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Author:	Tom Granleese, S.A. Clark and J.H.J van der Werf
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Cost-benefit of reproductive technologies in a Merino two tier structure

Tom Granleese[a,b], S.A. Clark[a,b] and J.H.J van der Werf[a,b]
[a] Co-operative Research Centre for Sheep Genetic Technologies, Armidale, Australia 2351
[b] School of Environmental and Rural Science, University of New England, Armidale, Australia 2351
Corresponding author: tgranlee@une.edu.au

Reproductive technologies such as artificial insemination (AI), multiple ovulation and embryo transfer (MOET) and juvenile *in vitro* embryo production and embryo transfer (JIVET) have the ability to accelerate genetic gain. Granleese *et al.*(2014) demonstrated that reproductive technologies can increase rates of genetic gain for a dual purpose Merino "*MP"* index while keeping inbreeding at a sustainable level (e.g. 1.0% increase per generation). They used optimal contribution selection (Wray and Goddard, 1994) along with genomic selection. Reproductive technologies and/or genomic selection usually comes at a significant financial investment to breeders directly using them. This paper aims to investigate the cost-benefit to a Merino breeder using reproductive technologies and genomic selection.

The breeder produces 400 stud lambs annually and supplies rams to a commercial flock of 10,000 ewes. Genetic improvement and selection was based on the Merino dual purpose index. The benefit from genetic improvement in the stud resulted in extra income generated from improved performance in the commercial flock. Rates of genetic improvement differed between different breeding programs used in the nucleus (Table). These breeding programs in the nucleus optimally assigned reproductive technologies to the very best ewes with genetic gain derived from Granleese *et al.*'s (2014) study. Subtracting costs due to phenotypic measurement, use of MOET and JIVET and genomic testing led to net profit which was discounted and accumulated to a net present value (NPV).

Table. Annual genetic gain (ΔG/yr), net present value at 5 (NPV_5) and 20 (NPV_{20}) years and year at which cost is recovered in a 10,000 commercial ewe flock for various stud breeding programs.

Breeding Program	GS[a]	ΔG/yr[b]	NPV_5[c]	NPV_{20}[c]	Cost Recov. (yr)
AI/N + MOET + JIVET	Yes	0.37	-74.2	3887.2	6
AI/N + MOET	Yes	0.27	-144.9	2632.0	7
AI/N	Yes	0.20	46.4	2409.9	4
AI/N + MOET + JIVET	No	0.15	-62.9	1492.2	7
AI/N + MOET	No	0.15	-93.5	1430.0	8
AI/N	No	0.10	112.6	1437.2	1

[a] GS = Genomic Selection; [b] from Granleese *et al.*(2014); [c] Net present value represented in units of $1000.

Over a 20 years period, there was little NPV difference between breeding programs that did not use genomic selection (GS) despite clear differences over the first 5 years (Table). After 20 years, the breeding program combination of AI/N+MOET+JIVET with GS resulted in an increase in NPV of 48% and 61% compared to AI/N+MOET+GS and AI/N+GS programs, respectively (Table). Despite having higher genetic gain than programs using AI only, MOET programs add similar NPV because they proved expensive, and these programs took the longest time to break even (Table). Increased lamb yields per ewe or decreased costs would decrease the cost per lamb in a MOET breeding programs. This could increase NPVs for breeding programs implementing MOET. JIVET was also expensive but provided a much clearer benefit due to a lower cost per lamb, combined with higher rates of genetic gain. However we only observe this when also using genomic selection.

This study provides evidence that genetic improvement programs that utilise reproductive technologies with genomic selection can give significant benefits to sheep breeders. However some of these benefits need to flow back to studs to cover the higher investment cost.

Granleese T. *et al.* (2014) *Animal Production Science,* submitted.
Wray N.R. and Goddard M.E. (1994) *Genetics Selection Evolution,* **26**:431-451.