Proc. Assoc. Advmt. Anim. Breed. Genet. 20:90-93

POTENTIAL ECONOMIC RETURN FROM USE OF FIXED-TIME ARTIFICIAL INSEMINATION AS PART OF A GENETIC IMPROVEMENT PROGRAMME

S.A.A Edwards[1], B.M. Burns[2], J. Allen[3] and M.R. McGowan[1]

[1]School of Veterinary Science, The University of Queensland, Gatton, QLD 4343
[2]The University of Queensland, Centre for Animal Science, Queensland Alliance for Agriculture and Food innovation, Rockhampton, QLD 4700
[3]Agriculture Business Research Institute, University of New England, Armidale, NSW 2350

SUMMARY

To investigate the potential return on investment of implementing a genetic improvement program in a self-replacing commercial Brahman breeding herd, three different selection and breeding strategies were evaluated through modelling, 1) Natural mating with no genetic improvement (NATM-G), 2) Natural mating with genetic improvement (NATM+G), and 3) Fixed-time AI (FTAI) with genetic improvement (FTAI+G). In each scenario, the Jap Ox Index was used to quantify genetic gain and improvements were made using a Brahman sire with a top 10% Jap Ox Index ($45). A sire was selected from the progeny generated in Year 1. This sire was then used in Year 3 for natural mating in a multiplier herd. A partial budget was used to calculate the cost per calf weaned. The costs per calf weaned in Year 1 were calculated to be $46.83, $371.42 and $173.76 for NATM-G, NATM+G and FTAI+G, respectively. The Jap Ox Index for the progeny was calculated to be $20.00, $32.50 and $32.50 for NATM-G, NATM+G and FTAI+G, respectively. However, when progeny from Year 1 were used in Year 3 for breeding, the costs per calf weaned in Year 3 were calculated to be $46.83, $10.27 and $4.35 for NATM-G, NATM+G and FTAI+G, respectively. In Year 3, Total Genetic Profit was calculated to be $0, $124.38 and $1017.00 for NATM-G, NATM+G and FTAI+G, respectively. This model supports the return on investment in genetic improvement in Brahman cattle in northern Australia, and demonstrates the potential value of FTAI in both disseminating improved genetics and improving rate of genetic gain.

INTRODUCTION

A range of local and global factors are impacting on the Australian beef industry contributing to an average return on assets of only 0.3 to 2.0%. Poor reproductive performance in extensively managed tropically adapted herds is one factor contributing to this poor financial performance (McCosker *et al.* 2010). Genetic improvement to increase herd productivity with a strong emphasis on reproduction has the ability to improve the financial performance of northern breeder herds. The results from recent molecular and quantitative genetic research enable selection of superior tropical breed sires for a range of traits such as age of puberty, postpartum re-conception interval and lifetime productivity (Fortes *et al.* 2012; Johnston *et al.* 2009). The large genetic variation in reproduction traits observed in Brahman genotypes provides substantial opportunity for improvement through genetic selection (Johnston *et al.* 2009). Artificial insemination (AI) provides a practical method of increasing the dissemination of superior genetics in commercial and seed-stock bull breeding herds. The use of AI in northern Australia is currently estimated to be less than 1% of the breeder herd and traditionally considered difficult to implement in extensively managed herds. A strategy to increase the dissemination of superior genetics in northern beef herds is use of fixed-time AI (FTAI), which eliminates the need for oestrus detection. FTAI is often associated with lower labor inputs, and enables insemination of large numbers of females and production of more calves than typical oestrus detection programs (Edwards *et al.* 2012). The objective of this study was to use modelling to compare the potential return on investment of implementing three different selection and breeding strategies 1) Natural mating with no genetic improvement (NATM-G), 2) Natural mating with genetic improvement (NATM+G), and 3) FTAI with genetic improvement (FTAI+G), in a self-replacing commercial Brahman breeding herd.

MATERIALS AND METHODS

The Brahman Jap Ox index was used to quantify genetic merit of sires (ABRI 2013) used in three different selection and breeding strategies; Strategy 1: NATM using breed average sires with no genetic improvement (NATM-G), Strategy 2: NATM with genetic improvement using a purchased top 10% Jap Ox sire (NATM+G), and Strategy 3: FTAI with genetic improvement using a top 10% Jap Ox sire (FTAI+G) and using NATM+G in Year 3 from selected progeny from Year 1. In each strategy, bulls were produced by NATM or FTAI in Year 1 from the bull breeding herd and used in Year 3 in the multiplier herd. Assumptions for purchase of sire and frozen semen, pregnancy rate to FTAI and overall weaning rate, and costs of FTAI in a 200 cow breeding herd are presented in Table 1.

The cows mated in each strategy were all assumed to have a breed average Jap Ox Index ($20). Genetic gain was calculated for each strategy using the following equations: *[(Sire Jap Ox Index) – ($20)]/2 = Calf Genetic Improvement.* In Year 3, when bulls produced from the Year 1 mating are used in the multiplier herd, the genetic gain is calculated as described above.

Table 1. List of assumptions and costs associated with NATM or FTAI

Item	Parameters and costs	Source
Breed average Brahman sire	Purchase price: $5,000	
Top 10% Jap Ox Brahman sire	Purchase price: $40,000; Semen Price: $50	
Station labour (@ $200/day)	FTAI: 5 personnel x 3 days = 15 units = $3000 NATM: 2 personnel x 1 days = 2 units = $400	
FTAI costs	Drugs to synchronise ovulation: $3524 AI technician: $1500	
Expected sire working life	4 years	(Smith *et al.* 2011)
Weaning rate (% cows joined)	71 %	(Schatz and Hearnden 2008)
Pregnancy rate to FTAI	35 %	(Edwards *et al.* 2012)
Bull:Cow ratio (NATM)	5 bulls for 200 cows (2.5%)	(Smith *et al.* 2011)

RESULTS AND DISCUSSION

The costs per calf born in Years 1 and 3 of each strategy are presented in Table 2. In the genetic improvement strategies, more genetically superior progeny were produced using FTAI than NATM (63 vs. 28, respectively). In the NATM+G scenario, as the purchase price of a natural mating sire is relatively high, only one sire was used, and thus the number of cows that could be mated to this sire was only 40 (using a 2.5% mating ratio). This strategy limits the production of genetically superior calves compared to that achieved using FTAI, where all cows in the bull breeding herd were AI once, resulting in a higher total number of genetically superior calves being produced. As a result, in both Years 1 and 3 the cost per genetically superior calf born was lower for the FTAI strategy compared to the NATM-G strategy.

Table 2. Cost per calf generated from NATM-G, NATM+G and FTAI+G strategies

Year 1	*Calculation*	*NATM-G*	*NATM+G*	*FTAI+G*
Bull breeding herd (n)	(A)	200	40[a]	200
FTAI costs[b]	(B)	-	-	$ 15,024.00
Cost per sire *(Table 1)*	(C)	$ 5,000.00	$ 40,000.00	$ 5,000.00
Sires (n) *(Table 1)*	(D)	5	1	5
Total sire expenses	C*D = (E)	$ 25,000	$ 40,000.00	$ 25,000
Labour costs	(F)	$ 400.00	$ 400.00	$ 3,400.00
Mating costs for Yr 1[c]	[B+(E/4)] + F = (G)	$ 6,650.00	$10,400.00	$ 24,674
Progeny by high genetic merit bull[d]	NATM: (A*0.71) = (H) FTAI: (A*0.35) = (H)	-	28 calves	63 calves
Progeny by average genetic merit bulls	NATM: (A*0.71) = (I) FTAI: (A*0.71)-H = (I)	142 calves	-	79 calves
Cost per calf	G/(H+I) = (K)	$ 46.83	$ 371.42	$173.76
Year 3		*Natural mating using sires generated in Yr 1*		
Bull breeding herd (n)	(L)	200	80[b]	200
Cost per sire	NATM-G: New Sires = (M) NATM+G, FTAI+G: K = (M)	$ 5,000.00	$ 371.42	$173.76
Sires (n) *(Table 1)*[e]	(N)	5	2	5
Total sire expenses	N*M= (O)	$ 25,000	$ 742.84	$ 868.80
Labour costs	(P)	$ 400.00	$ 400.00	$ 400.00
Mating costs for Yr 3	(O/4) + P = (Q)	$ 6,650.00	$ 585.71	$ 617.20
Progeny from mating	L*0.71 = (R)	142 calves	57 calves	142 calves
Total cost per calf	Q/R = (S)	**$ 46.83**	**$ 10.27**	**$ 4.35**

[a]Due to the relatively high purchase price it is assumed that only 1 purchased sire was used to breed replacement bulls.
[b] Insemination expenses include: Drugs to synchronise ovulation and, AI technician and semen costs.
[c] Mating costs include: Sire expenses and labour costs for mustering and yard handling associated with the mating strategy.
[d] Genetically improved progeny include: Number of calves born from genetic improvement mating. Weaning rate and pregnancy rates to FTAI are as per Table 1.
[e] A selection intensity of 16% was applied to sires generated from Year 1. Therefore, only 2 sires were retained to join 80 cows in the NATM+G strategy, however, 5 sires were available to join the entire bull breeding herd in the FTAI+G strategy.

The lack of adoption of artificial breeding technologies in the northern beef industry could be due to a perceived high cost per calf born. As FTAI+G can generate more high genetic merit calves than natural mating, the total costs of genetic improvement are spread across a greater number of progeny, resulting in a lower cost per calf born than NATM+G. This model assumes that the price of a natural mating sire is correlated with its genetic merit and in turn is correlated with price of semen from this sire. Some assumptions that have not been included in the model, are: 1) Genetically improved male progeny not retained for use in the herd may be sold for a higher price than average genetic merit progeny, 2) As a high selection pressure is applied to male progeny (only 16% of available progeny selected) the retained sires should have a higher actual Jap Ox index than calculated in the model, 3) Transport and other associated expenses of purchase of a high genetic merit natural mating sire have not been included, and 4) An increased proportion of females conceiving earlier in the mating period in FTAI may improve weaner values (Spitzer 1986). Total Genetic Profit was calculated to be $0, $237.25 and $1275.00 for NATM-G, NATM+G and FTAI+G, respectively (Table 3). In this comparison the FTAI+G strategy improved the genetic profit of the calves 5.4 times more than the NATM+G strategy. This is explained by the FTAI+G strategy producing 85 more calves by high genetic merit sires multiplying the effects of the genetic improvement strategy.

Table 3. Genetic profit from NATM-G, NATM+G and FTAI+G strategies.

Year 1	*Calculation*	*NATM-G*	*NATM+G*	*FTAI+G*
Bull breeding herd (n)	(A)	200	40[a]	200
Jap Ox Index of sires	(B)	$ 20	$ 45	$ 45
Average Jap Ox Index of cows	(C)	$ 20	$ 20	$ 20
Genetic gain per calf born	(B-C)/2 = (D)	$ 0	$ 12.50	$ 12.50
Calves by genetic. superior sire	(E)	0	28	63
Calves by genetic. average sire	(F)	142	-	79
Total genetic gain	E*D = (G)	$ 0.00	$ 350.00	$ 787.50
Jap Ox Index of progeny	(H)	$ 20.00	$ 32.50	$ 32.50
Year 3		*Natural mating using sires generated in Yr. 1*		
Bull breeding herd (n)	(I)	200	80	200
Jap Ox Index of sire	= (H)	$ 20.00	$ 32.50	$ 32.50
Calves from mating	I*0.71 = (J)	142	57	142
Genetic gain over average cow	(H-C)/2 = (K)	$ 0	$ 6.25	$ 6.25
Genetic gain – calves from replacement cows Yr. 1[c]	(D*0.5)*((E*0.5)*0.71)=(L)	$ 0	$ 62.13	$ 142.00
Calves from mating	(M)	140	56	140
Yr. 3 genetic gain of progeny	M*K = (N)	$ 0	$ 62.25	$ 875.00
Total Genetic Profit	L + N = (O)	**$ 0**	**$ 124.38**	**$ 1017.00**

[a] Due to the relatively high purchase price it is assumed that only 1 purchased sire will be used to breed replacement bulls.

[b] A selection intensity of 16% is applied to sires generated from Year 1. Therefore only 2 sires are retained to join 80 cows in the NATM+G Strategy, however, 5 sires are available to join to the entire bull breeding herd in the FTAI+G strategy.

[c] Assume all heifers from Year 1 are retained and bred in Year 3. Assume 50% of the calves born in Year 1 are female and the weaning percentage of these calves is 71%.

CONCLUSION

The results from this modelling support the return on investment in genetic improvement in Brahman cattle in northern Australia and demonstrate the potential value of FTAI in both disseminating improved genetics and improving rate of genetic gain.

REFERENCES

ABRI. (2013). *http://abri.une.edu.au* Accessed 8/2/2013 2013.

Edwards S.A.A., Bo G. A., Dawson K., and McGowan M.R. (2012). In: ‘Proceedings 17th Interational Congress on Animal Reproduction (ICAR), Vancouver, July 2012

Fortes M. R. S. et al. (2012). *Anim. Prod. Sci.* **52**: 143.

Johnston, D. J. et al. (2009). *Anim. Prod. Sci.* **49**: 399.

McCosker T., McLean D., and Holmes P. (2010). Meat and Livestock Australia Ltd., North Sydney, NSW.

Schatz T. J., and Hearnden M.N. (2008). *Aust. J. Exp. Agr.* **48**:940.

Smith D., McCosker K., Butler S. Fordyce G., Burns B., Jephcott S. and McGowan M. (2011) *Proc. North. Beef. Res. Updat. Conf.* 122

Spitzer J. C. (1986). In: Current therapy in theriogenology: Diagnosis, treatment and prevention of reproductive diseases in small and large animals. p 320-341. editor D. A. Morrow, W.B. Saunders Company, Philadelphia.