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## Sheep Updates 2007 - part 5

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## **BEEF INDUSTRY**

Papers not available at this time

## **GENETIC IMPROVEMENT**

# **Breech Strike Resistance: Selecting for resistance traits reduces breech strike**

**Bindi Murray, John Karlsson, Johan Greeff, DAFWA, Katanning 6317**

## **ABSTRACT**

Phasing out surgical mulesing has challenged the sheep industry to move toward more sustainable techniques to manage breech strike. Selecting lambs that have low levels of skin wrinkle, wool coverage, dags, urine stain or yellow wool and scour less (resistance traits) decreased their incidence of breech strike. The un-mulesed sheep that were selected for resistance traits had the same level of breech strike as mulesed sheep that were randomly selected. This trend will continue to be investigated in different ages, years and seasonal conditions.

## **AIMS**

Breech strike has been estimated to cost the industry A\$147 million in reduced income and increased expenses each year (1). This research forms part of a project that aims to breed Merino sheep that are resistant to breech strike.

The hypothesis tested in this paper is that sheep selected for resistance traits are less susceptible to breech strike than sheep selected randomly.

## **METHOD**

### *Selection program*

600 ewe lambs born in 2005 were sourced from various Western Australian sheep producers to initiate the research project. Lambing on the properties ranged from mid May to early September. Lambs were scored for resistance traits immediately prior to lamb marking to allocate them to one of three selection lines.

Those with high bare scores and low wrinkle scores were allocated to the intense selection (IS) line. Animals that showed any dag formation or urine staining were not considered for this line. Ewe lambs that tended towards the average of the whole flock were allocated to the control line and ewes taken at random to demonstrate the full variation of the flock were allocated to the commercial selection (CS) line. A total of 60 lambs were taken from each of the 10 properties and 20 were used in each of the selection lines.

The lambs were marked on the property between late July and late September and 50% of each line was mulesed with the other 50% left un-mulesed. All tails were docked. They were moved to the Mount Barker Research Station after weaning in November and run as one mob.

### *Measurements*

No measurements were taken on the source properties except prior to lamb marking. The ewe weaners were then scored for the resistance traits in December, May and November. Bodyweight, condition score and dag score were also recorded in March and September. At wool harvesting (Bioclip) in October greasy fleece weight, yield, clean fleece weight, fibre diameter, coefficient of variation of fibre diameter, staple strength, staple length and fibre curvature, were measured for all animals. Ordinal regression was used to analyse categorical data and ANOVA was used on the continuous variables.

## Management

The sheep were not treated to protect them against breech strike. Crutching was done only on welfare and clip preparation grounds. The sheep were monitored regularly, especially when fly strike was expected. Animals that became affected were treated immediately with a short acting fly treatment and infested dags and wool were removed. Flies were trapped during the year to monitor fly challenge.

## RESULTS

The IS line sheep that were un-mulesed had the same incidence of breech strike as the mulesed sheep in the control group (Figure 1).

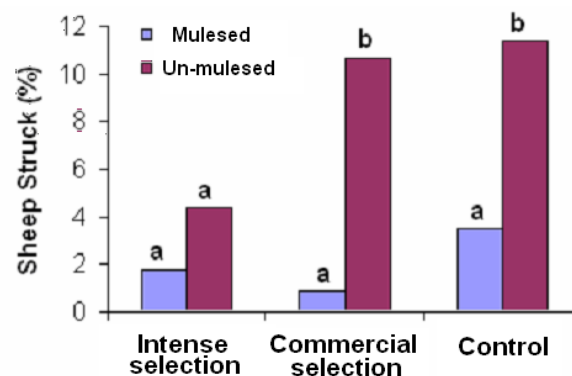


Figure 1. Incidence of breech strike in hoggets during 2006 at Mount Barker WA. There were three lines with different selection pressure for breech strike resistance and half of each line was un-mulesed.

The ewes in the IS line were significantly plainer, barer, less daggy and less likely to scour than the control group during 2006. They also had less urine staining and whiter wool. The IS line did not have significantly lower levels of dermo or fleece rot and there was no difference in worm egg count.

The IS line weighed more than the control line all year and produced wool that had lower CV of FD. There was an interaction between the source property and the selection lines in the other wool results.

The mulesed sheep had a lower body condition score than the un-mulesed sheep until they were nine months old when there was no difference between the groups. The mulesed sheep were also lighter all year ( $P < 0.1$ ). The mulesed sheep had lower dag scores when the average score for the mob was allowed to reach score 4. There was no difference in wool quality or quantity.

## CONCLUSION

Selecting lambs that had low visual scores for wrinkle, dags and urine stain and high visual scores for bare area at marking was as effective as mulesing sheep to reduce breech strike during 2006. Mulesing reduced the incidence of breech strike but affected growth in this environment and did not improve wool quality or quantity.

The dag score of mulesed sheep was lower than that of the un-mulesed sheep but under commercial conditions the mob would most likely have been crutched before they were allowed to reach an average of dag score 4. The improvement in the resistance traits of faecal consistency (scouring) and wool colour are surprising given that there was no direct selection placed on these traits when the animals were scored into the program.

## KEY WORDS

Mulesing, breech strike, genetic resistance

## **ACKNOWLEDGMENTS**

We wish to thank AWI for funding project EC940 and CSIRO Armidale as a collaborating research partner. We would also like to thank those local farmers who contributed animals to the project.

**Paper reviewed by:** Gus Rose

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# Breeding Merino Sheep for Worm Resistance increases profit in a Mediterranean Environment

John Karlsson and Johan Greeff, DAFWA, Katanning 6317

## ABSTRACT

In this trial the resistant line grew 0.2 kg more wool, and was 4.2 and 4.9 kg heavier than the control group at weaning and at hogget shearing, respectively which resulted in a 9.5% higher income from the resistant group. Therefore ram breeders should consider including worm resistance in their breeding objectives because of the economical and sustainability benefits.

## AIMS

To quantify and to demonstrate the whole farm benefits of worm resistant sheep.

## METHOD

The trial was done on the Mt Barker research station. The flock consists of 300 Merino ewes of which 150 were sourced from the Rylington Merino selection line and 150 ewes from the unselected control line (Karlsson *et al.* 1995). Within each line the ewes were allocated to three replicates and run in paddocks of approximately 5 hectares each, with 50 ewes per paddock to ensure a stocking rate of about 12 DSE which is approximately the average for this region. A set-stock management system was used to prevent any cross contamination that can occur between treatment groups. Six rams from each of the Rylington Merino resistant and control lines were used at two rams per replicate.

The lambs were born in July/August 2004 and weaned in November 2004. After weaning all the lambs were drenched and placed in separate paddocks to prevent any cross contamination. Live weights (BW), conditions score (CS) and faecal worm egg counts (WEC) were monitored approximately every 6 weeks. The animals were drenched at weaning but received no further drench as the WEC of each group did not exceed 250 eggs per gram. Animals were scored for dags and faecal consistency. Greasy fleece weight (GFW) was measured at shearing and a midside wool sample was collected and tested for fibre diameter (FD), coefficient of variation of FD, staple strength (SS), staple length (SL) and clean yield (YLD) which was used to calculate clean fleece weight (CFW).

### *Statistical analyses.*

Three hundred and twenty lambs were weaned and 159 records were available for the control and 161 records for the resistant group. The data were analysed with Genstat (2003) and a linear mixed model was fitted to the production traits. Only treatment (resistant vs. control genotype) and replicate were fitted as fixed effects in the model. Income from wool production was calculated using the Woolcheque prediction tool of Australian Wool Innovations (<http://www.wool.com.au/>) and income from meat production was calculated by using a standard price of \$1.20 per kg live weight after hogget shearing.

## RESULTS

The differences between the resistant and control genotypes are shown in Table 1. The resistant line had significantly lower WEC at weaning. There were no significant WEC differences at 14 months of age and the low WEC (52 vs 35 eggs per gram) indicates that the challenge during the year was very

low. However, the resistant line had a significantly lower DS. The resistant line was consistently heavier and had a higher CS than the control line. The resistant line produced about 0.2 kg more clean wool per sheep that was also 0.4 micron finer and had a higher yield.

The income from the resistant group was 9.5% higher than that for the control group (Table 2).

<b>Table 1. Difference in traits between the resistant and control line</b>					
Traits	Control	Resistant	Differ.	P	SED
WEC (epg) weaning	1093	373	-720	<0.001	122
BW (kg) weaning	18.7	22.9	4.2	<0.001	0.82
CS weaning	2.08	2.36	0.3	<0.001	0.08
BW (kg) hogget	49.0	53.9	4.9	<0.001	1.33
CS hogget	3.17	3.38	0.2	<0.001	0.08
CFW (kg) hogget	2.6	2.8	0.2	0.08	0.09
FD (mic)	20.6	20.2	-0.4	<0.001	0.29
CV (%)	24.4	20.4	-4.0	0.002	0.45
SS (N/Ktex)	22.8	21.9	-0.9	0.001	1.47

## CONCLUSION

The sheep that were bred for resistance to worms were more profitable than those not bred for resistance to worms, even though there was no need to drench after weaning. As WEC stayed low during the year and no drenching was necessary, drenching and labour costs were not included in this estimate.

The average estimated breeding value (EBV) of the foundation ewes sourced from the

Rylington Merino resistant and control lines were respectively 0.27 vs 0.26 kg for CFW, 2.9 vs 2.51 micron for FD, 3.8 vs 2.5 kg for BWT at shearing, 1.7 vs 1.8 % for CV and -0.75 vs -0.66 N/ktex for SS. This indicates that small genetic differences exist between the resistant and control ewes in the foundation population. The average EBV's of the control and resistant rams that were used to generate the progeny in this study showed that the resistant rams had a lower EBV for CFW (-0.07 vs. 0.17 kg), a lower EBV for FD (-1.7 vs. 3.03 mic.) and a higher EBV for BWT at shearing (4.1 vs. 2.7 kg) than the rams from the control line.

<b>Table 2. Differences in income from wool and meat production between the resistant and control line.</b>			
\$ Income from	Control	Control	Difference
Meat @ \$1.20/kg live weight	\$58.82	\$64.68	\$5.86
Wool	\$18.07	\$19.51	\$1.43
Total income	\$76.89	\$84.18	\$7.29

However, the resistant line actually grew 0.2 kg more wool, and was 4.2 and 4.9 kg heavier than the control group at weaning and at shearing, respectively. This indicates that the reduced worm burden contributed to bigger differences in production between the

resistant and control groups than expected. Therefore ram breeders should consider including worm resistance in their breeding objectives because of the huge economic benefits from the increase in productivity.

## **KEY WORDS**

Worm Resistant Sheep, Economic benefits

## **ACKNOWLEDGMENTS**

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**Paper reviewed by:** Dieter Palmer

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# Embryo losses were not increased when Merino ewes that had lost weight were supplemented with lupins

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## ABSTRACT

To determine whether extending supplementation with lupins after mating increases embryo losses, Merino ewes grazed dry pasture without a supplement (n=117) or were supplemented with 500 g/head/day of lupins for 6 days before insemination (Lupin 6, n=112) or for 6 days pre and 15 days post insemination (Lupin 6+15, n=121). All ewes lost weight ( $3.0 \pm 0.5$  kg;  $P < 0.001$ ) and condition ( $0.2 \pm 0.03$ ;  $P < 0.001$ ) leading up to insemination. The Lupin 6+15 group regained some weight post insemination ( $1.0 \pm 0.5$  kg;  $P < 0.001$ ). Ovulation, conception and pregnancy rates did not differ between supplemented and control ewes. Prolonged supplementation of ewes after insemination did not increase embryo losses.

## INTRODUCTION

Supplementing ewes before mating can increase ovulation rate, but extending supplementation to provide twice their requirements for maintenance after mating can increase embryo losses (Parr 1992). Lupins are commonly used to supplement ewes to increase ovulation rate, but it has not been established if feeding 500g/hd/day of lupins after mating increases embryo losses under field conditions.

This experiment tested the hypothesis that feeding 500g/hd/day of lupins for 15 days after mating would increase embryo losses.

## METHOD

In November 2006, 350 Merino ewes aged 2.5 years and weighing  $53.8 \pm 0.5$  kg with a condition score of  $2.9 \pm 0.02$  (0-5) were selected from a flock of 1500. The ovaries of 50 ewes were examined to ensure they were not ovulating. The ewes were synchronised with sponges of medroxi-progesterone (Cronogest®, Intervet, Australia) for 14 days with 200 IU of eCG (Folligon®, Intervet, Australia) injected at sponge removal, two days before artificial insemination (AI, Day 0). The ewes were randomly allocated to three groups on Day -17. The control group grazed dry pasture of predominantly barley grass and capeweed without a supplement (n=117). The second group grazed a similar pasture in a separate paddock and were supplemented with 500 g/head/day of lupins for 6 days from Day -7 to -2 (Lupin 6, n=112). The third group were supplemented with 500 g/head/day of lupins from Day -7 to -2 and then again from Day 1 to 15 (Lupin 6+15, n=121). The second and third groups grazed together until Day -2 when the second group was removed to graze with the control ewes. All ewes were housed in a shed without food and water for 24 hours before AI. The ewes were artificially inseminated 49 to 57 hours after sponge removal. Semen for AI was collected from four Texel rams, evaluated (mass motility  $>4$ ; concentration  $>4$ ) and pooled. The ejaculates were diluted 1:3 with UHT skim milk. The concentration of semen was evaluated in a haemocytometer and the insemination volume adjusted to give a dose of 200 million sperm per ewe. The ewes supplemented with lupins

each had at least 0.5 m access to the trail of lupins so they could all eat their share of lupins. Live weight and condition score were measured on Days -17, 5 and 17.

Ovulation rate was measured by transrectal ultrasonography on Day 10. Conception rate was calculated as the total number of ewes pregnant as a percent of the ewes that had corpora lutea on Day 10. Pregnancy rate was calculated as the total number of ewes pregnant as a percent of the ewes inseminated in each group, irrespective as to whether they showed corpora lutea or not. The number of actual embryos was determined by trans-rectal ultrasonography on Day 30 and confirmed by trans-abdominal ultrasonography on Day 60. On Day 144 the pregnant ewes were drafted and fitted with a numbered ear tag that was easy to read at lambing. Lambing was observed and recorded for each ewe. Changes in live weight and condition score were analysed by a mixed model procedure using SAS. Ovulation rate and percent embryo loss were analysed after log-transformation of the data. Pregnancy rate, conception rate and total embryo losses were analysed using a chi-square test. Significant differences between groups were accepted at the 95% confidence interval ( $P < 0.05$ ).

## RESULTS

Three hundred and forty five of the 350 ewes were inseminated (four ewes lost sponges and one ewe had an abnormal reproductive tract). Thirty-two ewes had no corpora lutea at Day 10 since they did not ovulate in response to synchronisation and these ewes were only included to calculate pregnancy rate. Supplementing with lupins for 6 days increased ovulation rate by only 6% (Table 1). All ewes lost weight and condition from Day -17 ( $54 \pm 0.5$  kg,  $2.9 \pm 0.02$ ) to Day 5 ( $51 \pm 0.5$  kg,  $2.7 \pm 0.03$ ;  $P < 0.001$ ). The Lupin 6+15 group regained some weight and condition from Day 5 to 17 ( $52 \pm 0.5$ ,  $2.9 \pm 0.03$ ;  $P < 0.001$ ). There were no differences between groups for conception and pregnancy rates (Table 1). Overall, all groups lost more embryos from Day 10 to 30 than from Day 30 to 60. Embryo losses were similar between supplemented and control ewes for both periods (Table 1). The number of lambs born indicated there were no fetal losses after Day 60.

**Table 1.** The reproductive performance of ewes grazing dry pasture alone (control), ewes supplemented with lupins from Day -7 to -1 relative to AI (Lupin 6) or ewes supplemented with lupins from Day -7 to 15 (Lupin 6+15)

	Control	Lupin 6	Lupin 6+15
Ovulation rate	$1.2 \pm 0.04$	$1.3 \pm 0.05$	$1.3 \pm 0.05$
Conception rate (%)	63 (65/104)	63 (63/100)	66 (71/108)
Pregnancy rate (%)	55 (65/117)	56 (63/112)	59 (71/121)
<b><u>Embryo losses</u></b>			
From Day 10 to Day 30 (%)	42 (53/125)	41 (52/127)	39 (54/140)
From Day 30 to Day 60 (%)	22 (16/73)	13 (10/75)	13 (11/86)

## CONCLUSION

In this experiment supplementing Merino ewes with 500g/hd/day of lupins for 15 days after insemination did not increase embryo losses. This may have been because the lupins fed after AI,

rather than being a supplement above maintenance, were used to regain some of the weight and condition the ewes lost prior to AI.

## **KEY WORDS**

Merino ewes, lupin supplement, ovulation rate, embryo survival

## **ACKNOWLEDGMENTS**

To Graeme Murdoch for providing the ewes and facilities and Jim-Jan Texel stud for the use of their rams. To Mark Ferguson, Kenneth Hart and Aprille Chadwick, for technical support.

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# Mineral nutrition of sheep grazing dual-purpose wheats

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## ‘TAKE-HOME’ MESSAGES

A survey of the mineral composition of cereal forages has shown that, relative to livestock requirements, winter wheat forage is usually adequate for calcium (Ca), marginal for magnesium (Mg), deficient in sodium (Na) but has excessive concentrations of potassium (K). Forage oats and barley had high concentrations of K but were adequate for Mg, Ca and Na.

Further work on sheep grazing winter wheat forage has confirmed a liveweight response to Mg, though the extent of this depended on stocking rate. In two trials, there were also marked responses to Na (salt) supplementation.

It is uncertain as yet whether these are separate or interacting effects, though there are good grounds for expecting an effect of Na supplementation on Mg absorption from the rumen of animals grazing forage with low Mg but very high K content.

Further work is needed to develop indicators which identify those cereal forages in which a response to Mg±Na is likely. At this stage, the forage K:Na ratio or the ratio K:(Mg+Ca) look promising. In the meantime, it would be sensible and cheap to provide livestock grazing winter wheat with a Mg/Na supplement consisting of 1:1 Causmag:salt.

## LIVEWEIGHT GAIN RESPONSES IN SHEEP GRAZING DUAL-PURPOSE WHEATS

### *General background*

The grazing of long-season, dual-purpose wheats is now a viable option in farming systems in southern Australia, following the development of cultivars suitable for this purpose, and can result in substantial liveweight gains. For example, Dove *et al.* (2002) recorded gains of 320-360 g/day in crossbred lambs grazing winter wheats. However, a review of recent winter wheat grazing trials (Dove 2006) identified a wide range in liveweight gains (140-360 g/day) in young sheep grazing seemingly similar crops. This variability can partly be related to lamb genotype; gains found with Merinos have usually been lower (140-240 g/day). However, even when gains are re-expressed as a percentage of live weight, there is still a two-fold range in gains of lambs grazing dual-purpose wheat (daily gain = 0.5-1.0% of live weight). Similar variability can be found in USA grazing trials using beef cattle. A major focus of wheat-grazing work has thus become an exploration of the factors which might contribute to this variability.

### *Factors affecting variability in liveweight gain when grazing dual-purpose wheats*

Leaving aside issues such as animal genotype and grazing pressure, the response of grazing animals to crops such as dual-purpose wheats might be affected by their preference for the chosen cultivar relative to other wheat cultivars, other cereals or to pasture, by how much forage they actually consume or by the nutritive value of the cereal forage. The results reviewed by Dove (2006) indicate that differences in preference are small and cannot explain the variability, and that forage intakes are adequate for rapid liveweight gains. Similarly, forage from dual-purpose cereals generally has a very high nutritive value, at least in terms of DM digestibilities (80-90+%) and crude protein contents

(21-26%). Differences in nutritive values within these ranges would not be sufficient to explain the two-fold range in observed liveweight gains.

Consequently, recent work has shifted focus to whether wheat herbage is deficient in specific nutrients, for example, minerals. Of particular interest was Mg, since research and farmer experience in the USA supported the case for possible subclinical Mg deficiency (i.e., no symptoms other than reduced growth) in livestock grazing winter wheat. In southern Australia, there are also several lines of evidence supporting the case that such deficiencies could occur.

- South-eastern Australia has a history of transient Mg deficiency in wheat, occurring as a result of reduced Mg absorption by the plant when the roots are in the acid topsoil, in which the low pH reduces Mg absorption (Coventry *et al.* 1987). Wheat forage grazed during this period may well be Mg-deficient for livestock. Once the wheat roots are in the subsoil, its usually higher pH results in increased Mg absorption and the deficiency resolves itself.
- Problems with Mg nutrition in grazing livestock in southern Australia are usually associated with winter grazing of all-grass or grass-dominant pastures of high protein and K content, relatively low soluble-carbohydrate content, but low Mg content. This almost perfectly describes a winter-wheat pasture! High protein and K contents reduce Mg absorption from the rumen. The lower levels of soluble sugars result in a lower rate of short-chain fatty acid production in the rumen which, indirectly, can reduce Mg absorption (see Berger 1992).

Based on this evidence, Mg was investigated as a supplement for animals grazing Wedgetail dual-purpose wheat near Harden in the 2005 season and liveweight gains were compared with unsupplemented animals (Table 1). The 54% increase in lamb liveweight gain cost only 1 cent/day per lamb, whereas the extra daily liveweight gain was worth >15 cents/day per lamb. Mineral analyses of the wheat forage (Table 2) indicated that it had high K content, adequate Ca content and marginal Mg content. The adequate Ca suggests that the observed weight gain response is unlikely to have been due to the Ca from the limestone.

**Table 1.** Comparison of the liveweight gain of unsupplemented crossbred lambs (37kg) grazing Wedgetail wheat with those of lambs given a magnesium supplement

Supplement	Liveweight gain (g/day)
Nil	184
Mg	283

Unpublished data, G. McMullen, H. Dove and F. Gummer (2005). Mg supplement was a 2:2:1 mixture of Causmag, ground limestone and salt.

However, several points need to be made about these data:

- The response to Mg required confirmation and its mechanism explored, especially in relation to the role of the Na coming from the salt inclusion in the supplement.
- Since Mg, K and possibly Na and Ca could be involved, Mg concentrations alone in wheat forage or in animals would not be an adequate yardstick. The use of ratios based on a range of minerals in wheat forage (or in the animal) is more likely to be useful.
- In turn, this suggested a pressing need to obtain much more data about the mineral content of winter-wheat forage and other forage cereals. This has formed a major part of the GRDC-funded work (Project CSP0009) over the last 12 months.

## THE MINERAL CONTENT OF CEREAL FORAGE

During 2006, samples were collected from a range of cereals grown during 2005 and 2006 in NSW, Victoria, Tasmania and Western Australia and were assayed for their content of both major and trace minerals. Data for Mg, Ca, K and Na are shown in Table 2, from which several conclusions can be drawn:

- All crops contained sufficient Ca to meet the daily requirement of young growing sheep.
- Oats, barley and, with one exception, triticale had Mg contents which met daily requirements. However, wheat forage frequently had Mg contents which were borderline or below, relative to daily requirements.

All cereal forage, and particularly the wheat, had K contents which were 5-10 times daily requirements for K.

Oats and barley had more than enough Na to meet daily requirements, but triticale occasionally was deficient in Na relative to animal requirements. However, almost all wheat samples were notably deficient in Na relative to animal requirements.

Table 2. Magnesium, calcium, potassium and sodium content of cereal forages grown in southern Australia in 2005/06, and comparison with daily requirements for growing sheep

	Magnesium	Calcium	Potassium	Sodium
Daily requirement (%DM)*	0.12	0.15-0.26	0.50	0.07-0.09
Crop forage				
<i>Tasmania (2005)</i>				
Oats (Bass)	0.24	0.36	2.30	0.49
Triticale (Crackerjack)	0.27	0.58	2.90	0.04
Wheat (mean of 6 varieties)	0.16	0.31	3.37	0.03
<i>Tasmania (2006)</i>				
Oats (Bass)	0.14	0.42	3.70	0.29
Barley (Yambla, Yerong)	0.15	0.67	3.34	0.29
Triticale (Breakwell)	0.11	0.39	3.49	0.04
Wheat (mean of 10 varieties)	0.12	0.54	3.32	0.06
<i>Harden 2005 (McMullen)</i>				
Wheat (Wedgetail)	0.13	0.30	3.21	0.05
<i>Canberra 2006 (Dove)</i>				

Wheat (Mackellar)	<i>0.12</i>	0.28	2.96	<i>0.009</i>
<i>SE Victoria (Kleven/Flint)</i>				
Oats (Targa,Bass, Lordship)	0.21	0.27	2.44	1.06
Triticale (Crackerjack, Jackie)	0.20	0.28	2.51	0.37
Wheat (mean of 10 varieties)	0.26	0.29	2.73	<i>0.08</i>
<i>WA wheat belt (Zhang)</i>				
Spring wheat (mean 5 var.)	0.19	0.40	4.53	<i>0.04</i>
Winter wheat (Wylah)	0.20	0.41	4.84	<i>0.05</i>

\*Based on (SCA 1990).

Values shown in bold italics are either at or below requirement level (Mg, Na) or greatly exceed it (K).

## MAGNESIUM AND SODIUM RESPONSES RE-VISITED

### *Magnesium*

During 2006, two experiments were conducted to evaluate further the responses to Mg. At Marrar, young crossbred sheep grazing Wedgetail wheat were offered either no supplement, or supplements containing Na (loose salt), Mg, Ca or roughage in various combinations (Table 3). Note that seasonal conditions were severe and herbage mass restricted intake and liveweight gain (measured over 29 days) during the trial. The most striking feature of these results is the apparent response to Na supplementation, with little evidence of response to the Mg supplement except with the (Mg+roughage) supplement.

**Table 3.** Liveweight gains of young crossbred sheep given supplements containing Na, Mg, Ca or roughage (hay)

Supplement	Daily liveweight gain (g)
Nil	131
Na	179
Na+Ca	169
Na+Ca+Mg	138
Na+Ca+Mg+roughage	166
Mg+roughage	162

Unpublished data, G. McMullen (2006)

In a second trial at Canberra, 30 kg Merino hoggets grazing Mackellar wheat at 3 stocking rates were either unsupplemented or were 'supplemented' indirectly with Mg by fertilizing the wheat with magnesium sulphate (425 kg/ha) 3 weeks before grazing commenced. During the grazing period (32

days), the Mg content of fertilized wheat forage was 0.15-0.20 %DM; Mg content in unfertilized wheat was 0.10 %DM or less. A significant response to Mg was obtained, but this depended on stocking rate. At 18 sheep/ha, liveweight gain was increased by 25% (35 g/day) in animals grazing the Mg-fertilized crop. At 47 sheep/ha, hoggets grazing the Mg-fertilized pasture grew 16% (24 g/day) more slowly than those grazing unfertilized pasture. We believe this occurred because they initially grew faster but subsequently ran out of forage.

### *Sodium*

The very low forage Na contents found in wheat, the possible involvement of Na as well as Mg in the response observed at Harden in 2005 and the apparent response to Na at Marrar in 2006 prompted a further trial at Canberra in 2006. Merino hoggets (30 kg) grazing at 36/ha on Mackellar wheat were either unsupplemented, or were given *ad libitum* access to loose salt in small troughs.

The animals offered the Na supplement grew 25% faster (211 g/day) than unsupplemented animals, which gained 169 g/day. They consumed the salt avidly; average salt intakes were 30 g/day per animal, equivalent to an intake of Na of 12 g/day. Assuming a DM intake of about 1.0-1.2 kg/day, this Na intake would increase the Na content of consumed forage from the very low level of 0.004% DM found in the wheat forage itself (well below animal requirements) to an effective level of 1.0-1.2% DM, thus satisfying Na requirements.

### **MAGNESIUM, SODIUM...OR A BALANCE OF MINERALS?**

The above results might suggest separate responses to Mg and to Na, but there are sound reasons for expecting a range of minerals, especially Mg, Ca, K and Na, to influence Mg metabolism in the animal (Kemp and t'Hart 1957; Coventry *et al.* 1987; Berger 1992). The very high concentrations of K in cereal forage are a cause for some concern, because high K intakes result in high K concentrations in rumen fluid, which are known to cause large decreases in Mg absorption from the rumen (see Coventry *et al.* 1987; Berger 1992). In relation to Na, Martens *et al.* (1987) reported a 55% increase in Mg absorption when sheep consuming a low-Na diet were supplemented with Na into the rumen, and suggested that ruminal K:Na ratios were a key driver of Mg absorption. It follows that Mg absorption could be increased if the K:Na ratio could be reduced either by reducing K intake (difficult while grazing cereal forage) or by increasing Na intake. The observed responses to Na may therefore be due to an indirect improvement in Mg status of the animals; this aspect requires further study.

In relation to Mg nutrition, we thus need some measure of forage quality which encompasses at least some of the above minerals, rather than just Mg content as such. Two possible measures (expressed in millequivalents) are the ratio of K:Na in forage, or a 'cation' ratio based on  $K/(Mg+Ca)$  as discussed by Kemp and t'Hart (1957) who suggested that if the cation ratio exceeds 2.2, mineral supplementation is required to prevent grass tetany. Coventry *et al.* (1987) cited cation ratios of 0.9-1.3 for subclover, but 3.5-3.9 for wheat. For the oat and wheat samples in Table 2, average cation ratios were 2.1 and 3.0, respectively, implying the need for supplementation with the wheats. The equivalent K:Na ratios of oats and wheat differed more markedly (3.9 and 66.8, respectively). This may prove a useful index, but the critical forage K:Na ratio for grazing livestock is not yet known. However, if the ratio for oats is taken as a guide and if animals eating 1 kg/day wheat forage with a K:Na ratio of 66.8 were also eating 20 g salt/day, the effective K:Na ratio of their ration would be reduced to 2.3, similar to the ratio for forage oats. This suggests target salt intakes of 20-30 g/day for sheep are sensible in practice (150-200 g/day for cattle).

For the prevention of grass tetany in beef cattle grazing winter wheat, Berger (1992) recommended that animals be supplemented with 1:1 mixtures of salt:MgO. For sheep under Australian grazing



conditions, the interactions of Na and Mg for liveweight gain are still being resolved but in the meantime, a sensible 'insurance policy' would be to supplement animals grazing winter wheat with salt:Causmag mixtures. The addition of grain to the supplement (1:1:1 salt:Causmag:grain) may also help increase Mg absorption. There has been no research on this aspect in Australia, but it may underlie the responses to roughage mentioned above.

## IMPLICATIONS AND ACTIONS

Relative to the mineral requirements of livestock, winter wheat forage is usually adequate for Ca, marginal for Mg, deficient in Na but contains excessive concentrations of K.

In sheep grazing winter wheat, liveweight gain responses to both Mg and Na have now been observed. It is not yet possible to say whether these are separate responses or an interaction, but there are good grounds for expecting a positive effect of Na on Mg absorption if the forage contains high levels of K.

Ratios based on K:Na and K/(Mg+Ca) appear useful indices of the need to supplement cereal forage with Mg/Na, but target ratios are yet to be defined. In the meantime, combined supplementation with salt:Causmag mixtures would be a cheap approach to improving liveweight gain and reducing grass tetany in livestock grazing winter wheat.

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# The effect of genetic potential and pre feedlot growth path on beef eating quality.

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## ABSTRACT

These results demonstrated there are important effects of growth and genetic potential for marbling or meat yield on marbling and meat eating quality characteristics. Eating quality was significantly higher in the progeny of animals whose sires were selected for marbling than in those selected for meat yield. Eating quality also tended to be higher in animals that had faster growth prior to feedlot entry. Selection of sires on genetic potential by EBV or breed characteristics produced expected responses in the traits of interest in the progeny, and no interactions with growth rate were seen.

## AIMS

Quantify the responses in carcass and meat quality traits in animals with diverse genetic potential for those traits when subjected to different growth paths between weaning and feedlot entry.

## METHOD

A complete description of the general experimental design, methods and measurements across all of the 4 sites within this Beef CRC project was reported by McKiernan et al. (2005). At the NSW site (near Griffith NSW), a total of 43 sires was used, sampling 3 carcass "class" categories - defined as high potential for retail beef yield % (RBY), high for intramuscular fat % (IMF) or high for both traits. EBV's for the carcass traits of interest were used (where available) in selection of the sires, which were drawn from Charolais, Limousin and Angus (for RBY), Black Wagyu and Angus (for IMF) and Red Wagyu and Angus (for RBY&IMF) breeds - giving 7 sire "types" within the 3 sire "classes". All matings were by AI to Hereford dams from a single herd. Steer progeny were grown at either conventional ("Slow" approximately 0.5 kg/d) or accelerated rates ("Fast" ~ 0.7 kg/d) from weaning to feedlot entry. Fast and Slow groups from successive calvings were managed to enter the feedlot at the same time as described by McKiernan et al. (2005). Following the backgrounding period, all animals were despatched to the feedlot as a single group when the mean overall liveweight was close to 400 kg in the paddock, which resulted in a mean of around 380 kg feedlot "induction weight". All animals had identical treatment during the 100 day commercial feedlot finishing phase prior to slaughter. Comprehensive carcass data were collected at the kill floor and in the chiller. Samples of meat from the striploin (M. longissimus lumborum) were taken for later analysis in the laboratory for IMF % and other objective measurements, and were also used for consumer palatability tests using MSA taste panel protocol. MSA feedback (chiller) data were used to examine treatment effects on carcass traits and predicted meat eating quality (PEQ) as generated by the MSA model. The analyses of effects on carcass traits were done with the PC software package Genstat 9 (2006), using a linear mixed model REML procedure.

## RESULTS

Faster growth pre feedlot resulted in increased subcutaneous fatness and EMA. There was no difference in RBY% due to growth treatment, but this trait clearly responded to genetic selection. Faster growth resulted in increased IMF%, although not evident in marble scores.

Effects of growth treatment and sire class on traits related to eating quality are shown in Table 1. The effect of growth treatment on CMQ4 score (actual eating quality) favouring faster growth was small but significant at the level of  $P = 0.07$ , giving reasonable confidence of a real effect, and consistent with the significantly higher IMF% for the fast growth treatment. There was no difference in the PEQ between growth treatments. The association of better eating quality with higher marbling/IMF% was

well demonstrated by comparison of means grouped by class (Table 1), with the high IMF category clearly superior to the others.

**Table 1.** Effects of growth rate and of sire carcass “class” (grouped by expected yield or marbling potential) on meat quality traits and palatability as assessed by chiller and laboratory measurements and by sensory testing using taste panels. Maximum numbers available for analyses for each group shown (n).

Trait	Growth				Class			
	Slow	Fast	s.e.d	P	High RBY	High RBY & High IMF	s.e.d	P
(Chiller - n)	(260)	(299)			(214)	(172)	(173)	
MSA AUS marble score	1.36	1.39	0.035	ns	1.2	1.5	1.6	0.15 <0.001
MSA pred. eating quality <sup>1</sup>	57.7	57.7	0.19	ns	57.3	58.0	58.6	0.51 0.04
(Lab chemical - n)	(216)	(235)			(168)	(145)	(138)	
IMF%	3.61	4.15	0.170	0.001	3.22	4.18	4.66	0.34 <0.001
(Lab objectives - n)	(188)	(173)			(141)	(111)	(109)	
Shear force (N) <sup>2</sup>	40.0	40.8	1.15	ns	41.0	42.1	37.5	2.34 ns
Compression (N) <sup>2</sup>	16.2	15.8	0.25	0.048	16.2	16.3	15.4	0.43 0.08
Cooking loss (%)	22.6	22.8	0.30	ns	22.4	23.2	22.6	0.52 ns
(Sensory - n)	(226)	(226)			(179)	(135)	(138)	
CMQ4 score <sup>3</sup>	53.2	55.4	1.35	0.067	52.9	52.4	58.5	2.57 0.04
% samples failing 3 Star <sup>4</sup>	28	28			34	30	19	

<sup>1</sup>Predicted eating quality (PEQ) from MSA model for the (grilled) striploin (“STA” – MSA cut) <sup>2</sup>Shear force and compression expressed as Newtons (N = kg force x 9.81) ; N > 45 considered approaching “tough” <sup>3</sup>Sensory eating quality - clipped CMQ4 score using MSA testing protocol for the (grilled) striploin (“STA” – MSA cut)

<sup>4</sup>Raw data only from sensory tests – samples below CMQ4 score 48 (“3 Star” cutoff)

## CONCLUSION

There were significant differences between sire class for CMQ4 scores and a small but convincing advantage (P ~ 0.07) to fast growth treatment. There was a clear association of IMF% and marbling scores with palatability. Thus any strategies that increase IMF% in the carcass, through genetics or growth rate, should improve eating quality. Laboratory measurements related to tenderness are useful predictors of meat eating quality. The agreement between shear force and CMQ4 sensory scores was good and both these parameters were well related to IMF% and marble scores. Results reported by Gregory et al. (1994) suggested that genotypes with high yield potential may have lower eating quality. The current results agree to some extent but also showed that high yielding genotypes can produce meat of acceptable eating quality, although lower than that from genotypes with higher potential for fat deposition. The higher yielding types may therefore require more specific management to maintain acceptable palatability. The results here are consistent with improved palatability following higher growth during backgrounding which by nature must deliver younger animals at the same finish weight. Age at slaughter has emerged as an important industry issue, and there are likely to be increased penalties in price/kg of carcass weight for animals that exceed age limits for nominated slaughter weights. On the other hand the processors get greater efficiency from heavier carcasses, so the message is clear that high growth rates will become increasingly important to deliver the desired carcass weight at the youngest possible age, thus requiring management for fast growth.

## KEY WORDS

Carcass traits, eating quality, pre feedlot growth path, genetic potential.

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# Long-term consequences of growth and nutrition of cattle early in life for beef production

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## ABSTRACT

Retail yield from cattle severely restricted in growth during pregnancy and/or from birth to weaning is reduced compared to cattle well grown early in life, when compared at the same age later in life. However, retail yield and carcass composition of low and high birth weight calves are similar when compared at the same carcass weight. At equivalent carcass weights, cattle that are grown slowly from birth to weaning have carcasses of similar or leaner composition than those grown rapidly within pasture based production systems followed by feedlot finishing. Adverse effects on beef quality due to restricted growth early in life are not evident. There are economic benefits resulting from adequate maternal nutrition.

## AIMS

This paper reviews research on consequences of cattle nutrition and growth during foetal and neonatal life for subsequent growth, efficiency, carcass, yield and beef quality characteristics (Greenwood and Cafe 2007). It includes findings from our recent studies on consequences of growth during pregnancy and to weaning (Greenwood *et al.* 2006). The reader is also referred to reviews on consequences of prenatal development in livestock by Bell (2006), and on consequences of foetal, pre-weaning and early post-weaning nutrition and growth of cattle by Greenwood *et al.* (2005).

## METHOD

Cattle sired by Piedmontese or Wagyu bulls were bred and grown within pasture-based nutritional systems followed by feedlot finishing. Effects of low (mean 28.6 kg, n = 120) and high (38.8 kg, n = 120) birth weight followed by slow (mean 554 g/d, n = 119) or rapid (875 g/d, n = 121) growth to weaning on subsequent growth, efficiency in the feedlot, and carcass, yield and beef quality characteristics at approximately 30 months of age were examined (Greenwood *et al.* 2006). Analyses were also undertaken to determine the economic impact of nutritional constraints during early life of cattle (Alford *et al.* 2007).

## RESULTS

### *Growth and efficiency*

Severe, chronic growth retardation of cattle early in life is associated with reduced growth potential, resulting in smaller animals at any given age. The capacity for long-term compensatory growth diminishes as the age of onset of severe nutritional restriction resulting in prolonged growth retardation declines, such that more extreme intrauterine growth retardation can result in slower growth throughout postnatal life. Neither restricted growth in utero or from birth to weaning influenced efficiency of nutrient utilisation later in life in the feedlot.

### *Carcass characteristics and yield*

Retail yield from cattle severely restricted in growth during pregnancy or from birth to weaning is reduced compared to cattle well-grown early in life, when compared at the same age later in life. However, retail yield and carcass composition of low and high birth weight calves are similar at the same carcass weight. At equivalent carcass weights, calves that are grown slowly from birth to weaning have carcasses of similar or leaner composition than those grown rapidly. However, if high energy, concentrate feed is provided following severe growth restriction from birth to weaning, then at

equivalent weights post-weaning the slowly-grown, small weaners may be fatter than their well-grown contemporaries.

### **Beef quality**

Restricted prenatal and pre-weaning nutrition and growth do not adversely affect measures of beef quality including shear force, compression, cooking loss and colour. Similarly, bovine myofibre characteristics are little affected in the long-term by growth in utero or from birth to weaning

### ***Interactions between prenatal and pre-weaning growth***

Interactions were not evident between prenatal and pre-weaning growth for subsequent growth, efficiency, carcass, yield and beef quality characteristics, within our pasture-based production systems.

### ***Interactions with genotype***

A major objective of our research has been to determine the extent to which genotype may interact with nutrition early in life to influence productive characteristics. To achieve this objective, our research included offspring of Piedmontese (a high muscling and higher birth weight breed, homozygous for a mutation that produces non-functional myostatin) and Wagyu (a high marbling or intramuscular fat and lower birth weight breed) bulls mated to Hereford cows. Perhaps surprisingly, no interactions between sire-genotype and growth early in life were evident for any growth, efficiency, carcass, and yield and beef quality parameters.

### ***Economics***

Economic benefits resulting from adequate maternal nutrition, especially during pregnancy, to optimise growth of offspring to market weights are primarily due to advantages in carcass weight and retail beef yield at a given age, reduced feed costs to reach a given market weight, stocking rates and subsequent reproductive rates of breeding cows, but not due to differences in beef quality characteristics (Alford et al. 2007).

## **CONCLUSION**

Within pasture-based production systems for beef cattle, the plasticity of the carcass tissues, particularly of muscle, allows animals that are growth-retarded early in life to attain normal composition at equivalent weights in the long-term, albeit at older ages. However, the quality of nutrition during recovery from growth retardation during early-life may be important in determining the subsequent composition of young, light weight cattle relative to their heavier counterparts.

## **KEY WORDS**

Birth weight, growth, neonate, nutrition, meat quality

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