Variation in Male Reproductive Traits in Tropical Cattle

A major research project within the Cooperative Research Centre for Beef Genetic Technologies (Beef CRC) studied ways to define the genetic control of traditional and novel measures of reproductive performance in Tropical cattle in Northern Australia. One of the major project aims was to was to identify early-in-life predictors of fertility both phenotypically (bull fertility as reflected by improved calf output) and genetically (the fertility of a bull's female and male progeny) to increase the rate of improvement in female reproduction in Northern Australia.

PROJECT DESIGN

A total of 4063 male progeny were generated by natural mating between the years 2004-2010 from cows involved in the Beef CRC Lifetime Fertility Project. These were comprised of 1629 Brahmans and 2124 Tropical Composites. A total of 136 sires were used to generate the progeny, comprised of 60 Brahmans and 76 Tropical Composites. Of these, 40 sires, 13 Brahmans and 27 Tropical Composites, were used in multiple years and locations to generate genetic linkage.

The male progeny were breed and run till weaning on research stations at "Brian Pastures" Gayndah, "Toorak" Julia Creek, "Brigalow Theodore" ,"Swan's Lagoon" Ayr and "Belmont" Rockhampton. After weaning the male progeny were transported and run at 2 locations being"Brigalow" (progeny from "Brian Pastures", "Toorak", "Brigalow" and "Swans Lagoon") and "Belmont" (progeny from "Belmont"). A small number of male calves from Belmont were sent to Brigalow to maintain linkage.

The bulls were recorded pre-weaning (4 months), at weaning (6 months), and then every 3 months through to 2 years of age for a range of reproductive traits. The measurements that were recorded are outlined in Tables 1 and 2.

Reproductive trait measurements included scrotal circumference, bull breeding soundness evaluation (BBSE), sperm morphology assessment at 12, 18 and 24 months of age and analysis of blood hormones levels for Luteinising hormone (influences testosterone production and onset of puberty, Inhibin (influences the regulation of sperm production), and Insulin-like growth factor-1 (IGF-1). In addition, male progeny were measured for a comprehensive range of other production traits such as live weight, flight time, fatness, eye muscle area (EMA) and hip height.

Table 1 : Reproductive Trait Measurements Collected at Each Different Age

Age (Months)	Weight	Scrotal Circ	Blood Sample	BBSE
0	✔			
4	✔		✔	
6	✔	✔	✔	
9	✔	✔		
12	✔	✔	✔	✔
15	✔	✔		
18	✔	✔	✔	✔
21	✔	✔		
24	✔	✔	✔	✔

Table 2 : Measurements Collected Within Bull Breeding Soundness Evaluation (BBSE)

Physical Scores	Reproductive Check	Semen Evaluation	Sperm Assessment
Leg Structure	Scrotal Circumference	Mass Activity	Morphology
Feet	Testis Tone	Motility	Percent Normal Sperm
Eyes	Sheath		Percent Abnormal Sperm
Body Condition	Penis		

NON-GENETIC EFFECTS

The month in which the bulls were born had a considerable effect, with development delayed in younger bulls. The difference between September and January born calves at 18 months was 42 kg live weight, 3 cm smaller scrotal circumference, 15% lower motility and 29% lower percent normal sperm.

GENETIC EFFECTS

Results from the Beef CRC research show the heritability estimates were generally moderate for semen quality traits and high for hormone traits and scrotal circumference (see Table 3). This indicated that these male fertility traits were under some genetic control and consequently could be improved through selection

The research showed a relatively strong genetic relationship between scrotal circumference, motility, mass activity and percent normal sperm when measured at 12 months in Tropical Composites and 18 months in Brahmans. These genetic associations suggest that scrotal circumference and sperm motility traits can potential be measured as early in life indicators of bull fertility.

GENETIC DIFFERENCES BETWEEN ANIMALS

Further analysis revealed that there was up to a 16.5% difference in percent normal sperm between the sons of bulls due to genetic differences between their sires. These results further demonstrate that genetic improvement for important semen quality traits can be made through selection.

CONCLUSIONS

The results emphasise the opportunity that exists to improve male fertility in tropical beef cattle breeds by focusing recording and selection on early in life male reproduction traits.

Scrotal Circumference was one amongst the most heritable of the bull traits studied but the magnitude of positive genetic correlation to semen quality traits varied between breed and age of measurement. Scrotal circumference is an easy to measure trait that should be taken at 400 days of age rather than at a later age to identify those bulls with superior genetics for fertility.

Opportunities exist to improve male fertility traits by selecting and mating bulls with good Scrotal Size EBVs, good semen quality as measured by BBSE, and whose dams have female reproductive performance information recorded with BREEDPLAN for the calculation of Days to Calving EBVs (particularly reproductive information for maiden heifers and first calf cows).

Table 3 : Heritabilities of Key Male Reproductive Traits

Category	Trait	Measurement Age	Heritability	
			Brahman	Tropical Composite
Hormone	Inhibin	4 months	0.74	0.72
	LH	4 months	0.31	0.48
	IGF-1	6 months	0.44	0.36
Scrotal	Scrotal Circumference	18 months	0.75	0.43
Semen Quality	Mass Activity	18 months	0.24	0.13
	Motility	18 months	0.15	0.15
	Percent Normal	18 months	0.25	0.20

Table 4 : Genetic Correlatins Between Scrotal Circumference & Semen Quality Traits

Breed	Age at Measurement	Mass Activity	Motility	Percent Normal
Brahman	18 months	0.82	0.79	0.50
Brahman Composite	12 months	0.60	0.56	0.55

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