Proc. Assoc. Advmt. Anim. Breed. Genet. 19:231-234

PEDIGREE MATCHMAKER: CAN IT TELL US MORE THAN JUST PEDIGREE?

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SUMMARY

Pedigree MatchMaker is an RFID panel reader system that collects sheep movements to and from watering points over a 2 week period to identify pedigree. While this system was primarily developed to identify the pedigree of lambs, it may also provide information relating to lamb and ewe behaviour traits which influence sheep performance. Traits were calculated from the Pedigree MatchMaker data to describe the level of association between the lamb and its assigned dam, as well as some traits to reflect timing and frequency of passes through the panel reader. Variance components for these traits were estimated and relationships with other standard Sheep Genetics production traits studied. The Pedigree MatchMaker traits examined in this study were shown to be moderately heritable ranging from 0.15 average time between a ewe and her lamb to 0.53 for the number of close reads. The preliminary correlations suggest some favourable correlations between these traits and production traits. Based on these results further study is warranted on a larger data set.

INTRODUCTION

Assigning pedigree is a vital part of any modern breeding program. The CRC for Sheep Industry Innovation (www.sheepcrc.org.au) and its predecessor along with a number of collaborating sheep breeders, developed a system using radio frequency ear tags to assign pedigree by association (Richards *et al.* 2006; Richards and Atkins 2007). The Pedigree MatchMaker (PMM) system utilises a portable panel radio frequency identification tag (RFID) reader to capture sheep movement to and from a watering point over a 2 week period. While PMM has been shown to assign pedigree relatively accurately (90 to 96%) (Richards and Atkins 2007) it may be possible to examine the data in more detail to identify other traits which describe the level of association between animals, as well as other behaviour traits. The aim of this study was to define and calculate additional traits from the PMM data and estimate their heritability and correlations with standard sheep production traits.

MATERIALS AND METHODS

Data. All data for this study originated from the Centre Plus Merino ram breeding flock (www.centreplus.com.au). PMM data were available from 4 years and comprised RFID tag reads for ewes and their lambs as they entered and exited a watering point over a 2 week period. From these data a series of traits were calculated which aimed to describe lamb and ewe association and watering behaviour of the sheep. These traits were:

Compat — The compatibility between the lamb and the ewe chosen as the dam. Calculated as a function of the number of reads and average distance in reads from the selected dam, adjusted for each lambs superiority above his/her dam group. Compat = (C/A)*(P/100) where C is the number of times a lamb follows a ewe within 2 tag reads, A is the average distance in tags reads the lambs tag is from the ewes tag (1 to 2) and P is C expressed as a percentage of the average of C for all lambs for each ewe.

* AGBU is a joint venture of Industry and Investment NSW and University of New England

CloseReads	The number of reads within 5 secs of the selected dam.
AvSecs	The average time in seconds between the lamb and its selected dam.
nTimes	The number of times the animal passed through the reader.
AvgTime	The average time of the day since midnight when the animals tag was captured.
nDays	The number of days during the PMM period that the animals tag was captured.
Times/day	The average number of times per day that the animal passed through the reader.

The calculation of all times traits excluded hours where the animal had more than 4 reads to avoid problems arising from animals which played and camped close to the panel reader. A summary of the data used for each PMM trait is shown in Table 1.

These PMM traits were then merged with pedigree and performance data extracted from the Sheep Genetics MERINOSELECT database (Brown *et al.* 2007), which included birth (Bwt), weaning (Wwt), post weaning (Pwt), and yearling body weight (Ywt); yearling fat depth (Ycf), yearling eye muscle depth (Yemd), hogget greasy fleece weight (Hgfw), hogget fibre diameter (Hfd), hogget fibre diameter coefficient of variation (Hfdcv), hogget staple length (Hsl), hogget staple strength (Hss), yearling worm egg count (Ywec) and number of lambs weaned (Nlw). The pedigree was built using all ancestral information available and resulted in a pedigree comprising 3,535 animals, 318 sires and 1,426 dams. The 384 repeat records for the PMM traits originated from ewes having records across years as well as some animals being lambs in one year and ewes in subsequent years. On average dams had 2.2 progeny (ranging from 1 to 8), with 82% of lambs coming from dams with more than 1 progeny.

Table 1. Summary of the data used in this study

Trait	Animals	Records	Mean	SD	Min	Max
Compat	1,634	1,634	48.5	67.9	0.0	753.0
CloseReads	1,379	1,379	6.9	5.2	1.0	33.0
AvSecs	1,379	1,379	2.4	0.9	0.0	5.0
nTimes	2,391	2,962	22.8	12.2	1.0	71.0
AvgTime	2,391	2,962	10.7	2.0	4.0	23.0
nDays	2,391	2,962	12.0	5.3	1.0	27.0
Times/day	2,391	2,962	1.9	0.7	1.0	12.0

Analysis. Parameters were estimated in univariate analyses for each PMM trait, fitting an animal model in ASReml (Gilmour *et al.* 2009). All traits were treated as a trait of the lamb. The model fitted the fixed effects of contemporary group and rearing type. Contemporary group was defined as year and PMM group. Random effects fitted included direct genetic effects and a maternal permanent environment effect. For the time traits which had repeated records a repeatability term was also fitted. A series of bivariate analyses was performed to estimate the correlations within PMM traits and those with the standard Sheep Genetic production traits. For production traits the data were analysed in the manner described for the Sheep Genetics analyses (Brown *et al.* 2007).

RESULTS AND DISCUSSION

All traits except AvSecs were moderately to highly heritable ranging from 0.32 to 0.53 (Table 2). The maternal environmental effects for these traits ranged from 0.02 to 0.13. AvSecs had a lower heritability (0.15) but significant maternal effects (0.12). These results suggest that all the PMM have genetic variation and could be changed through selection. The relatively small maternal effects are somewhat surprising given the young age of the lambs and obvious influence of the ewe. However the size of the data set may have restricted that ability to separate the maternal effects adequately. Very little repeated record variance was estimated for the time traits resulting in the repeatability simply being a function of the heritability.

Table 2. Phenotypic variance (σ^2_p), direct (h^2) heritability, maternal permanent environment (c^2) and repeatability (rep) effects as a proportion of phenotypic variance for the PMM traits (s.e. in parentheses)

Trait	σ^2_p	h^2	c^2	rep
Compat	4132.00 (175.32)	0.33 (0.09)	0.04 (0.03)	
CloseReads	25.96 (1.31)	0.53 (0.10)	0.12 (0.04)	
AvSecs	0.72 (0.03)	0.15 (0.08)	0.12 (0.04)	
nTimes	106.57 (3.39)	0.42 (0.03)	0.05 (0.02)	0.42 (0.03)
AvgTime	3.75 (0.12)	0.32 (0.03)	0.13 (0.03)	0.32 (0.03)
nDays	17.07 (0.53)	0.42 (0.03)	0.02 (0.02)	0.42 (0.03)
Times/day	0.44 (0.01)	0.36 (0.03)	0.13 (0.02)	0.36 (0.03)

Compat, CloseReads, nTimes and nDays were all highly genetically correlated (0.54 to 0.98) (Table 3). Furthermore animals that had higher compatibility or more close reads also had less time on average between the ewe and its assigned lamb (-0.53).

Table 3. Genetic (below) and phenotypic (above) correlations for PMM traits (s.e. in parentheses)

	Compat	CloseReads	AvSecs	nTimes	AvgTime	nDays	Times/day
Compat		0.80 (0.01)	-0.08 (0.03)	0.55 (0.02)	-0.02 (0.03)	0.50 (0.02)	0.22 (0.02)
CloseReads	0.98 (0.02)		-0.18 (0.03)	0.79 (0.05)	-0.15 (0.11)	0.90 (0.04)	0.25 (0.10)
AvSecs	-0.18 (0.27)	-0.53 (0.21)		-0.09 (0.19)	0.14 (0.22)	-0.04 (0.20)	-0.21 (0.19)
nTimes	0.92 (0.03)	0.54 (0.02)	-0.05 (0.03)		-0.06 (0.02)	0.79 (0.01)	0.51 (0.02)
AvgTime	-0.24 (0.13)	0.00 (0.03)	-0.05 (0.03)	-0.08 (0.07)		-0.08 (0.02)	0.04 (0.02)
nDays	0.98 (0.03)	0.62 (0.02)	-0.08 (0.03)	0.86 (0.02)	-0.08 (0.07)		0.08 (0.02)
Times/day	0.46 (0.11)	0.20 (0.03)	-0.04 (0.03)	0.64 (0.05)	-0.03 (0.08)	0.31 (0.07)	

Animals with higher birth weight had more close reads and higher Compat with their assigned dam (Table 4) which is likely to reflect the greater strength and ability to bond with its mother. Compat, CloseReads, nTimes and nDays all had favorable correlations with weaning weight and hogget greasy fleece weight. CloseReads and AvSecs also had favorable correlations with hogget fibre diameter. These results suggest that lambs with closer association with their dam had higher weaning weights and greater production later in life. These results are also likely to be partly driven by greater maternal influence or milk production but at present insufficient data are available to fully separate all the maternal effects. However the finding that Compat is uncorrelated with Pwt and Ywt is unusual given the high correlations between bodyweight traits. This is likely to be a consequence of most animals having Wwt records while only approximately half had a Pwt or Ywt. There could also be some influence of the intervention caused by the PMM system on Wwt which is removed by the time Pwt and Ywts are recorded.

CloseReads, AvSecs, nTimes, nDays and Times/day were favourably correlated with hogget staple length. These results may indicate that animals which drink more frequently produce longer wool. There was a favourable correlation of Compat and CloseReads with yearling worm egg count but also indications of an unfavourable correlation between nTimes with Ywec. This result suggests that there may be a negative relationship between watering frequency and worm burdens however this result appears illogical given that sheep that drank more than once per day may had a smaller foraging radius (Markwick 2007) thereby increasing their exposure to worm burden.

There was no indication of favourable correlations between PMM traits to NLW, nor were there any significant correlations between AvgTime and production traits.

Table 4. Phenotypic correlations of PMM traits with production traits (s.e. in parentheses with correlations significant different from zero based on s.e. shaded)

	Compat	CloseReads	AvSecs	nTimes	AvgTime	nDays	Times/day
Bwt	0.35 (0.14)	0.38 (0.04)	0.02 (0.05)	-0.06 (0.04)	-0.02 (0.04)	-0.09 (0.04)	0.00 (0.05)
Wwt	0.20 (0.03)	0.30 (0.02)	-0.01 (0.03)	0.18 (0.02)	-0.02 (0.03)	0.19 (0.02)	0.05 (0.03)
Pwt	0.06 (0.04)	0.19 (0.04)	0.07 (0.04)	0.19 (0.04)	0.05 (0.04)	0.14 (0.04)	0.18 (0.04)
Ywt	0.04 (0.04)	0.25 (0.03)	0.03 (0.04)	0.13 (0.03)	0.02 (0.04)	0.15 (0.03)	0.04 (0.04)
Ycf	-0.01 (0.04)	0.02 (0.04)	-0.00 (0.04)	-0.02 (0.04)	-0.02 (0.04)	0.02 (0.04)	-0.01 (0.04)
Yemd	0.00 (0.04)	0.01 (0.04)	-0.06 (0.04)	-0.05 (0.04)	0.00 (0.04)	-0.00 (0.04)	-0.06 (0.05)
Hgfw	0.10 (0.03)	0.19 (0.03)	0.05 (0.03)	0.10 (0.03)	0.04 (0.03)	0.13 (0.03)	0.03 (0.03)
Hfd	-0.03 (0.03)	-0.08 (0.03)	0.06 (0.03)	0.04 (0.03)	-0.00 (0.03)	0.05 (0.03)	0.04 (0.03)
Hdcv	-0.06 (0.03)	-0.10 (0.03)	0.01 (0.03)	-0.07 (0.03)	-0.04 (0.03)	-0.05 (0.03)	-0.05 (0.03)
Hsl	0.03 (0.03)	0.10 (0.03)	0.08 (0.03)	0.10 (0.03)	0.02 (0.03)	0.08 (0.03)	0.07 (0.03)
Hss	0.03 (0.04)	0.05 (0.04)	0.06 (0.04)	0.01 (0.04)	0.08 (0.04)	-0.02 (0.04)	0.06 (0.05)
Ywec	-0.10 (0.06)	-0.12 (0.05)	0.06 (0.05)	-0.12 (0.05)	-0.08 (0.06)	-0.08 (0.05)	-0.09 (0.06)
Nlw	-0.17 (0.10)	0.03 (0.04)	0.03 (0.03)	-0.00 (0.03)	-0.00 (0.03)	-0.01 (0.03)	-0.01 (0.03)

The preliminary genetic correlations (not presented) between PMM traits and production traits were similar to the phenotypic correlations however more data are required to estimate genetic correlations with sufficient accuracy to be reported.

CONCLUSIONS

Genetic variation is apparent for the PMM traits studied suggesting that genetic improvement is possible if these traits are shown to influence sheep production. The preliminary correlations suggest favourable relationships of both compatibility score and watering frequency with production traits. However more data are required to estimate more accurate genetic parameters and fully separate maternal genetic effects.

ACKNOWLEDGMENTS

This research is funded by Meat and Livestock Australia and Australian Wool Innovation, and Sheep Genetics is made possible through the support of the Australian sheep industry. The Pedigree MatckMaker system was developed by the CRC for Sheep Industry Innovation, its predecessor and the collaborating sheep breeders.

REFERENCES

Brown D.J., Huisman A.E., Swan A.A., Graser H-U., Woolaston R.R., Ball A.J., Atkins K.D. and Banks R.B. (2007) *Proc. Ass. Adv. Anim. Breed. Genet.* **17**: 187.

Gilmour A.R., Gogel B.J., Cullis B.R. and Thompson R. (2009) ASReml User Guide Release 3.0 VSN International Ltd, Hemel Hempstead, HP1 1ES, UK.

Markwick G. (2007) Water requirements for sheep and cattle, PRIMEFACT 326, NSW Department of Primary Industries, Orange, NSW.

Richards J.S., Atkins K.D., Mortimer M. and Semple S.J. (2006) *Aust. Soc. Anim. Prod. 26th Biennial Conf. 2006* Short Comm. 31, Perth, July.

Richards J.S. and Atkins K.D. (2007) *Proc. Ass. Adv. Anim. Breed. Genet.* **17**: 403.