Breech Strike Genetics

This Project is a collaborative research effort of CSIRO Animal, Food and Health sciences, Armidale, NSW and Department of Agriculture and Food WA supported by Australian Wool Innovation Limited

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In this newsletter we report on some of the annual activities of the Armidale selection lines including;

- ***Flystrike results for the 2012-13 fly season (moderate flystrike incidence),***
- ***Wool production and reproduction results for 2012***

We also have an update on activities that were introduced in the previous issue (no. 5. November 2012);

- ***The 2nd (and final year) results relating to changes in breech traits in breeding ewes throughout the reproduction cycle.***
- ***Update on the flystrike genomics work***

In addition, genetic trends in the Resistant and Susceptible selection lines for a range of production traits are examined in light of the original objective and the change in the breeding objective that occurred in 2010.

Figure 1. 2011 drop ewes, both selection lines (Resistant and Susceptible, in the Spring of 2012)

Flystrike genomics update

In 2012 we commenced a flystrike genomics project with the aim of identifying regions on the Merino genome associated with breech flystrike resistance or susceptibility.

This work has taken a little longer to progress than anticipated because the technology in this field changes very rapidly. This Project was originally proposed with a design based on ovine 50K SNP Beadchips (those that have been used in the Sheep Genetics/ Sheep CRC Genomics Pilot Projects). However, in the period between Project proposal and commencement, a High Density (700K, HD) ovine SNP Beadchip was developed. So, some additional time has been spent in evaluating several different strategies and the Project has now been redesigned (using the same budget) to use the 700K HD Beadchips instead.

Animals from both the Armidale and Mt Barker flocks that have been breech struck (and particularly those that have been struck on multiple occasions) are paired with not-struck animals from the same contemporary groups (same flock, birth-year, sex, mulesing status, and degree of breech wrinkle, breech cover and dag). This is called a case-control design and is used routinely in human medical and disease studies.

These pairs of animals will be genotyped using the 700K HD SNP Beadchips. Some additional animals will also be genotyped with a pooled DNA technique using lower density chips (7K or 12K). Whole genome analysis will be performed to identify statistically significant deviations in allele frequency between the struck and not-struck populations. A good result will be a list of SNP and genomic regions which display clear evidence for selection in response to breech flystrike.

As we go to press, the DNA extractions are complete the HD SNP chips have been delivered to our Brisbane laboratory, and the genotyping work is in progress.

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Flystrike Results in 2012-13

The 2012-13 fly season was regarded to be a moderate flystrike incidence year. In that year there were consistent trends in all sheep classes indicating Resistant line animals have lower breech strike rates than those in the Susceptible lines. The differences between the selection lines were not statistically significant, but they are in general agreement with results from previous years when the line differences have been statistically significant. Figure 2 shows the breech strike results for the 2012 drop weaners, 2011 drop yearling ewes and the breeding flock.

Among the breech strike indicator traits (which include breech wrinkle, breech and crutch cover, dag and urine stain), dag was significantly associated with breech strike in weaners and yearlings. Expression of dag in this flock and environment is usually low, but when it does occur, it puts the sheep at very high risk of breech strike.

In the history of this flock, average dag score of any mob is usually less than 1.5, has never exceeded 2.0, and the percentage of animals in any mob with dag score greater than 2 rarely exceeds 10%. The level of dag in the yearling ewes this year was among the highest recorded in this Project (average 1.52, 13% > score 2). This demonstrates that on the occasions that dag is an issue, the sheep are at very high risk of breech strike.

Although very few animals in this environment exhibit severe dag (greater than score 2), those that do so during the flystrike season are at very high risk of breech strike. Figure 3 shows the relationship between breech wrinkle and breech strike, and between dag and breech strike in yearling ewes in 2012-13. These results were very similar to those for the weaners and demonstrate that in this particular year dag was a far greater influence on breech strike than breech wrinkle.

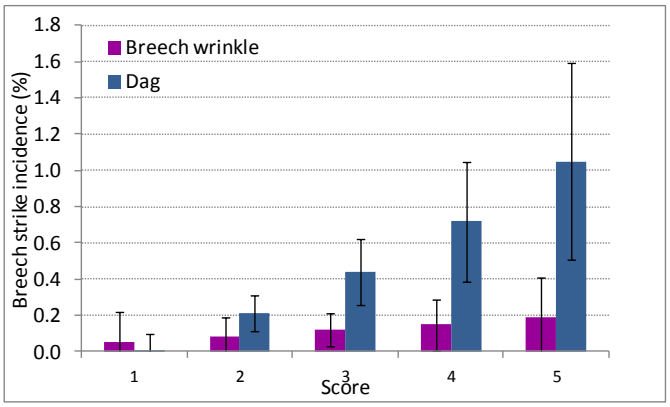


Figure 3. Association between breech wrinkle and breech strike, and between dag and breech strike in yearling ewes in 2012-13. Note: dag scores 4 and 5 have very high errors associated with the breech strike estimates because there are so few animals in those categories compared to the lower dag scores.

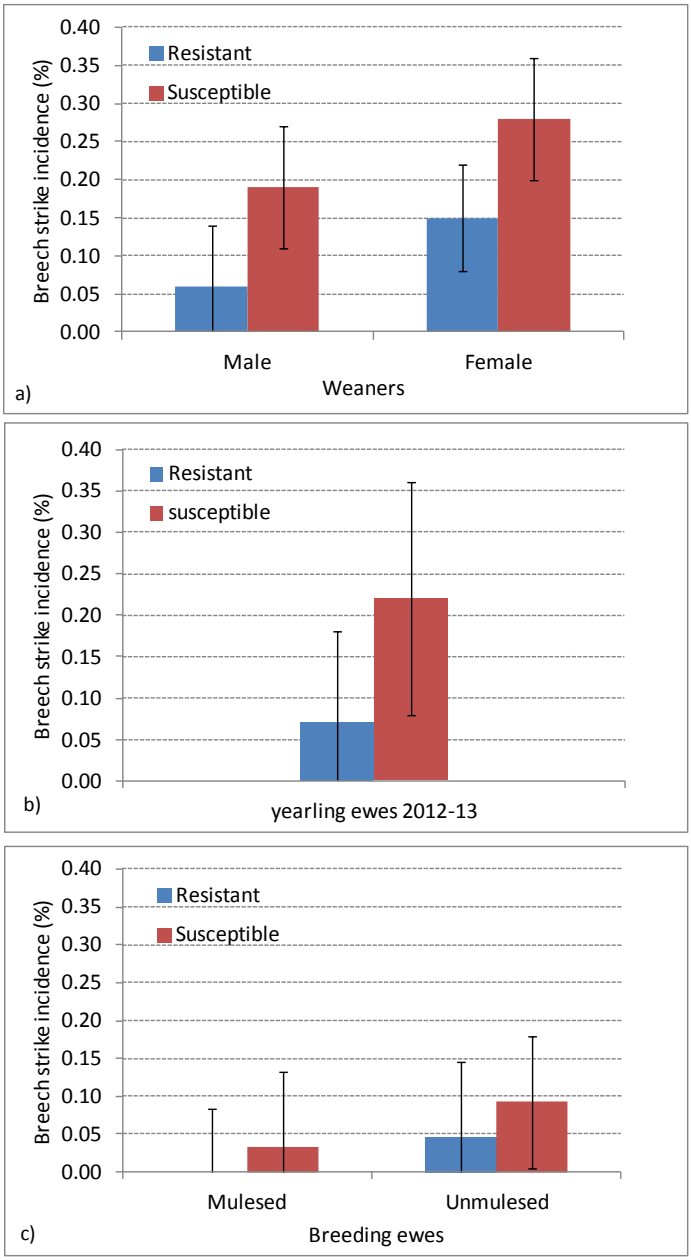


Figure 2. 2012-13 breech strike in a) weaner rams and ewes (all unmulesed), b) yearling ewes (all unmulesed), and c) breeding ewes (mulesed and unmulesed).

Effects of fertility (pregnant/dry) and net reproduction rate (lambs weaned) on breech strike rate were tested in the breeding flock, and although not statistically significant, there was some evidence that dry ewes were more likely to be breech struck than those that were pregnant (0.15 (0.28) *vs* 0.03 (0.08). The unknown though, is; are ewes that are flystrike susceptible also less fertile or, are ewes that don't become pregnant more susceptible (eg. because they have longer staple length and therefore more urine stain)? Again, there are very high errors on those breech strike estimates because the breech strike rate in the breeding ewes was low and there were very few dry ewes.

Reproduction performance

Table 1. is a summary of reproduction performance in the Resistant and Susceptible selection lines to date. The reproduction figures vary widely between years due to environment, breeding flock age structure, and mating methods. However, there are consistent selection line differences in favour of the Resistant line, across years in fertility (ewes pregnant/dry), fecundity (number of lambs born) and net reproduction rate (number of lambs weaned). In the earlier years of the Project mating was entirely by artificial insemination because we were using sires from industry. See pages 4-6 for additional production results.

Table 1. Summary of reproduction performance by selection line and mating year.

		Mating year						
		2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
	Ewe age classes	2-4yo ('01-03 drop)	2yo ('05 drop)	2-3yo ('05-06 drop)	2-4yo ('05-07 drop)		2-6yo ('05-09 drop)	3-7yo ('05-09 drop)
	Mating method	AI only	AI only	AI only	AI + BU		AI + BU	Natural
Resistant line	**Ewes mated (n)**	200	202	200	208	No mating	201	192
	Sires (n)	4	4	4	4		5	4
	Fertility (%)	69	50	66	89		93	98
	Fecundity (NLB, %)	87	53	80	116		123	151
	NLW (%)	69	41	60	85		98	136
Susceptible line	**Ewes mated (n)**	208	200	196	208		203	200
	Sires (n)	4	4	4	4		5	4
	Fertility (%)	67	44	61	89		93	91
	Fecundity (NLB, %)	84	44	68	109		106	131
	NLW (%)	66	38	52	80		70	102

AI = intrauterine artificial insemination, BU = backup ram single sire mated for 21 days starting 14 days post-AI

All reproduction traits as a percentage of ewes mated

Figure 5. Sires from the Resistant (Left) and Susceptible (Right) selection lines at Armidale. These are not necessarily the sires used in any particular year, but an example of the sheep type emerging from the two lines.

Wool Production in the Resistant and Susceptible lines

Production traits in the Resistant and Susceptible lines are outlined below. Details for two groups of sheep are presented – the 2011 drop as yearlings in 2012 (Table 2), and the breeding ewe flock at the 2013 shearing (Table 3). Annual reproduction and wool production cycles are not synchronised in this production system — ewes were late pregnant and lactating with the 2012 drop lambs during the 2012-13 wool growing year.

Table 2. Selection line means (s.e.) and ASBV's (where applicable) for 2011 drop yearling bodyweight, fleece, wrinkle and wool cover traits.

	Selection line means			ASBV's (yearling)	
	Resistant	Susceptible	P	Resistant	Susceptible
yWT (kg)	34.3 (0.5)	31.2 (0.7)	*	1.4	-1.7
CFW (kg)	2.08 (0.04)	1.98 (0.06)	ns	-8.4	-12.6
MFD (µm)	15.8 (0.1)	15.4 (0.1)	ns	-1.9	-2.3
CVD (%)	18.5 (0.1)	19.0 (0.2)	ns	-1.7	-1.1
CURV (º/mm)	102.4 (0.9)	104.1 (1.2)	ns	8.2	11.8
SL (mm)	77.0 (1.1)	69.3 (1.5)	**	-0.4	-6.8
SS (N/ktex)	32.6 (0.5)	32.2 (0.7)	ns	2.7	2.4
BRWR (1-5)	2.79 (0.09)	3.55 (0.12)	**	-0.58	0.55
CCOV (1-5)	3.59 (0.07)	3.88 (0.09)	P=0.075		
BCOV (1-5)	3.68 (0.07)	4.05 (0.09)	*		
ns not significant, * P<0.05, ** P<0.01, ***P<0.001					

Table 3. Selection line means from the 2013 shearing (s.e.), and ASBVs (July 2013) for breeding ewe body-weight (pre-mating), fleece traits and number of lambs weaned.

	Selection line means 2013 shearing			ASBV's (adult)	
	Resistant	Susceptible	P	Resistant	Susceptible
BWT (kg)	52.2 (0.6)	49.6 90.5)	*	1.2	-2.2
CFW (kg)	2.92 (0.04)	3.06 (0.04)	*	-6.1	-8.6
MFD (µm)	17.4 (0.1)	17.0 (0.1)	**	-1.9	-2.6
CVD (%)	17.9 (0.2)	17.9 (0.1)	ns	-0.8	-0.5
CURV (◦/mm)	102.9 (1.2)	105.6 (1.1)	***	6.6	11.4
SL (mm)	81.0 (0.9)	74.4 (0.8)	***	-3.7	-8.7
SS (N/ktex)	35.7 (0.6)	33.6 (0.5)	ns	0.9	0.8
NLW	-	-	-	0.01	-0.02
ns not significant, * P<0.05, ** P<0.01, *** P<0.001; NA not yet available					

For all traits except fleece weight of adults, selection line mean values are consistent with the ASBV's. For example, in yearlings the Resistant line has heavier bodyweight, broader fibre diameter and heavier fleece weight than the Susceptible line, and the respective ASBVs reflect those figures. For adult ewes, the Resistant line have heavier bodyweight, broader fibre diameter but lighter fleece weight than the Susceptible line, but the ASBV's for adult fleece weight indicate the opposite (i.e. that the Resistant line should have heavier fleece weight than the Susceptible line).

The reason for the discrepancy around adult fleece weight is unknown, but was also observed in the previous year in this flock. This may have occurred because the actual group means are based on data from a single year where the ewes were at various ages and parities, while the ASBV's are calculated from their 2 year-old (1st adult) record which occurs when the ewes are mid-pregnant for the first time. There may be several reasons why the Resistant line ewes do indeed have lower fleece weights as adults; they lose more wool from the points as they age and are affected by reproduction; fleece weight may be compromised by reproduction to a greater degree in the Resistant than Susceptible line (since the NLW in the Resistant line is higher than for the Susceptible line); or the effect observed could be 'carry-over' from the earlier years of the Project when the selection lines were highly divergent for fleece weight.

Genetic trends in Production traits

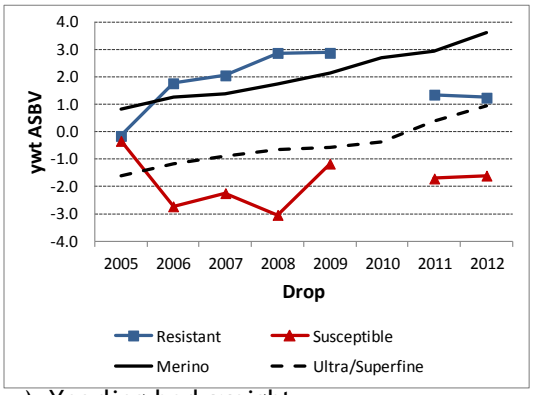
Figure 6 a) to j) shows genetic trends based on Sheep Genetics ASBV's in the Resistant and Susceptible lines for key production traits. No progeny were produced in 2010 (hence the gap in the line graphs), as that was a period between cessation of the original project and subsequent continuation.

The flock structure and selection procedure was changed prior to the 2011 drop. The flock was changed from 3 selection lines (Control, Commercial and Intense selection) with flystrike indicators as the selection criteria (predominantly breech wrinkle, breech cover and dags) to 2 selection lines (Susceptible and Resistant) with flystrike history as the primary selection criterion followed by the flystrike indicators. The control line of 2005-2009 inclusive is regarded to be equivalent to the current Susceptible line, and the Intense selection line of 2005-2009 is regarded to be equivalent to the current Resistant line.

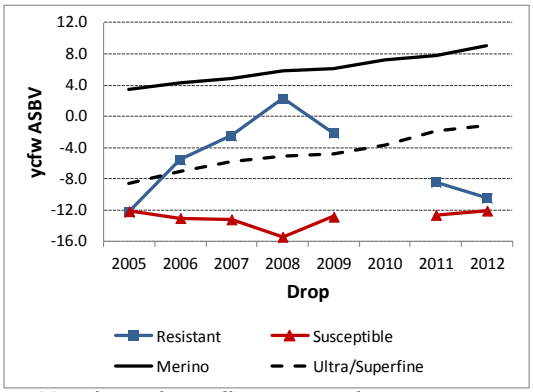
In early 2011 there was also a one-off selection procedure to confine the sheep/wool type to superfine/fine wool sheep which are more suited to the local environment. Sheep of very broad fibre diameter and low fibre curvature, predominantly progeny of medium wool sires, were removed from the flock. These are the reasons for the clear change in direction of some traits between the 2009 and 2011 drop.

The Resistant and Susceptible selection lines are highly divergent for early breech wrinkle, and lay either side of both the Merino and Superfine breed averages (Figure 6h)). Both selection lines are superior to the Superfine average for CV of fibre diameter (Figure 6 d)) and staple strength (Figure 6 f)), but are several percentage points below the Superfine average for clean fleece weight (Figure 6 b)). For all traits except CV of fibre diameter, the Resistant line lies closer to the Superfine breed average than the Susceptible line.

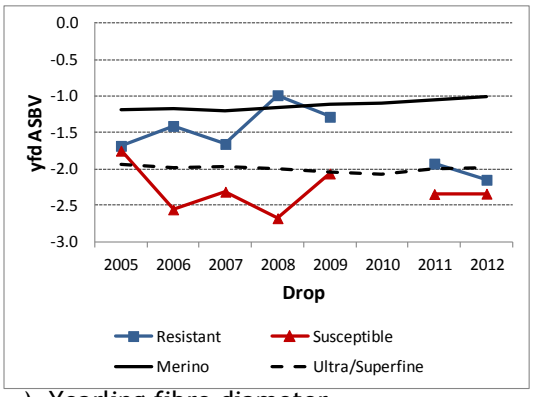
Both selection lines are close to the Superfine average for the Fibre Production Plus (FP+) index, but the genetic trends in the individual traits indicate they achieve that in different ways. The Susceptible line has advantage over the Resistant line in fibre diameter and staple strength (both important traits in the FP+ index), but the Resistant line has advantages over the Susceptible line in bodyweight, fleece weight and number of lambs weaned.



a) Yearling bodyweight



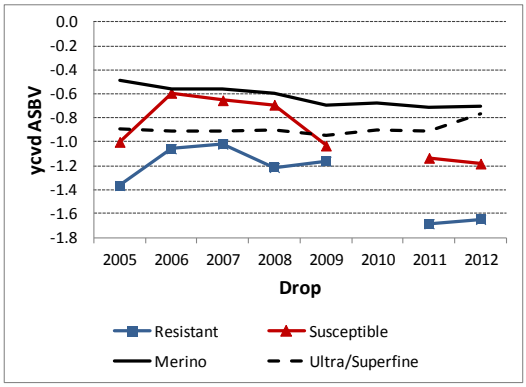
b) Yearling clean fleece weight



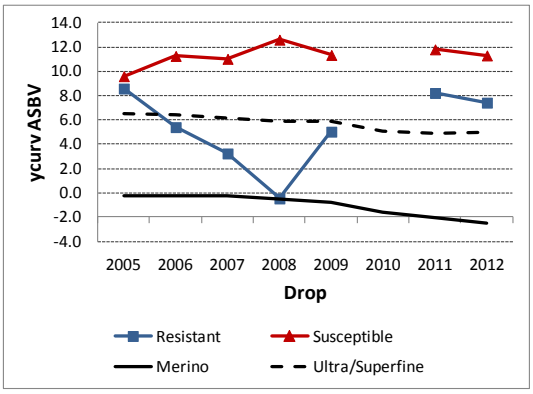
c) Yearling fibre diameter

Figure 6 (continued over page). Genetic trends in production traits for Resistant (actually Intense Selection 2005-09, then Resistant 2011-12) and Susceptible lines (actually Unselected Control 2005-2009, then Susctepible 2011-12). Solid black lines indicate Merino breed trait averages, and dotted black lines indicate Superfine type trait averages (June 2012), a) bodyweight; b) clean fleece weight; c) fibre diameter; d) coefficient of variation of fibre diameter; e) staple length; f) staple strength; g) fibre curvature; h) breech wrinkle; i) number lambs weaned; j) fibre production plus index.

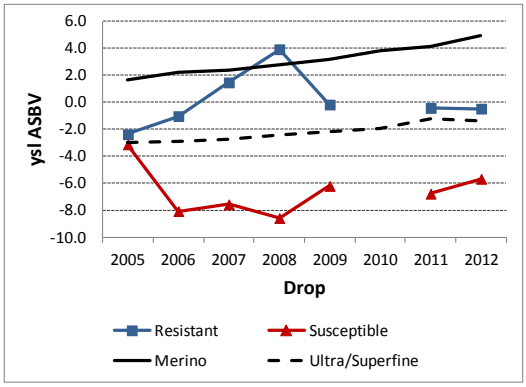
Genetic trends (continued from previous page)



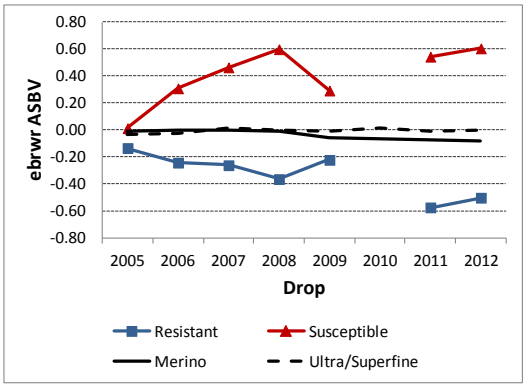
d) Yearling coefficient of variation of fibre diameter



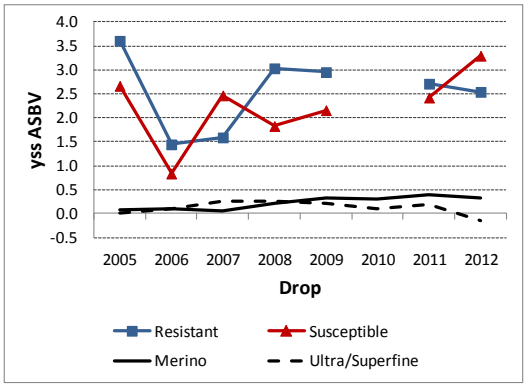
g) Yearling fibre curvature



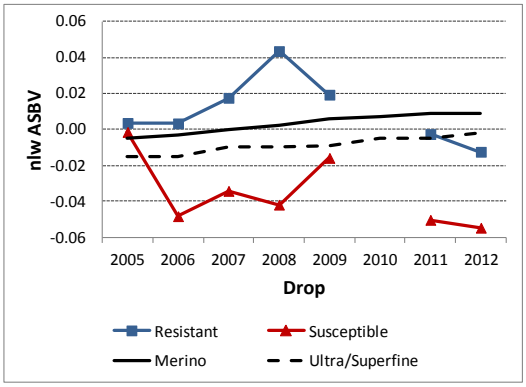
e) Yearling staple length



h) Early breech wrinkle

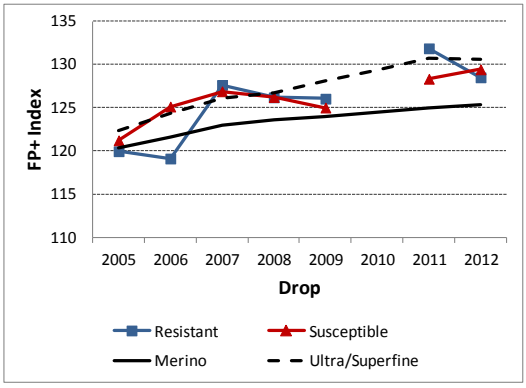


f) Yearling staple strength



i) Number of lambs weaned

Figure 6 (continued from previous page). Genetic trends in production traits for Resistant and Susceptible lines. Solid black lines indicate Merino breed trait averages, and dotted black lines indicate Superfine type trait averages (June 2012), a) bodyweight; b) clean fleece weight; c) fibre diameter; d) coefficient of variation of fibre diameter; e) staple length; f) staple strength; g) fibre curvature; h) breech wrinkle; i) number lambs weaned; j) fibre production plus index.



j) Fibre production Plus Index

Changes in breech traits in breeding ewes during the year

Introduction

2012 was the 2nd of a 2-year study of changes in breech traits with changes in physiological state of breeding ewes. This is of interest as it potentially has implications for breeding for breech flystrike resistance using indirect indicators — in a commercial setting, most measurement of breech traits for selection purposes will be conducted on young animals, but in at least some environments, breeding ewes are a susceptible class of animals.

Methods

The flock was measured for several breech traits on 3 occasions over the 2012 production cycle. Measurements were conducted post-weaning in January; off-shears, late pregnancy in July; and post-weaning in late January 2013. Breech traits included were breech wrinkle (BRWR), crutch cover (CCOV), and breech cover (BCOV).

A natural mating was conducted for 5 weeks commencing in the first week of April 2012. Except for during the mating and lambing periods, when the ewes were in single-sire groups, all ewes were run together.

Two factors relating to reproduction effects were examined. These were reproduction performance previous to 2012 and in the current year (2012), and both were a combination of fertility (pregnant/not) and net reproduction rate (lamb(s) weaned).

Effect of previous reproductive performance

Reproductive performance in previous years affected all traits in January 2012 (pre-mating) except breech bare depth. The clearest effect of reproductive history was on crutch cover. Ewes that were dry had significantly higher (more woolly) crutch cover than ewes that lambed-and-lost, and those that had lambed-and-lost had significantly higher crutch cover than those that had reared lambs previously (Figure 7. Breech cover tended to reflect crutch cover in that dry or lambed-and-lost ewes tended to have higher breech cover scores (more woolly) than ewes that had reared lambs. Face cover has not specifically examined here, but is known to be genetically correlated with breech cover in this flock (0.52 (0.11)).

Effect of current reproductive performance

Reproductive performance in the current year was a significant effect on all traits at some, or all time-points. Dry ewes consistently exhibited higher crutch and breech cover (i.e. were more woolly) than ewes

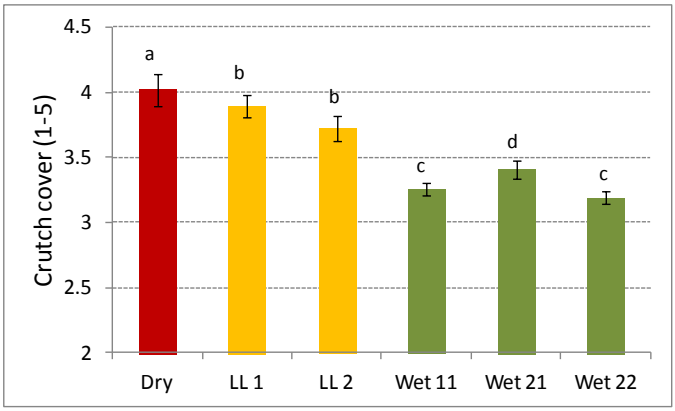


Figure 7. Effect of previous reproductive performance on crutch cover. Dry (previously dry on all occasions); LL1 (never reared, lambed-and-lost once); LL2 (never reared, lambed-and-lost at least twice); Wet11 (pregnant once and reared once); Wet21 (pregnant at least twice, reared once); Wet22 (pregnant and reared at least twice). Red bar = Dry, yellow bars = LL, green bars = Wet. Bars with the common superscript are not significantly different from each other.

that became pregnant during 2012 (regardless of whether they lambed-and-lost or reared a lamb(s)). Ewes that reared lambs (i.e. maintained a lactation) were barer around the breech and crutch at weaning than those that lambed-and-lost, which were intermediate between wet and dry ewes (Figure 8, over page). ***This result indicates that crutch cover, or loss of wool fibre in the inguinal and udder region is associated with lactation rather than pregnancy.***

Breech wrinkle results (Figure 8, over page) were consistent with the previous year and ***indicate that changes in breech wrinkle are associated with body condition.*** Dry ewes were the most wrinkly, but their wrinkle score decreased over the year. Pregnant ewes were plainest in July (late pregnancy), suggesting their low wrinkle score was associated with their physical size and shape at that time. At weaning (in January) both wet and lambed-and-lost ewes had similar degree of wrinkle, which was also similar at the same time the previous year.

Changes in breech traits in breeding ewes during the year

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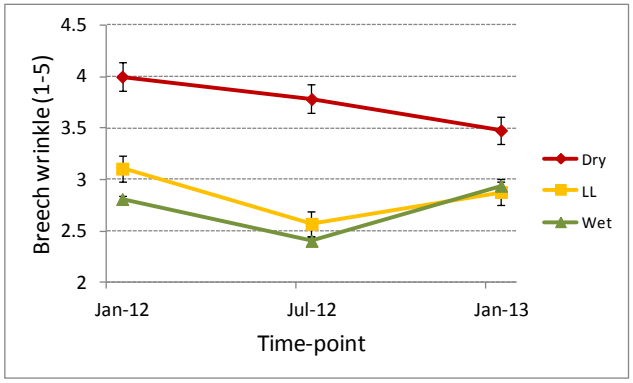

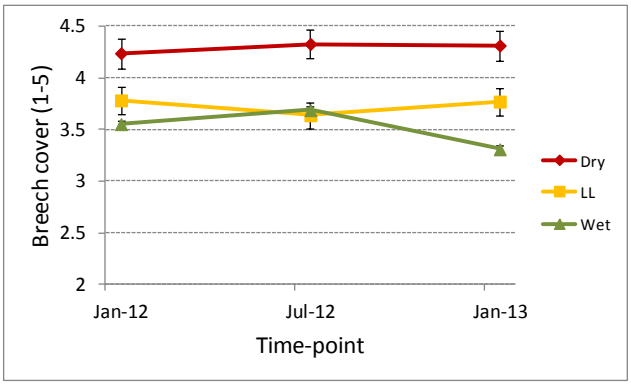

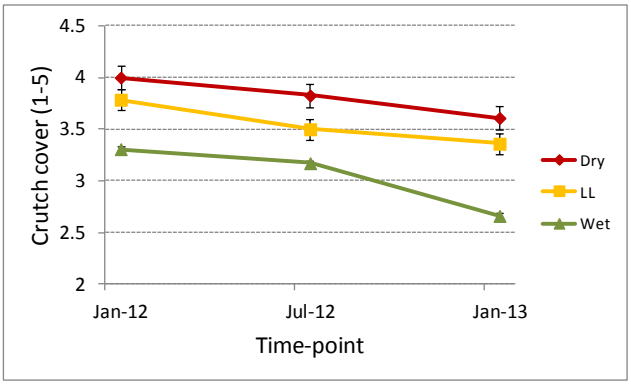

Figure 8. Effect of reproduction in 2012 on breech wrinkle (upper), crutch cover (middle) and breech cover (lower).

Conclusion

Results relating to reproduction effects on wrinkle and breech traits were generally consistent across the two years of study and indicate that changes in wrinkle during the year are associated with changes in the ewes' physical state (pregnant/not). By contrast, changes in wool cover are associated with lactation rather than pregnancy. This observation is more pronounced for crutch cover (inguinal region) than breech cover. These results provide scientific evidence for an observation that has been made anecdotally in industry for some time – that ewes that repeatedly rear lambs are barer than those that do not.

Earlier issues of this newsletter outlined the project background, objectives and design, along with progress reports and interim results. Copies are available from Heather Brewer using details below or go to http://www.wool.com/Grow_Animal-Health_Flystrike-prevention.htm

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