLAN stacks genetics and does not translate to actual production gains	27.9% [29]
No / minimal rewards for sale of animals with EBVs	46.2% [48]
Cost too high	33.7% [35]

Stud breeders that are members of Breedplan were asked to indicate the aspects of Breedplan they think could be improved (Table 23). The most commonly mentioned potential improvements were across breed comparisons, improved recording of Breedplan practices within herd, and standardised availability of traits across breeds.

Table 23. Percentage and [number] of stud breeders in Breedplan and who expressed ideas to improve the genetic analyses.

Rating identified by respondents	% and No. respondents (n=88)
Produce Breedplan EBVs that allow comparison across breeds rather than within breed	56.8% [50]
Standardise the availability of traits across breeds	48.9% [43]
More regular Breedplan analyses i.e. weekly	5.7% [5]
Improve the Breedplan recording practices of herds	51.1% [45]
Shorten the time it takes to implement new technology into Breedplan e.g. use of Genomics	33.0% [29]
Improve selection $Index EBVs	29.6% [26]
Expand the range of traits analysed	21.6% [19]

Of the 179 stud breeders indicating their confidence in various selection tools, the average confidence score was 4.83 with a relatively even distribution between those that were either extremely confident, fairly confident or little confidence (33%, 33% and 30% respectively) as shown in table 24.

Table 24. Percentage and [number] of stud breeders recording their confidence in the use of available selection tools (EBVs, Indexes, genomics) to achieve progressive genetic improvement in their beef enterprise and that of their bull buying clients?.

Rating identified by Stud	% and No. respondents (n=179)
No confidence	4.5% [8]
1 = Little confidence	12.3% [22]
2	6.2% [11]
3	11.2% [20]
4	8.9% [16]
5 = Fairly confident	16.2% [29]
6	7.82% [14]
7 = great confidence	13.4% [24]
8	8.9% [16]
9 = Extremly confident	10.6% [19]

Stud breeders were asked if they sold bulls into northern Australia and how their clients selected bulls. The frequency of the major traits identified by 113 respondents were visual appeal (74%), leg and feet structure (66%), temperament / docility (59%), polledness (53%), bull breeder reputation – follow up service (49%), bone - not fine boned and frame score / size (45%), and scrotal circumference (43%). These are in contrast with Breedplan EBVs

e.g. full component of Breedplan EBVs, EBVs with weights and $Indexes which were 15%, 7% and 5% respectively as criteria of much lesser perceived importance.

4.3 Discussion

During the survey period much of northern Australia was under severe drought with producers' available time at a premium due to managing nutritional deficiency particularly through 2013 and up to February 2014.

Previous beef industry reports addressing beef production issues in northern Australia, have identified the variable and often ineffective use of genetic information in selection decisions by beef producers. Relatively recent northern industry reports again cite the unprofitable economic plight of many beef producers (McCosker *et al*, 2010 and McLean *et al* 2014). The major limitations to higher income per Adult Equivalent in northern Australia are poor reproductive rates, high calf mortality and lower sale live weights following lower growth rates according to McLean et al (2014). Various research studies (Bullpower, CRC III Beef Quality, Cash Cow studies and McGowan *et al* (2014)) have shown both the low levels of reproductive performance and the potential opportunities to make significant improvements in herd fertility initially through bull selection. The Australian standards for BBSE provide beef producers with a national phenotypic bull fertility language and the opportunity to establish minimal acceptable fertility criteria for their bull purchases. The opportunity to set standards and the responsibility to apply them, lies clearly with beef producers in their search for increased herd profitability. The current study has identified a generally poorly defined focus by beef producers (stud and commercial) and in some instances a negative attitude towards the measurement and implementation of genetic information to specifically improve reproductive rate using fertility measures.

4.3.1 Demographics and bull management

Survey response rates and sector representation

Of the 293 individual producer responses in the phone survey of northern Australia out of a possible 821 candidates available to the interviewers. Some candidates ultimately did not qualify due to having sold all cattle, too few numbers, no interest in cooperating and inability to identify a suitable time. In total 33% of respondents represented the stud industry. An additional 233 responses were received from the email survey sent to about 3,000 stud breeders across Australia (excluding the top end of Western Australia) with the majority in southern states. The email response rate (8%) was very low with incomplete responses. No respondents answered both surveys as the phone survey participants were excluded from the email survey. This highlights the limits of this approach. It also questions the representativeness of the email survey responses and the data should therefore be interpreted cautiously.

The geographic spread of phone survey respondents was South East Queensland (23%), South West Queensland (46%), Central Queensland (21%), North Queensland, Northern territory and the top of Western Australia (11% combined). The majority (95%) of the businesses were owner operators.

In both surveys, respondents were primarily males between the ages of 36 – 65-years-old. Relative to the phone survey, 19% more females answered the email survey. Overall, both groups are reasonably comparable. In the MLA 2002 report, 82% of respondents were male and 67% of respondents were older than 41-years-old.

Bull selection and culling practices

Herd size

44% of stud breeders in northern Australia and 65% the southern stud breeders reported less than 200 head. In contrast, only 15% of commercial breeders have less than 200 head. Whilst there are greater numbers in individual northern studs which benefits the size of management groups, the real genetic comparisons will depend on husbandry practices applied to the mating's. With 50% of commercial breeders having more than 500 head, the benefit from more objective selection practices becomes increasingly important, especially the opportunity for improved reproductive potential identified by McGowan et (2013) and the focus on increased Kg beef turned off / AE as highlighted by McLean et al (2014).

The cattle breeds of the northern beef industry have changed significantly from predominantly *Bos Taurus* (British) base in the 1950s (Beattie 1956) to a more *Bos Indicus* based herd. In the last decade, the majority of commercial herds in northern Australia are cross breeding to generate either first cross or some composite mixture of genotypes similar to that reported by Bortolussi, *et al* (2005b) and supported by (63%) of commercial herds crossbreeding in this study. However, Bortolussi et al (2005b) reported that much of the crossbreeding that is carried out is also unstructured or with ill-defined goals. This latter observation is consistent with the relatively high frequency of subjective traits identified by respondents in this study and the commercial industry's confidence rating of 5.2 in using available selection tools. However, the incorporation of 'other breeds' could potentially be associated with the better fertility or eating quality of composites over straight Brahmans. Also, it is not clear if the cross breeding will persist once a stabilized composite is achieved.

In the northern stud breeding industry, the majority of breeders spend greater than $8,000/replacement bull with structural soundness, conformation and temperament being most frequently identified as driving their selection criteria. Breedplan EBVs and fertility measures (Bull Breeding Soundness Evaluation report, scrotal circumference measures and Semen % normal spermatozoa) each respectively attracted decreasing importance as selection criteria affecting price paid. There was some indication that bulls older than 2-year-old attracted a price tag of more than $8,000/bull. In contrast with the 109 northern stud breeders supplying bulls into the industry, 46% (102) of the southern studs do not send bulls into northern Australia but 22% sell more than 11 bulls per year into the north. However, the survey did not allow us to define whether these bulls were tropically adapted or had genetic or fertility information associated with them. The 2004 Northern Territory pastoral survey has indicated that purchased bulls were most commonly sourced from Queensland.

From the phone survey focussing on the north, 89% and 85% of stud and commercial breeders respectively are mating bulls at between two and three percent of bulls to females. The mating percentage is not related to age of purchase of the bulls which is generally 2-year-old. However, 20% of commercial breeders are purchasing younger bulls at 12 to 18-months-old. These mating percentages are consistent with the Australian Veterinary Association, Cattle Veterinary BBSE standards given variations in herd and paddock sizes.

The Northern Territory survey (2004) data indicates that those producers use on average 4.3% bulls in an environment that is very extensive by nature and potentially influenced by the ineffectiveness of mustering and the retention of 'mickey' bulls as well as a perceived cost saving. Cost was identified, as a selection criteria, by 40% of commercial respondents, in this phone survey.

Oddy, (2002) found 35% of the 142 respondents 'bred bulls for their own use'. However, the common use of 'bull multiplier herds', with the retention of the "tops" of their male calves, has not been supported by the current study. Only 6% of studs and 3% of the commercial herds either 'kept their own male calves' or 'purchase another properties uncastrated male calves/yearlings at a low price'. This reduction leaves the question either "does the northern

industry no longer recognise the impact of ineffective musters (particularly male calves)" or "is the industry insufficiently objective to be able to quantify the origin of all their bull power" or "has the percentage of retained males / low cost bulls really declined as reported"?.

The older the age of culling herd sires, the lower is the genetic progress in the herd. Bortolussi *et al* (2005b) reported similar ages of culling to the current phone survey, peaking at 6 to 8 years old. In the commercial industry there is a significant relationship between age of culling and "breakdown in legs and feet" with fewer bulls being culled as 3 to 4-year-olds. This structural breakdown in bulls may be impacting on the selection decisions of many stud and commercial breeders who awarded a highest priority to "Structural soundness of legs, feet, joints sheath and prepuce"

Following culling decisions based on structural breakdown, are decisions based on poor performance, concern for increased inbreeding and age of the bull. The northern commercial industry has a similar large emphasis on structural breakdown followed by increased inbreeding which is possibly unqualified given the unknown parentage of most animals and the large herd sizes. Poor temperament of the bull is of higher importance to commercial producers. Across the northern industry, there appears to be a very low reliance on either BBSE testing of bull's fertility or accessing animals with genetic fertility and growth information.

Bull selection criteria

Current bull selection criteria

A survey of primarily non-stud breeders across northern Australia by O'Rourke *et al* (1992) highlighted that 93% of producers rated superior bull selection as important. However, in that survey selection methods were generally free of objective measures and genetic differences with only 43% of producers valuing performance recording. The current study found that, while EBVs were among the top 4 traits nominated by both studs and commercial breeders, only 28% of stud breeders and 36% of commercial breeders reported high dependence on Breedplan information when selecting bulls for purchase. (The email survey, covering studs across Australia, found that 43% rate EBVs as high value.) It appears that the use of objective data for bull selection in northern Australia has not increased since the 1992 study.

Both stud and commercial producers identified temperament, structural soundness and conformation as the top three traits for bull selection, followed by EBVs. However, stud producers perceived the major priority of their clients to be temperament (58% frequency of response), with other traits such as EBVs ranked relatively lowly (24% or thereabouts). Interestingly, a similar question in the national email survey of studs found their perception of clients' priority traits to be visual appeal (74% frequency), leg and feet structure (66%), and temperament (59%), EBVs were perceived to be an infrequent priority (15% or less) for their clients.

$Indexes for specific target markets provide the beef breeder with an economic weighting presented as a single $Index combining the various currently genetically assessed traits. These $Index EBVs were low down the frequency of identification by respondents as a tool for bull selection criteria, with stud breeders identifying these as ninth most important and commercial breeders giving them little recognition in twentieth place.

The results of the current study for northern Australia are generally consistent with those aspects pertaining to breeding and genetics reported by Bortolussi *et al* (2005b). They also found regional patterns existing with *Bos Indicus* breeds being more common in herds in the northern parts of their survey area and *Bos Indicus x Bos Taurus* genotypes more popular in the southern herds

The frequency of respondents identifying structural soundness in this survey, is consistent with the greater than 90% of respondents identifying the same trait in the survey of Bortolussi *et al* (2005). Breedplan EBVs as used in selection decisions ranked fourth (53% for stud and 52%for commercial breeders) which is similar to the 52% of breeders identifying Breedplan as a bull selection criteria reported by Bortolussssi *et al* (2005) in that north Australian survey. Similarly, temperament ranked highest in the commercial industry, but in this survey ranked third in the stud industry. Polledness was about sixth order in frequency of identification by the stud sector, but was identified in fourteenth place by the commercial industry which is evidence of increased importance being placed on this trait relative to the Bortolussi *et al* (2005) survey selection criteria where it was not identified. Semen morphology was identified in ninth place by the stud sector and eleventh by the commercial industry but not identified in previous surveys.

Other desirable selection traits but suitable bulls are not available. The responses to this question failed to uncover any new traits, but rather reinforced existing tools identified by breeders. The stud sector would include Breedplan EBVs and polledness if suitable bulls were available. The commercial sector identified temperament and the breeder's cow herd background data, as well as Breedplan EBVs and percent normal spermatozoa. Polledness and intramuscular fat percent were mentioned at a relatively low frequency.

Future selection criteria.

Traits identified by respondents for future bull selection did not identify any new traits. There was a continued focus by studs on structural soundness of feet, legs and joints as the major trait. Temperament, conformation and Breedplan EBVs were the next most important. Commercial producers also signalled a future emphasis on the currently most important traits - temperament, structural soundness and conformation

Involvement with and utilisation of Breedplan

Studs recording data for input to Breedplan

57% of stud breeders have either never recorded or submitted Breedplan data, or have ceased recording data. The 43% of studs in northern Australia that are current Breedplan members was consistent with the 42% response received from across Australia in the electronic survey.

Of northern stud producers, 28% were enthusiastic recorders of data for Breedplan EBVs while 15% recorded limited EBVs. The 44% of surveyed stud breeders who have never recorded data in Breedplan identified their major concerns as 'Breedplan does not work' (42%) and 'insufficient time to collect the data' (37%). Stud breeders that have ceased recording in Breedplan identified their main reasons as the belief that 'Breedplan does not work ('converting physical measures to EBVs') and that there was 'little or no financial reward from sale animals'.

By comparison, the national email survey of studs found that, of those not registered with, or not providing data to, Breedplan, their main concerns were:

- lack of financial rewards for the sale of animals with EBVs (46%)
- cost too high (34%)
- lack of time (31%)
- lack of confidence that Breedplan works (27.9%).

Recruiting more stud herds into Breedplan will require:

- Convincing a large segment of industry that the mechanics of Breedplan are sound and reliably accelerates genetic improvement in the herd
- Establishing a clear value proposition for stud herds with respect to investing time in data collection.

The status quo will most likely see a stagnation or decline in the number of northern bulls with objective assessment of genetic merit.

The major Breedplan traits recorded by stud breeders were, in order of frequency of response: weight traits – weaning weight (200 day), yearling weight (400 day) and final weight (600 day), date of birth, scrotal size at yearling age and horn/poll status. Crush side semen assessment was more frequently mentioned than percent normal sperm. Studs that continue to submit data to Breedplan identified desirable improvements as:

- Improve those herds with poor recording practices
- Increase the range of economically important traits
- More rapid inclusion of genomic information into EBVs

This compares with the improvements identified in the national email survey:

- across breed comparisons
- Improve the Breedplan recording practices of herds
- standardised availability of traits across breeds

Use of Breedplan for selecting bulls

Of northern studs, 28% reported a high dependence on Breedplan information for selecting bulls for purchase. By comparison, the national email survey found 43% of studs rated EBVs of high value. Of commercial breeders, 36% had a high level of dependence on EBVs.

For both sectors, 70-75% of breeders did not use $Indexes for selecting bulls. Further, at this point in time the beef industry places little emphasis on genomics as a selection tool.

Blakeley (2001) reported 23% of respondents used EBVs for bull selection while Bortolussi *et al* (2005b) reported that Breedplan was used by about 50% of northern producers. In a more recent survey of reef catchment regions in Queensland, Moravek *et al* (2013) found that 48% of respondents used EBVs in their selection of bulls.

So, what does the project data indicate about current adoption of Breedplan information for bull selection? In relation to adoption rates of other technologies in beef cattle production, 28% of studs and 36% of commercial producers reporting high dependency on Breedplan would be considered moderately successful.

Does other data from the study support this level of adoption? The most frequently mentioned traits for bull selection amongst both stud and commercial producers were temperament, structural soundness and conformation (60-80% frequency). However, for both sectors EBVs were the next most frequently reported trait (50-60%). This is consistent with the apparent adoption rate of Breedplan information – EBVs should not be utilised in isolation from other important traits. However, not all data was consistent with this. Stud producers perceive that the most important trait for their customers was docility, and EBVs had a relatively low frequency of mention. Data from the national email survey of studs were consistent with this perception of low reliance on EBVs by stud clients.

Another line of evidence for likely adoption rates is data on demand and supply for tropical breed bulls in northern Australia. With 30% or more of producers having a high dependence on Breedplan information for bull selection, there appears to be a very large unmet demand

for Breedplan bulls. This concept is supported by the 48% of stud breeders and 27% of commercial breeders that identified Breedplan EBVs as selection criteria if suitable bulls (the number of available bulls) were available. One would expect studs to report an increase in requests for EBVs from clients. Further, one could expect that Breedplan bulls would attract a premium price. While there are no published data on the relative pricing of Breedplan bulls versus others, those studs who have ceased recording for Breedplan did report one of the major reasons as being lack of financial rewards for the sale of Breedplan bulls.

It appears, therefore, that at least some of the 30% or more of survey respondents who report a high dependency on Breedplan information, do not pursue the information with complete dependence and in a way that affects the supply and/or price of Breedplan bulls.

Given additional adoption is highly desirable, how can this be achieved? Unfortunately, breeders who did not value 'Breedplan information' (not applicable to 3 little value or not used) were not asked for the reasons. The 75% of breeders not valuing $indices were asked for their reasons, but the high rate of 'no reason given', especially amongst commercial producers (74% of non-users), makes it hard to infer anything with confidence. This collective indifference suggests commercial producers have little knowledge of, or interest in, $indices. For studs, 39% reported that they either did not believe in $indices, were uninterested, or thought them irrelevant. The national email survey of studs, by comparison, found that 40% put little value, and 37% put modest value, on $Indices. This may suggest that many breeders do not appreciate the financial benefits achievable in their herd if bulls are selected with economic weightings assigned to the various traits relative to the target markets.

The average confidence score for 'using selection tools and setting breeding objectives to achieve financial improvement' was 4.3 and 4.6 for northern stud and commercial breeders respectively. In studs across Australia the average confidence score was 4.8 which is only marginally better than that recorded for studs in the north. Of greater insight, was that 86% and 48% of stud and commercial sectors, respectively, reported a fair or better level of confidence in use of selection tools and setting breeding objectives. For studs, 65% were very confident. Assuming 'selection tools' was interpreted as Breedplan information, it infers that most stud breeders in particular believe they have a reasonable understanding of applying Breedplan information. If this is the case, then extension efforts should recognise this perception. It is noted that while the national email survey found 70% of studs to have fair or better levels of confidence in use of selection tools and setting breeding objectives, only 35% reported high levels of confidence.

It is also interesting that the respondents in a northern beef industry review for the development of breeding and genetics training packages, (Blakeley, 2001) rated their confidence (out of 10) in bull selection and genetics at 10 and 7.4, respectively. It is likely that confidence in bull selection is quite different to confidence in use of genetic technologies (including EBVs). There are no data in the current study on confidence in bull selection per se (i.e., in isolation from 'selection tools'). It may well be that producers remain very confident in their capacity to select bulls regardless of their dependence or understanding of EBVs and other Breedplan information. When considering the respondents confidence rating for bull selection and genetics, relative to the reports of Bortolussi *et al* (2005b) and McLean *et al* (2014), there appears to be a considerable difference between an individual's perception of his/her ability and the economic imperatives of a northern beef business.

Studies reported by Burns and Ruvie (1996), Freer *et al* (2003), Hammond (2006), Upton (2007) and as recently as Lee and Pitchford (2014) have all highlighted barriers to adoption and listed issues relevant to effective communication, reliable genetic technologies and 'proof of profit' within a diverse and fragmented beef industry. The difficulties no doubt have increased with declining government services across all states (Lee and Pitchford 2014) which puts even greater pressure on the need for 'key players' or champions (Upton 2007) providing consistent breeding and genetic messages to beef producers.

The issue of technology 'pull through' has been identified by Lee and Pitchford (2014) citing the lack of market signals from commercial beef producers back to stud breeders and possibly ultimately from the processing sector to at least the commercial industry. There is no doubt that all of the above are integrally linked to the financial benefits that follow adoption of the technologies as highlighted by Farquaharson et al (2002) and McCosker *et al* (2010).

Previous studies on adoption of genetics in grazed production systems suggest that those northern beef producers yet to adopt genetic technologies will need to be convinced about four points:

1. the importance of profit to their goals,
2. the key drivers of profit in their beef enterprise,
3. the relationship of genetics to these profit drivers, and
4. the most effective means for genetic improvement.

The increased involvement in and the associated greater importance assigned to Breedplan suggests that a closer association with the data collection and genetic outputs (EBVs), the more the individual breeders understand its power and ability to predict an animal's worth for the various traits measured. In this study in northern Australia, about 58% and 63% of stud and commercial breeders respectively indicated that they either 'used Breedplan sometimes or depended on it' which is less than the 72% of stud breeders across Australia. The responses from stud breeders across Australia indicates that 28% either consider Breedplan 'not applicable' or "it has not used or of little value". Whilst the respondents dependence on Breedplan in the Bortolussi *et al* (2005) survey cannot be deducted, there would appear to be a slight increase from their report of 52% of north Australian beef producers using Breedplan.

Commercial breeders using straight breeding were more likely to assign greater dependence on Breedplan than those using crossbreeding where heterosis would be present. Also 35 to 50-year-olds were more likely to value Breedplan than 20 to 35-year-olds.

The weighting of various traits relative to target markets as provided by $Index EBVs is available from many breed society genetic analyses. Specifically, stud and commercial breeders place similar importance on $Indexes. About 24% and 30% of stud and commercial breeders use $Indexes in their selection criteria. The fact that more commercial breeders using $Indexes is not surprising given their closer association with target markets, but the percentage of northern respondents appears much greater than those that identified $indexes with relative importance in their selection criteria both currently and potentially into the future. There would appear to be many more southern stud breeders (60%) using $Indexes than their counterparts in the north. This information was not gathered in the earlier surveys, so no change over time could be identified.

The average importance rating, from the national email survey of stud producers, for $Indexes was 4.1. 32% consider $Indexes are either 'not applicable or they never use them. 52% of these stud breeders use them 'sometimes or consider them highly important'.

With this lack of perceived value from $Indexes, it is no surprise that the view expressed by Banks (2005) that the rates of genetic progress in Australia (and particularly northern Australia) are lower than achievable, is still as relevant today. However, this survey has uncovered some suggestions to enhance the $Index structures to include other traits that are being driven by other stakeholders in the Australian beef industry. And these are:

- Inclusion of a weighting for polledness in the selection criteria,

- Inclusion of a weighting for docility / temperament for work place health and safety benefits in addition to meat quality effects,
- Inclusion of structural soundness criteria – legs, feet, joints, sheath and penile structure, and
- Inclusion of male semen traits; enhancing the other current fertility measures.

In northern Australia, 38% and 35% of stud and commercial breeders indicated they "use genomic information sometimes to depend on it for selection". In contrast, 53% of studs across Australia have indicated they apply this relative emphasis. However, these responses conflict with the relative emphasis given to genomic information in the breeders selection criteria both currently and potentially into the future, where this information rated extremely lowly (2-9%) across stud and commercial and current to a potential trait in the future. No trends for the use of this trait, are available from previous surveys. Since between 63-65% of northern breeders indicated it was either "not applicable or of little value", there is an indication that at this point in time the beef industry places little emphasis on this as a selection tool which is rapidly becoming part of the single step Genomic Breeding Values (GBV) produced by Breedplan. Of the 36% of stud breeders that indicated genomic information was not applicable, the majority (62%) were also not involved in Breedplan. This may suggest there is a developing need to communicate the increasing role of genomic information to all sectors of the beef industry across Australia.

4.3.2 Utilisation of selection tools to increase herd profitability

As anticipated, stud breeders were more confident in the use of selection tools than commercial breeders. Stud and commercial breeders in northern Australia rated their confidence in using available selection tools as 6.8 and 5.2 respectively. Almost 89% of the stud breeders and only 62% of the commercial breeders indicated they could demonstrate increased profitability as a result of their selection decisions. However, the stud breeder's confidence in demonstrating increased profitability does not appear to be linked to the use of genetic differences but possibly more likely linked to their perceived skills in the application of other selection tools that they value as more important eg structural assessment and temperament rating etc.

The relative importance of available selection tools (EBVs, $Indexes and genomic information), as assigned by stud breeders across Australia, is reflected in the average rating of 4.8 with 57% indicating their confidence above "fairly confident to extremely confident'. In contrast, in northern Australia, 93% of stud and 73% of commercial breeders rated their confidence above "fairly confident to extremely confident''. This apparently big difference in their average confidence scores particularly between the Australia wide stud breeders and northern stud breeders suggests the northern breeders either have a better understanding with an associated level of confidence or their confidence is surpassing their real understanding. The latter is distinctly possible in light of the weightings assigned to these selection tools when breeders were asked to list their selection decision criteria and both $Indexes and genomic information ranked extremely low. The is every possibility that breeders across Australia (stud and commercial) will benefit from a continued extension focus presenting the tools, their application and "their proof of profit" when applying these tools in selection decisions in a beef business.

Perceived changes in target market

There was no relationship between the stud and commercial industries as to whether their target market specifications have changed. It is therefore not surprising that there is no perceived need for selection criteria to be changed. Almost 10% more commercial breeders

believe the target market specifications have changed thereby affecting a small shift in their selection criteria.

A total of 85% of the northern stud breeders surveyed indicated they sold bulls into northern Australia. In contrast, about 49% of stud breeders across Australia sell bulls into northern Australia which raises the question of increased percentages of less adapted genotypes in the northern beef industry. In contrast, this surge in temperate bull numbers in the north may have a small effect on the carcase quality of the progeny or a flow through effect in the bull multiplier herds and some increased hybrid vigour. The traits they believe are important to northern breeders are primarily those that are clearly visible / phenotypic. The critical measures that are not visible rate very low and are perceived to have relatively little importance.

Is genetics a hard sell?

McCosker *et al* (2010) cited 'the need to continue to develop skills and capacity of business managers and ensure bull selection is appropriate in order to account for the pressure likely to be incurred within a given breeding system'. Bortolussi et al (2005b) and McLean et al (2014) each have identified essential components lacking in many northern beef breeding businesses, yet the beef industry continues to default to the more visible traits used by breeders for many generations as evidenced by the percentage of respondents identifying these traits used with greater frequency.

Data from stud breeders across Australia and the northern stud breeders has considerable similarities. The rating of clearly visible traits/phenotypic traits has an over whelming influence on the critical limitations of profitability of a northern beef enterprise. This is consistent with Moravek *et al* (2013) who reported that few producers appear to be recording adequate herd information to make management decisions as evidenced by less than 50% of producers adopting objective selection and genetic technologies eg EBVs. However, this 2013 study had limited ability to quantify the extent of adoption, into their breeding program, by those 50% of breeders who indicated they adopted various technologies. In essence, this highlights the need to measure key performance traits in order to manage the herd.

Given that fertility associated traits and measures have been identified as critical components of a northern beef enterprise (O'Rourke *et al* 1992, McCosker *et al* 2010 and McGowan *et al* 2013), there is a continued need to assist the northern beef producers with this knowledge and understanding. Northern beef producers currently appear to have little appreciation for the developing genomic technologies (including fertility traits) and their role in selection tools and increased herd profitability. Hence, there is continued need to provide targeted 'extension training activities' that are attractive to stud and commercial breeders and address gaps in the industry knowledge base and also boost the confidence level of the breeders in using available genetic tools.

The northern industry functions as a collection of many somewhat independent stakeholders. The majority of these stakeholders can be both geographically isolated and financially independent. However, the beef producer endeavours to synthesise the inputs received by these various 'players' and combine the information received at the base level where environmental variability, global financial influences and the immediate social fabric of neighbours and peers each have the effect of reducing the incoming information. This should be noted in light of the skewed older age structure of the beef industry and potentially having limited formal education.

A more cohesive approach between all stakeholders eg financial institutions (including agents), insurance service providers, meat processing facilities and government agencies to name but a few of the general groups could enhance the worth and benefits of an objective

approach to performance recording and objective decision making for financial improvement in a beef businesses. The need to "measure to manage" continues to be critically important for decision making in a beef enterprise given the variable environmental impacts and the susceptibility of the north Australian producer to global financial fluctuations.

5 Conclusions/recommendations

The use of a low cost email approach, to gather attitudinal survey information, is limited both from the percentage of the population responding, the completeness of the responses received and the need to provide clear unambiguous alternatives for simplified answers. In contrast, the use of a phone based survey, gathers more detailed attitudinal information, but comes at a much higher labour cost and is very much affected by the timing of the survey relative to season and industry wide activities. Neither approach to data collection can be demonstrated to have complete responses for all questions. The questionnaire format is a trade-off between gathering relevant information, yet avoiding additional qualifying supportive information within a succinct questionnaire that is sufficiently enticing to the respondent.

Traditional approaches, to selection by beef producers, remains supreme. There is slight evidence of changes in the decision making processes of the northern beef industry relative to breeding and selection decisions in the past two and a half decades. Furthermore, stud breeders across Australia arrive at selection decisions using similar information. The stud industry as a whole has many similarities irrespective of geographic location. In contrast, the northern commercial beef industry has utilised the benefits of crossbreeding – the strengths of individual breeds to address the environmental constraints. However, there is evidence of increased emphasis by many breeders who have adopted genetic selection tools (Breedplan EBVs) with 58% and 72% of northern and Australia wide studs respectively, indicating their approach is to use this aspect either "some of the information occasionally" or consider it "highly important".

Beef cattle breeders tend to be older and male which suggests they could be less conducive to change and more risk adverse. One would tend to think that this sector would potentially value objective information to place the herd in a more profitable position. However, the high percentage of stud and commercial breeders (89% and 61% respectively) that indicated they could demonstrate the relationship between their selection criteria and a more profitable herd financially would not appear to be consistent with the general declining industry profitability described by McLean et al (2014). This suggests a real disconnection between breeder selection decisions, business profitability and the long term sustainability of the beef industry under the current breeding and selection decisions.

The beef industry is typified by a 'stud' hierarchy of 'straight breeders' that are custodians of the gene flow into the industry. Given that 44% of northern stud breeders have never been in Breedplan and they have a major impact on the genetic progress and direction of various breeds there continues to be a real need to have a targeted extension activity aimed at these individual herds. The presenters must be equipped to address the following points of view:

- What is Breedplan and EBVs,
- How Breedplan takes physical data into calculating EBVs,
- How to streamline the physical recording of data to submitting data for analyses,
- Breed societies and their 'analyses' times and return of analysed data,
- Interpretation of EBV data, and
- Personal available to help collect, submit and facilitate data transfer and interpretation.

This survey has also highlighted the commercial breeders lower level of confidence in technologies such as Breedplan EBVs and $Indexes as indicated by the drop in their average confidence scores compared to stud breeders. The industry, as a whole, places minimal emphasis on genomic information given its emerging potential influence on Genomic Breeding Values. This is matched by their continued reliance on the 'clearly visible' phenotypic traits that have been used by breeders for many years at the expense of estimated genetic differences and fertility measures that require a more detailed thorough examination. Therefore, tailor made training activities are necessary to target the commercial beef producer with a focus on understanding, applying the data to their selection process and the impact on the financial viability of the enterprise. This extension effort is in contrast with those studs driving the production of bulls with EBVs. There is evidence that commercial breeders should be encouraged to first attend a 'Business EDGE' workshop to identify the financial imperative, rather then attend the 'Breeding EDGE' where the individual components are discussed in layman's terms.

Amidst the declining number of service providers there is an acute need to crystallise the current stakeholders and assist beef producers with consistent breeding and genetic messages from basic fertility measures to genetic and then genomic information.

6 Key communication messages

This study involved a phone survey of 293 commercial and stud breeders across northern Australia and an additional email survey of 233 stud breeders Australia wide. The phone survey obtained subjective responses from breeders regarding their selection decisions rather than using leading questions with defined answers as has been used in previous surveys.

Despite considerable Australian research investment into the development of breeding and genetic technologies, the level of adoption by the stud industry is still much lower than desirable.

The northern commercial beef industry is not effectively utilising the available objective genetic technologies and research outputs eg Bull Breeding Soundness Evaluation skills to improve the accuracy of selection decisions and minimise or overcome the escalating costs of production.

For the industry to overcome the increasing costs of production, there needs to be an increased focus towards a more objective business approach using:

- A range of existing Breedplan EBVs,
- $Indexes for appropriate target markets,
- Bull Breeding Soundness Evaluation measures including scrotal size and percent normal spermatozoa, and
- Genomic profiles supporting the current genetic differences as well as those relevant to specific abnormality traits.

The declining number of service providers across Australia is a potential critical limitation and must be addressed by all industry stakeholders to ensure the effective dissemination of breeding and genetics selection practices.

An encouragement of commercial beef breeders to utilise data capture devices 'crush-side' and measure more animal performance traits that benefit them in being more objective in their selection practices to achieve better target market compliance. An increased recording

of data by the commercial industry has the potential to increase their appreciation of genetic differences. Whilst this survey found they place little emphasis on the developing genomic technologies, these technologies may well streamline the recording accuracy of traits and the difficult to measure traits and integrate well with target market data output.

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8 Appendices

8.1 Appendix Ia. The survey questionnaire sent to beef producers to follow whilst responding over the phone to the interviewer.

Survey of Industry Breeding and Selection decisions

Meat and Livestock Australia in association with Tropical Beef Technology Services are seeking an improved understanding of beef producer's approaches to breeding and selection decisions. This survey is intended to provide insight about beef breeding selection decisions and modify way we invest in breeding and genetics into the future.

We would like you to read this survey form and we will complete the questions with you over the phone at a time convenient to you. We anticipate it will take about 20 to 25 minutes to complete. **All information is strictly confidential with no specific identification of individuals or businesses. Thank you for assisting.**

Section 1: Your beef enterprise and herd

Q 1. Approximately, how many stud and commercial cows do you run in your beef enterprise?

Seedstock / stud herd ……females, Commercial herd…….females

If you have less than 50 females in the stud or 200 commercial cows; thank you for offering to participate in the survey. Unfortunately we require samples from herds with larger numbers of breeders.

If the herd has greater than 200 breeders;

Q 2. What is/are the postcode/s for your property/properties? Postcode/s ……]

Q 3. How would you categorise your Gender and Age; M/ F 20-35, 35-45, 45-55, 55-65, >65?

Q 4a. How would you describe your breeding program? Straight breeding, Cross breeding or Composite

Q 4b. What is/are the major breed/s you currently use in your beef business?

Q 4c. What do you expect to be the major breed/s in your business in the future eg next 10 years?

Q 5. Which would best describe your relationship with the beef enterprise?

Owner/operator or Manager

Q 6. What average price do you budget on paying for your replacement bull?

Q 7a. How many bulls would you purchase each year?……..(bulls)

Q 7b. What bull % are you using in your herd?……..%

Q 8a. Approximately, how old are the bulls you purchase each year?……year-old

Q 8b. At what age do you dispose of your bulls?…….year-old

Q 8c. What is your reason for culling your bulls?…….

Section 2: All producers making breeding selection decisions

Q 9a. Currently in your bull selection decisions, describe how you arrive at a selection decision for each bull [*describe what you consider and the relative importance* - 1 (most important) to 10 (least important)]

……..

……..

Q 9b. Are there traits you would like to include in your bull selection decisions, but suitable bulls are not available? ……

……

Q 10. If you could have a crystal ball; 10 years into the future, describe how you think you will arrive at a selection decision for each bull [*describe what you consider and the relative importance* - 1 (most important) to 10 (least important)]

……..

……..

Section 3: Questions for Stud / seedstock breeders only

Q 11. If you are a **stud breeder**, please indicate your involvement with Breedplan.

Q 12. How important on a scale of 0 to 9, [0-not applicable, 1=little value and 9 depend on it]; do you rate Breedplan information as part of your selection criteria?

Q 13. How much emphasis on a scale of 0 to 9, [0-not applicable, 1=little value and 9 depend on it] do you place on genomic information eg DNA markers or MVP?

Q 14a. If you are a stud and have never been in Breedplan; please share your reasons for not being involved.

Q 14b. If you are a stud and have ceased recording and submitting Breedplan data; please share your concerns that caused you to stop recording data.

Q 14c. If you are a stud and still recording and submitting Breedplan data, what aspects do you think are working well and what could be improved.

Q 15. As a stud breeder, tell me what you record on farm in your herd to assist your selection decisions?

Q 16. As a stud breeder, tell me what you believe your bull customers require when purchasing a bull?

Q 17. Do you use $ Index EBV's in your selection criteria?

Q 18. Please rate your confidence on a scale of 0 to 9, [0-no confidence, 1=little confidence and 9 extremely confident] in using available selection tools and setting your herds breeding objectives to achieve progressive financial improvement in your beef enterprise?

Q 19a. Have your target market specifications changed, affecting your selection criteria?

Q 19b. Can you demonstrate how your bull selection decisions are putting your herd in a more profitable position under current financial constraints?

Section 5: Questions for Commercial breeders only

Q 20. How important on a scale of 0 to 9, [0-not applicable, 1=little value and 9 depend on it]; do you rate Breedplan information as part of your selection criteria?

Q 21. How much emphasis on a scale of 0 to 9, [0-not applicable, 1=little value and 9 depend on it] do you place on genomic information eg DNA markers or MVP?

Q 22. Do you use $ Index EBV's in your selection?

Q 23. Please rate your confidence on a scale of 0 to 9, [0-no confidence, 1=little confidence and 9 extremely confident] in using available selection tools and setting your herds breeding objectives to achieve progressive financial improvement in your beef enterprise?

Q 24a. Have your target market specifications changed, affecting your selection criteria?

Q 24b. Can you demonstrate how your bull selection decisions are putting your herd in a more profitable position under current financial constraints?

Section 6: All respondents

Q 25. Have we missed any important criteria you use in your selection decisions?

……

……

Thank you for your time in completing the questionnaire.

Would you like a summary report, when compiled, sent to you?

Yes [ ] No [ ]

8.2 Appendix Ib. The electronic survey emailed to stud breeders using the ABRI data base.

Survey of Industry Breeding and Selection Decisions

1. Welcome to this Beef Industry Survey

Meat and Livestock Australia (MLA) in association with Tropical Beef Technology Services (TBTS), a division of the ABRI, are focussed on an improved understanding of beef producer attitudes to bull selection decisions in Northern Australia. This survey is intended to gain an indication of beef breeders attitudes, in this case seedstock producers, towards selection decisions that in turn may be reflected in the way we invest in breeding and genetics into the future.

We would appreciate you completing this electronic survey at your earliest convenience. We anticipate it will take about 10 minutes to complete.

All information is strictly confidential with individuals or businesses being anonymous. Thank you in anticipation.

*******Some seedstock breeders will have completed a similar survey via telephone. If you were one of these, please ignore this survey request.*

1. What is your gender?

- ◯ Male
- ◯ Female

2. What is your age?

- ◯ 18 to 24
- ◯ 25 to 34
- ◯ 35 to 44
- ◯ 45 to 54
- ◯ 55 to 64
- ◯ 65 to 74
- ◯ 75 or older

Survey of Industry Breeding and Selection Decisions

2.

3. What is the size of your beef breeding seedstock operation?

- 50 cows or less
- 51 to 200 cows
- 200 to 500 cows
- greater than 500 cows

4. How many bulls would you sell into northern Australia each year? Northern Australia is defined as Queensland, the Northern Territory and the top half of Western Australia.

- Nil
- A small number (1 to 5) very occasionally and not every year
- 1 to 10
- 11 to 50
- 50 to 200
- 200 and above

Survey of Industry Breeding and Selection Decisions

3.

5. Currently, which of the following best describes how you arrive at a selection decision for each bull entering your breeding program. Please select one or multiple items.

- [ ] Structural soundness e.g. Feet, legs, joints
- [ ] Conformation e.g. Backline, Length
- [ ] Cost / Price
- [ ] Visual muscling
- [ ] Complete Bull Breeding Soundness Evaluation (BBSE) Information
- [ ] Fleshing
- [ ] DNA Marker Information
- [ ] BREEDPLAN EBVs
- [ ] Dam Fertility Data e.g. Intercalving Interval
- [ ] Polledness i.e. Not horned
- [ ] Temperament / Docility
- [ ] Scrotal circumference
- [ ] Molecular Value Prediction (MVPs)
- [ ] Breed
- [ ] Background of cow herd
- [ ] Physical measures/Raw data e.g. EMA and Fat scans data, Birth weights
- [ ] Specific bull use e.g. heifer bull
- [ ] Cattle must look good i.e. Visual Appeal
- [ ] Semen % Normal spermatozoa
- [ ] Coat Type
- [ ] BREEDPLAN EBV Accuracy %
- [ ] Genomic profile e.g. 50K SNP Panel
- [ ] Intra-muscular fat%
- [ ] Pedigree or Bloodlines
- [ ] Selection Index i.e. $ Index
- [ ] Bulls that are classified
- [ ] Stud name or reputation

Survey of Industry Breeding and Selection Decisions

6. Are there any other traits or items you would add to your list that help you determine your bull selection decisions? If so please enter them below.

Survey of Industry Breeding and Selection Decisions

7. If you could have a crystal ball, looking 10 years into the future, which of the following best describes the additional items you think you will use to arrive at a selection decision for each bull. Please select one or multiple items.

- [ ] Structural soundness e.g. Feet, legs, joints
- [ ] Conformation e.g. Backline, Length
- [ ] Cost / Price
- [ ] Visual muscling
- [ ] Complete Bull Breeding Soundness Evaluation (BBSE) Information
- [ ] Fleshing
- [ ] DNA Marker Information
- [ ] BREEDPLAN EBVs
- [ ] Dam Fertility Data e.g. Intercalving Interval
- [ ] Polledness i.e. Not horned
- [ ] Temperament / Docility
- [ ] Scrotal circumference
- [ ] Molecular Value Prediction (MVPs)
- [ ] Breed
- [ ] Background of cow herd
- [ ] Physical measures/Raw data e.g. EMA and Fat scans data, Birth weights
- [ ] Specific bull use e.g. heifer bull
- [ ] Cattle must look good i.e. Visual Appeal
- [ ] Semen % Normal spermatozoa
- [ ] Coat Type
- [ ] BREEDPLAN EBV Accuracy %
- [ ] Genomic profile e.g. 50K SNP Panel
- [ ] Intra-muscular fat%
- [ ] Pedigree or Bloodlines
- [ ] Selection Index i.e. $ Index
- [ ] Bulls that are classified
- [ ] Stud name or reputation

Survey of Industry Breeding and Selection Decisions

8. Are there any other traits or items you would add to your list that help you determine your bull selection decisions in 10 years time? If so, please enter them below.

Survey of Industry Breeding and Selection Decisions

9.

9. How important are BREEDPLAN EBVs as part of your selection criteria?

0 - Not applicable	1 - Little Value/ not used	2	3	4	5 - Some value i.e. use some of the information or occasionally	6	7	8	9 - Highly important
○	○	○	○	○	○	○	○	○	○

10. How important are Selection Indexes/$ Indexes as part of your selection criteria?

0 - Not applicable	1 - Little Value/ not used	2	3	4	5 - Some value i.e. use some of the information or occasionally	6	7	8	9 - Highly important
○	○	○	○	○	○	○	○	○	○

11. How important is Genomic information as part of your selection criteria (e.g. DNA Marker or MVPs)?

0 - Not applicable	1 - Little Value/not used	2	3	4	5 - Some value i.e. use some of the information or occasionally	6	7	8	9 - Highly important
○	○	○	○	○	○	○	○	○	○

12. Are you a current BREEDPLAN member?

○ Yes - Go to Question 15

○ No - Go to Question 13

Survey of Industry Breeding and Selection Decisions

13. If you have not recorded or ceased recording with BREEDPLAN, please indicate your thoughts by ticking the appropriate response or responses. *If you are a current BREEDPLAN member skip this question and go to question 15.*

- ☐ I don't think BREEDPLAN works i.e. taking physical data to EBVs
- ☐ Insufficient bulls available with EBV in my breed
- ☐ I don't understand EBVs
- ☐ I'm not interested
- ☐ I'm too old
- ☐ I have insufficient time to collect and submit data
- ☐ Turn around time from submitting data to analyses is too long
- ☐ Does not rank our bulls in the correct order of genetic merit
- ☐ Does not work for 100% of animals
- ☐ BREEDPLAN stacks genetics and does not translate to actual production gains
- ☐ No or minimal financial rewards for sale animals with EBVs
- ☐ Cost too high

14. Are there any other reason you have not recorded or ceased recording with BREEDPLAN? If so please enter your thoughts below.

15. As a seedstock herd that is a BREEDPLAN member, please indicate what aspects you think could be improved by ticking the appropriate response or responses. *If you are not a BREEDPLAN member please skip this question.*

- ☐ BREEDPLAN EBVs that allow comparision across breeds rather than within breed
- ☐ Standardise the availability of traits across breeds
- ☐ More regular BREEDPLAN analyses i.e. weekly
- ☐ Improve the BREEDPLAN recording practices of herds
- ☐ Shorten the time it takes to implement new technology into BREEDPLAN e.g. use of genomics
- ☐ Improve Selection Indexes
- ☐ Expand the range of traits analysed

16. Are there any other BREEDPLAN areas that could be improved? If so please enter your thoughts below.

Survey of Industry Breeding and Selection Decisions

6.

17. As a bull breeder, what do you record on farm to assist selection decisions in your herd? Please indicate these by ticking the appropriate repsonse or responses.

- ☐ Date of Birth
- ☐ Calving Ease Traits - e.g. Birth Weight, Calving Difficulty Scores
- ☐ Weaning Weights (200 day weight)
- ☐ Yearling Weights (400 day weights)
- ☐ 18 month Weights (600 day weights)
- ☐ Cow weights at weaning
- ☐ Scrotal size on yearling bulls
- ☐ Scrotal size on 2 year old bulls
- ☐ Mating details e.g. bull in and out dates, AI programs
- ☐ Sire and/or dam Indentification through DNA
- ☐ Semen % Normal
- ☐ Ultrasound Scans - EMA, Fats
- ☐ Ultrasound Scans - IMF
- ☐ Polled, Horned, Scurred Status
- ☐ Genomic Profiles e.g. 50K SNP Panel
- ☐ Temperament/Docility
- ☐ Score Structure Traits e.g. Legs, feet.
- ☐ Crush side semen evaluations

18. Are there any other things that you record on farm to assist with your selection decisions? If so please enter your thoughts below.

19. Please rate your confidence (out of 10) in using available selection tools (EBVs, Indexes, Genomics) to achieve progressive genetic improvement in your beef enterprise and that of your bull buying clients?

0 - No confidence	1 - Little confidence	2	3	4	5 - Fairly confident	6	7	8	9 - Extremely Confident
○	○	○	○	○	○	○	○	○	○

Survey of Industry Breeding and Selection Decisions

7.

20. If you sell bulls into northern Australia (i.e. Queensland, Northern Territory, top half of Western Australia) how are these bull buyers/clients selecting their bulls? Please select one or more response below.

- [ ] I don't know
- [ ] Visual Appeal
- [ ] Bone i.e. not fine boned
- [ ] Polledness (i.e. no horns)
- [ ] Well finished, fat bulls
- [ ] Pasture finished bulls i.e. no grain
- [ ] BREEDPLAN EBVs - sub-set e.g. just weights
- [ ] Full set of BREEDPLAN EBVs
- [ ] Selection Indexes/$ Indexes
- [ ] Complete Bull Breeding Soundness Evaluation (BBSE) Information
- [ ] Semen Morphology % Normal
- [ ] Scrotal Circumference
- [ ] Raw Scans - EMA, Fats
- [ ] Raw Scans - IMF
- [ ] Dam Fertility data e.g. Interval/ving Period, Age of first calf
- [ ] Temperament/Docility
- [ ] Frame Score/Size
- [ ] Structure - legs, feet
- [ ] Longevity
- [ ] Bull breeder reputation or follow up service.

21. Are there any other items that your northern Bull buyers are using to select their bulls? If so please enter them below.

********** Thankyou for completing this survey. Your time is greatly appreciated. **********

8.3 Appendix II a, b, c: Traits identified by beef producers as used in their selection decisions and reported by the stud and commercial enterprises of the northern beef industry.

Appendix II a: Percentage [number] of respondents identifying traits they include in their selection decisions according to stud and commercial breeders.

Currently used traits	Stud (n=109)	Commercial (n=229)
Structural soundness – feet, legs and joints	75% [82]	77% [177]
Conformation eg backline	64% [70]	75% [172]
Cost of the bull/price	7% [8]	40% [91]
Degree of muscling	34% [37]	44% [101]
Bull Breeding Soundness Evaluation report	12% [13]	33% [75]
Fleshing	15% [16]	32% [74]
DNA trait marker	0% [0]	3% [7]
Breedplan EBVs	53% [58]	52% [118]
Inter-calving Interval data	19% [21]	17% [40]
Poll animals	34% [37]	33% [76]
Temperament/docile bulls	62% [68]	78% [179]
Scrotal circumference	39% [42]	45% [104]
Molecular Value Prediction (MVP)	3% [3]	2% [4]
Breed	11% [12]	42% [96]
Breeders cow herd background data	12% [13]	17% [39]
Physical measures (scan data, birth weight, etc)	43% [47]	43% [99]
Heifer bull, specific for herd mating use	2% [2]	13% [30]
Cattle must look good	25% [27]	34% [79]
Semen % normal spermatozoa	27% [29]	35% [80]
Coat type/coat colour	30% [33]	26% [59]
Breedplan Accuracy %	3% [3]	19% [43]
Genomic wide scan 5, 10, 50 and up to 800K SNP data	2% [2]	7% [17]
Intra muscular fat %	8% [9]	21% [48]
Bloodlines/pedigree	26% [28]	26% [60]
$ Index EBV	6% [6]	20% [45]
Classified bulls	3% [3]	21% [47]
Stud name/repeat buyer	15% [16]	47% [107]
Sheath	11% [12]	7% [15]
Bone	6% [7]	2% [5]

Appendix II b: Percentage [number] of respondents identifying traits they would like to include in their selection decisions according to stud and commercial breeders "If suitable bulls were available".

Desired traits if suitable bulls were available	Stud (n=42)	Commercial (n=62)
Bull Breeding Soundness Evaluation report	5% [2]	8% [5]
Breedplan EBVs	48% [20]	27% [17]
Coat type/coat colour	2% [1]	3% [2]
DNA trait marker	5% [2]	11% [7]
Intra muscular fat %	2% [1]	19% [12]
$Index EBV	2% [1]	13% [8]
Genomic wide scan 5, 10, 50 and up to 800K SNP data	2% [1]	5% [3]
Poll animals	26% [11]	23% [14]
Inter-calving Interval data	5% [2]	13% [8]
Temperament/docile bulls	14% [6]	31% [19]
Scrotal circumference at weaning or 12-month-old	5% [2]	21% [13]
Molecular Value Prediction (MVP)	7% [3]	3% [2]
Breeders' cow herd background data	14% [6]	29% [18]
Semen % normal spermatozoa	12% [5]	26% [16]
Other:		

Appendix II c: Percentage and [number] of respondent identified traits they think may be important in their selection decisions according to stud and commercial breders “Possibly 10 years into the future”.

Potential future traits	Stud (n=106)	Commercial (n=202)
Structural soundness – feet, legs and joints	72% [76]	73% [148]
Conformation eg backline	59% [63]	67% [136]
Cost of the bull/Price	5% [5]	34% [68]
Degree of muscling	32% [34]	46% [92]
Bull Breeding Soundness Evaluation report	12% [13]	34% [69]
Fleshing	17% [18]	33% [67]
DNA trait marker	7% [7]	11% [22]
Breedplan EBVs	55% [58]	50% [101]
Inter-calving Interval data	19% [20]	22% [44]
Poll animals	34% [36]	40% [81]
Temperament/docile bulls	61% [65]	75% [151]
Scrotal circumference	40% [42]	42% [84]
Molecular Value Prediction (MVP)	6% [6]	3% [6]
Breed	10% [11]	44% [88]
Breeders cow herd background data	9% [10]	8% [17]
Physical measures (scan data, birth weight, etc)	41% [43]	43% [87]
Heifer bull, specific for herd mating use	3% [3]	14% [29]
Cattle must look good	24% [25]	32% [64]
Semen % normal spermatozoa	27% [29]	36% [73]
Coat type/coat colour	27% [29]	27% [55]
Breedplan Accuracy %	4% [4]	23% [47]
Genomic wide scan 5, 10, 50 and up to 800K SNP data	9% [10]	6% [13]
Intra muscular fat %	8% [9]	23% [47]
Bloodlines/pedigree	25% [27]	27% [54]
$ Index EBV	9% [10]	26% [52]
Classified bulls	3% [3]	24% [49]
Stud name/repeat buyer	11% [12]	45% [91]
Other:		

8.4 Appendix III a, b, Stud breeder responses to the traits recorded on farm to assist selection decisions.

Appendix III a: Percentage and [number] of traits recorded by studs for their "on farm selection decisions".

Current traits recorded on farm	Stud (n=99)
Date of birth	40.4% [40]
Sire identification/DNA	17.2% [17]
Calving ease	15.2% [15]
Birth weight	16.2% [16]
Weaner/200d weight	41.4% [41]
Yearling/400d weight	41.4% [41]
Final/600d weight	37.4% [37]
Scrotal size at yearling	38.4% [38]
Bull in/out dates	28.3% [28]
Semen morph (%N)	25.3% [25]
P8 fat	31.3% [31]
12/13 rib fat	31.3% [31]
EMA	32.3% [32]
IMF%	27.3% [27]
Evidence of hernia	9.1% [9]
Poll/horn status	36.4% [36]
Net feed intake	1% [1]
Trait DNA	12.1% [12]
Leg structures	11.1% [11]
Temperament	18.2% [18]
Calving ease	-
Semen evaluation crush-side	31.3% [31]

Appendix III b: Percentage and [number] of stud breeders who believe their customers require the following traits when purchasing a bull.

Current traits recorded on farm	**Stud (92)**
Don't have details	3.3% [3]
Well finished/fat bull	6.5% [6]
Pasture fed balls	6.5% [6]
Complete EBV profile	10.9% [10]
Full BBSE	4.3% [4]
Semen morph (%N)	25.0% [23]
SC measurements	29.3% [27]
EMA	30.4% [28]
IMF%	27.2% [25]
Bull's dam fertility data	13.0% [12]
Frame score/size	10.9% [10]
Big bone (not fine)	16.3% [15]
Limited EBVs	26.1% [24]
Docile/quiet	63.0% [58]
Sire longevity	6.5% [6]
$Index EBVs	-
Genomic and DNA marker	-
Poll/horn data	27.2% [25]
DNA fingerprint	1.1% [1]

8.5 Appendix IV. Post code allocation of regions