Sheep CRC Practical Wisdom Notes

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Know it. Do it.

Benefits of Reproductive Technologies in Closed Nucleus Sheep Breeding

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Key points

- MOET can always accelerate rate of genetic gain
- JIVET can only accelerate rates of genetic gain more than MOET when using genomic selection
- The biggest benefits from reproductive technologies and genomic selection are achieved when selecting on traits before phenotypic measurement
- Mate selection programs are important to help optimise genetic gain and limit inbreeding

Reproductive technologies

Reproductive technologies that are used in the Australian sheep industry (in order of use) are artificial insemination (AI), multiple ovulation and embryo transfer (MOET), and juvenile *in vitro* embryo transfer (JIVET).

Artificial insemination is usually performed laproscopically on ewes whose oestrus cycles have been synchronised. Semen is often frozen-thawed and been bought from other studs. AI is an effective method of introducing new high ranking sires into a flock with each unit of semen a fraction of the cost of the value of the ram himself. AI has been shown to slightly increase lambing percentage over natural mating scenarios.

Multiple ovulation and embryo transfer is performed on sexually mature ewes. The donor ewes require a series of hormonal injections to help them super-ovulate—or release many eggs at once. These eggs are fertilised via AI and then “flushed” five days later. The embryos are then transferred to recipient ewes whose oestrus cycles have been synchronised with the donor ewe(s’). MOET programs can yield between 1 and 25 live lambs per donor ewe but often average around 4–6 lambs.

Juvenile *in vitro* embryo transfer can only be performed on juvenile ewe lambs around 4–8 weeks of age. Donor ewe lambs have their ovaries hormonally stimulated, eggs are then surgically aspirated from their ovaries. These eggs are fertilised in a lab (often by frozen-thawed semen) and then grown in the lab for 5 days. Embryos are then transferred into recipients whose oestrus cycle have been synchronised with the day of fertilisation. JIVET programs can yield between 1 and 80 live lambs per donor ewe but often average around 8–15 lambs.

How much genetic gain can we achieve?

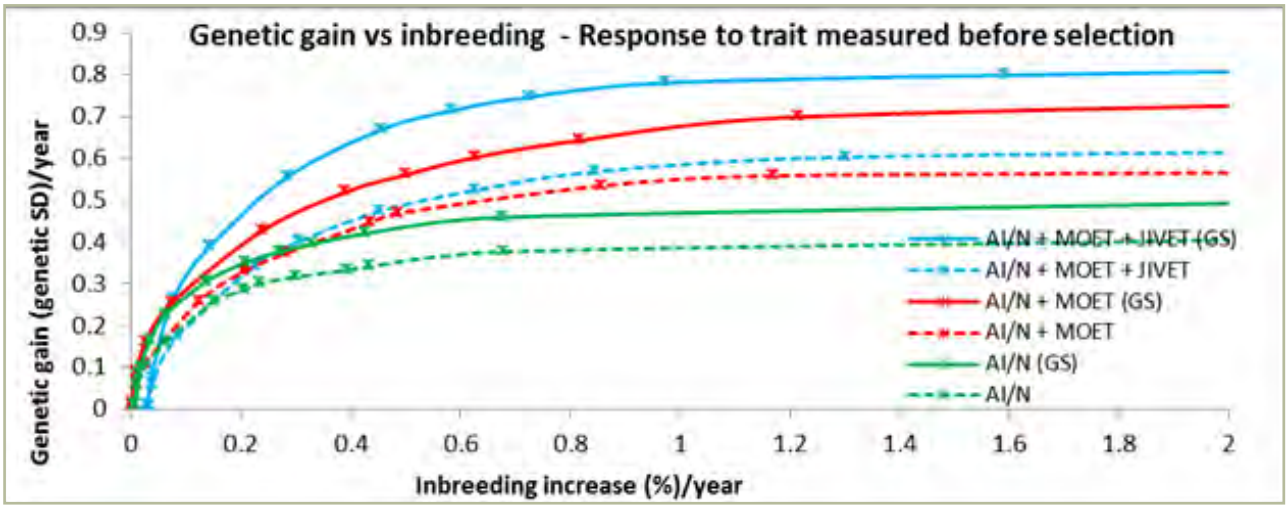
Artificial insemination in closed nucleus breeding programs will yield little extra genetic gain compared to using natural mating.

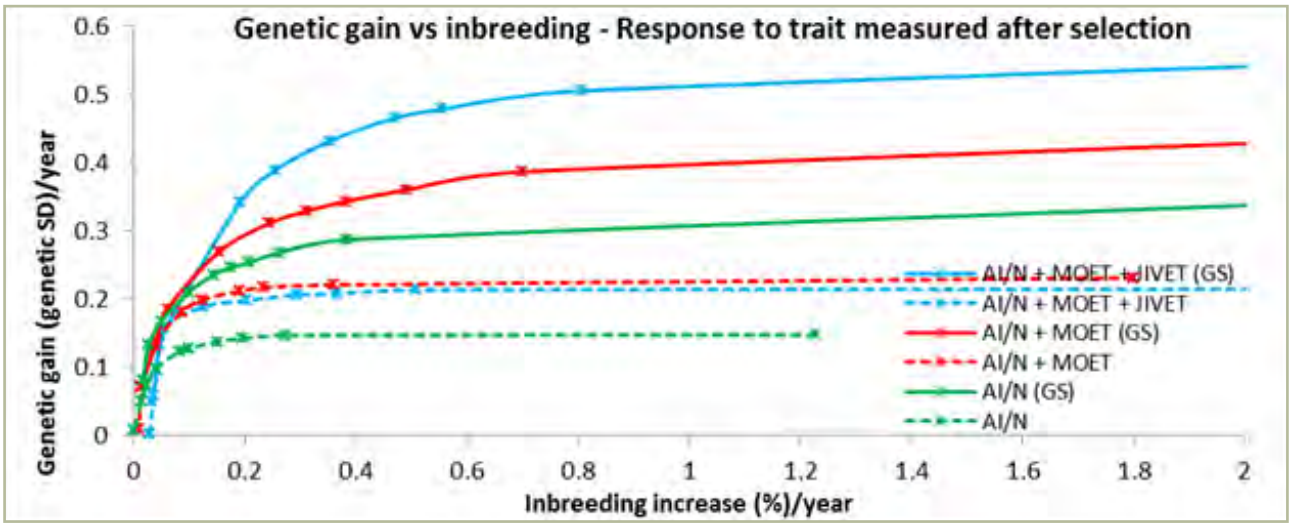
The amount of extra gain using genomic selection with reproductive technologies will depend on when traits are (or if they are) measured on selection candidates. Genomic selection provides most benefit to animals that are selected prior to measurement.

MOET can yield from 25–50% extra genetic gain when used with artificial insemination or natural mating (AI/N) without using genomic selection. If MOET and genomic selection are used together genetic gain can increase by 80–180% when compared to AI/N breeding programs not using genomic selection. Genetic gain can be attributed to increasing selection intensity on elite females

from within the nucleus. Variation around gains will depend on when traits are measured in breeding objectives. Genomic selection provides most benefit to animals that are selected prior to measurement.

JIVET used in conjunction with AI/N and MOET yields *no extra genetic gain without the use of genomic selection*. However, in the same scenario where selection candidates are genotyped, the addition of JIVET to AI/N and MOET will yield 200–400% more genetic gain than AI/N (no GS) breeding programs. Accelerated rates of genetic gain can be attributed to increased selection intensity on elite females (identified during genomic selection), and by decreasing generation interval in the juvenile donors.





Figures: Average annual genetic gain (genetic standard deviations) and rate of inbreeding (%) in A) trait measured before selection and B) trait measured after selection using reproductive technologies with and without genomic selection. Data points represent different penalties on co-ancestry, with no penalty on the far right and a high penalty on the far left.

Inbreeding

High levels of inbreeding should be avoided as inbreeding can increase chances of expression of lethal recessive diseases, decrease fertility and production. Using reproductive technologies increases selection intensity on selection candidates, meaning less sheep are bred from. This can lead to increased rates of inbreeding if left unsupervised or unpenalised (far right of Figures A and B). This is caused by selecting the best families within a flock. Mate selection programs such as Matesel are an effective method of optimising rates of genetic gain and managing inbreeding rates if pedigree is known in the nucleus. Mate selection programs can optimise allocations of matings meaning the best individuals from each family are selected. This helps reduce inbreeding without sacrificing too much genetic gain. Selecting for too much diversity is usually impractical given so many different sires are used AND rates of genetic gain suffer (far left of Figures A and B).

Costs

The cost of reproductive technologies is a significant motivating factor in deciding whether or not to use them. The cost of reproductive technologies per lamb will vary from program to program depending on the success of each one. The cost of each program in a closed nucleus will depend upon:

- Drugs
- Labour
- Professional services
- Semen collection cost (if applicable)
- Cost of empty recipients
- Cost of semen (if open nucleus)

To put an average on cost per lamb in a closed nucleus for each program we have consulted literature, technicians and producers (Table 1).

Table 1: The range of live progeny per female per mating for the various reproductive methods, average cost per ewe to apply reproductive technology and average cost per lamb from reproductive technology.

Program	AI	MOET	JIVET
Average lambs	1	5	12
Range of lambs	0-3	0-25	0-80
Coast of semen	40	40	5
Cost per ewe ($)	65	600	1200
Cost per lamb ($)	65	120	100

The cost of using reproductive technologies can be recouped two ways to make using them an economically viable mating option. The first method for recouping the cost of using reproductive technologies is to attract a premium for sale of sheep. A premium can often be achieved when ASBVs of sheep are very high, which can be the result of accelerating rates of genetic gain using reproductive technologies. The second method is to recoup costs by breeding sheep in a nucleus to sire progeny in a commercial flock owned by the same producer. This is the most effective way to capture all of the benefit of accelerated genetic gain breeding programs. To make either option viable, nucleus breeders should be aiming for annual gains of at least 3 index points ($3) per year per sheep on average in the nucleus.

More information

Granleese et al. (2015) http://www.gsejournal.org/content/47/1/70