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Research into Lamb Meat Quality

In association with AbacusBio Limited

Alliance Group Limited

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Alliance
Group
Lorneville
Plant

Executive Summary

Exceptional product quality and food safety standards are vital for Alliance Group's export markets. Alliance Group Ltd targets "high-end" consumers with discerning palates who rate meat quality highly when making purchasing decisions. Over a number of years Alliance Group has invested in technologies and research to ensure our brands represent quality and safety to those consumers. These investments include the Farm Assurance Programme, VIAscan® and X-ray technologies, the Enviro-Mark and ISO 14001 programme and on-going involvement in the Meat & Wool New Zealand Central Progeny Test.

Over the past two years Alliance Group Ltd has run a series of trials to determine ways in which meat quality can be improved through farm management practices. Meat quality is made up of a number of traits including meat and fat colour, pH, tenderness and factors affecting eating quality such as taste, juiciness and aroma.

This booklet outlines Alliance Group's on-going investigations into the influence of genetics, diet, growth rate, yield and castration status on meat quality traits. The trial work has been independently designed and analysed by AbacusBio Ltd. The key findings from these trials were as follows:

- there was genetic variation in all the meat quality traits assessed, with colour stability and tenderness being potential candidates for genetic selection programmes;
- there were no differences in the eating quality of meat from lambs fed on a variety of forage treatments, however, different forages did influence meat colour stability, tenderness and pH and further investigations of these relationships are in progress;
- the eating quality of lambs in all the trials was very good, however, slower growing lambs had better eating quality than faster growing lambs in a trial which was set up to examine this relationship; this is being investigated further;
- there were no differences in the eating quality of entire, crypt or wether lambs and as such Alliance Group is retaining its policy of not distinguishing ram lambs from other lambs, provided they are under 12 months of age and are in the acceptable weight range;
- lamb meat from the Merino breed had higher pH than meat from conventional meat breeds; this did not translate to different eating quality, but it does serve as a reminder to Merino growers to minimise stress before processing.

These results show there are potential ways in which meat quality can be improved on-farm, either genetically or through diet. The challenge for making improvements is how we incorporate them on-farm and/or into breeding programmes. There may be several options; for example, it may be as simple as getting farmers to finish on a particular forage type and/or not on others, or it may involve encouraging breeders to select rams with superior meat quality through a DNA test. We still have more work to do in this area and trials are currently underway.

Introduction

Alliance Group Ltd has a reputation for producing high quality meat products. This has been built on meticulous food production techniques, world class systems and a strong focus on consumer needs. As consumer demands have changed, our extensive range of meat and meat-related products have become more sophisticated and we keep a watching brief on international consumer trends to ensure our products meet expectations.

Meat quality is increasingly important to consumers. In a recent survey it was shown that German consumers rate meat quality highly when making purchasing decisions, with freshness, taste and appearance being the top three influences (Figure 1). Alliance Group's market focus for lamb meat is high-end consumers with discerning palates. As such, it is vital that we maintain the high quality of our lamb products so those consumers have an outstanding culinary experience every time they eat our lamb.

Variation in meat quality can be introduced at all stages during production, from farm to market. The New Zealand meat industry has traditionally focused on processing and packaging as the main avenues for improvement of lamb meat quality. However, meat quality is also influenced by genetics and farm management practices, such as feed type and quality, age, sex and stress levels.

Over the past two years Alliance Group Ltd has taken a broad approach to evaluate ways in which meat quality can be improved. In a series of trials, the company has evaluated a number of factors which influence meat quality. The results from these trials and what they mean to you as Alliance Group shareholders are outlined in this booklet. It is important to note that these investigations are a work in progress and we will update you with new results as they develop.

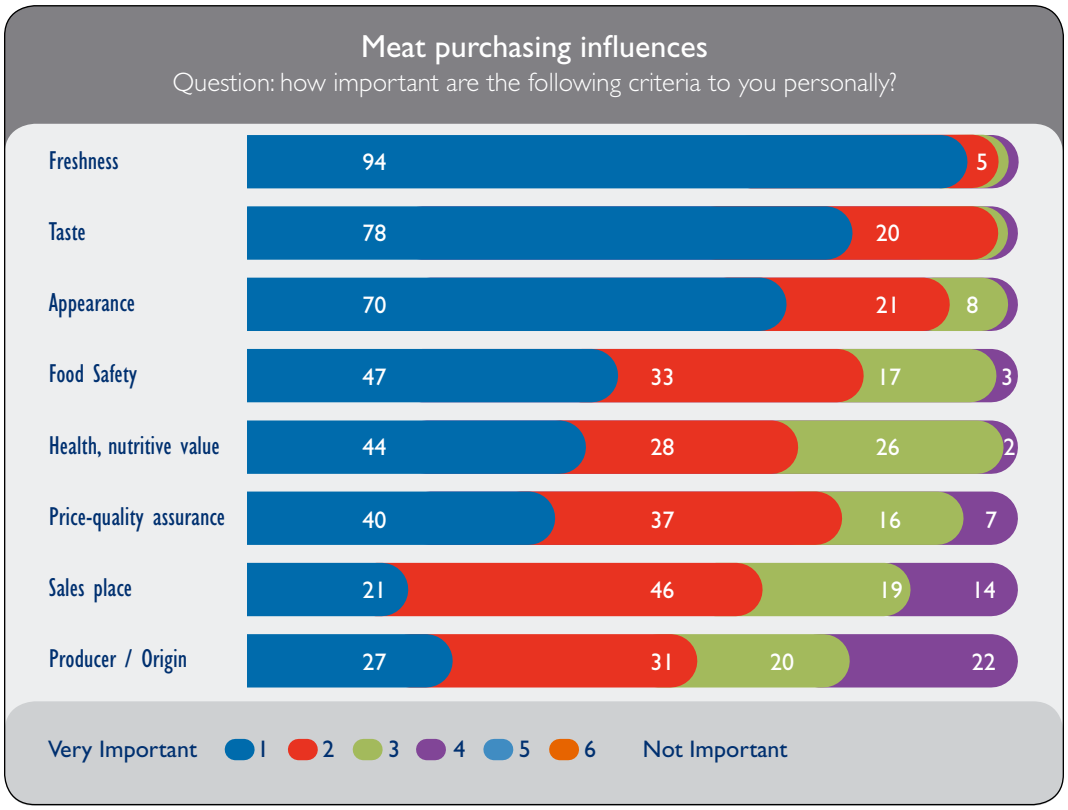


Figure 1. Consumer survey showing what influences meat purchasing decisions (2009, source: Trend Census Market Research)

Meat Quality Measurements

Meat quality is made up of a number of traits including meat and fat colour, pH, tenderness and factors affecting the eating experience such as taste, juiciness and smell. The nutritional quality of the meat is important to consumers with vitamin and essential mineral content (such as iron) and types of fatty acids (such as omega-3) playing a role.

For the trials discussed in this booklet, meat colour stability, tenderness, pH and eating quality were measured. All trials were designed and analysed independently by AbacusBio Ltd.

Meat colour stability

Meat colour stability is important for the international chilled lamb market due to the time spent in transit before reaching supermarket shelves.

Consumers judge the freshness of meat by how bright and red it is on display. When meat is initially cut it is a purple colour which changes to bright red after exposure to oxygen. This process is called "blooming" and takes about half an hour. As time progresses the surface of the sliced meat changes from red to an undesirable brown colour. High quality products are able to hold the desired bright red colour for longer.

Figure 2. Wrapped loin samples for colour stability measurements

To measure meat colour stability, loins from the trials were tagged and vacuum packed at boning (24 hours after processing). The loins were stored for eight weeks at –1°C. Each loin was then sliced into three pieces and wrapped in trays and stored at 4°C to simulate retail display (Figure 2). For the second year of trials, samples were stored in modified atmosphere packaging of 80:20 oxygen:carbon dioxide.

The first colour measurement was taken at two hours and then at 24, 48, 96 (four days) and 168 hours (seven days). Measurements were taken using a Minolta Chromameter (CR-400) (Figure 3). The chromameter measures colour using the standard CIE LAB colour variables (L = whiteness/brightness; a* = redness; b* = yellowness).

From the data collected, colour deterioration was calculated. This is the product of two variables, namely initial colour and the rate of colour deterioration. Also calculated was the time for the a* colour to deteriorate to the undesirable level of 16 by regressing the colour readings against time. The units of the trait are hours and we called this trait "deterioration to a*16".

Figure 3. Colour stability measurement with a chromameter

Tenderness

International markets have signalled that lamb meat tenderness is important, especially in frozen lamb, which makes up 70% of total export volume.

Tenderness measurements were taken on chilled and frozen loins. Thawed samples were cooked in a 100°C water bath to an internal temperature of 75°C and allowed to cool to 2°C. Peak shear force measurements were made using a MIRINZ pneumatic tenderometer (Figure 4). The tenderometer measures the force it takes to shear the cooked meat. The higher the shear force, the tougher the meat. Generally, meat with a shear force of greater than 11KgF is considered tough.

Figure 4. MIRINZ pneumatic tenderometer

pH

Meat pH has a desirable range of 5.4-5.8. Meat with a pH between 5.8 and 6.0 is known to be intermediate, while meat with a pH greater than 6.0 is considered high. pH influences meat quality in a number of ways:

1 a high pH (>6.0) can permit the growth of spoilage bacteria which decreases shelf-life;

2 intermediate pH increases meat toughness, while high pH meat can be "mushy";

3 high pH meat is darker (has a lower L* brightness score) and is often referred to as "dark-cutting meat" (Figure 5).

All of the meat in the trials outlined in this booklet had pH measurements taken at eight weeks post-processing, with three measurements taken from each loin and averaged for analysis.

Figure 5. Normal pH loin slices (right) and high pH bottom loin slices (left)

Eating quality

Alliance Group has an excellent reputation internationally for the eating quality of its products. It is vital that this reputation is maintained to obtain the best returns for shareholders.

Eating quality is difficult to measure as it is made up of a number of traits including aroma, flavour, texture and succulence. While each of these traits is distinct, they are correlated with each other and a consumer may not be able to distinguish why they liked or disliked a piece of meat. For this reason, trained taste panellists were used for all the taste measurements reported in this booklet. The panellists were taught to distinguish among the different eating quality traits and score the traits appropriately.

For the different trials described in this booklet, three types of taste panel have been used to obtain statistically appropriate results for the particular trial:

1 Scale test: the meat samples are presented to the panellists in random order. Panellists score each piece of meat on a scale of 1-9 for aroma, flavour, texture and succulence. These quantitative scores can then be compared and analysed. The scale test was used to analyse the meat samples from the Meat & Wool New Zealand Central Progeny Test (page 5) and the Agricom pasture trial (page 7);

2 Paired descriptive test: the panellists are presented with pairs of meat samples, each sample being from a different treatment. Each sample is scored on a scale of 1-9 as in the scale test. The paired descriptive test was used in the growth and yield trial (page 11);

3 Triangle test: panellists receive three coded samples and are told two of the samples are the same and one is different. Panellists are asked to identify the odd sample. Triangle tests are used to determine if one treatment is different to another. Triangle tests were used to determine if the panellists could distinguish between entire, crypt and castrated lambs (page 13) and Merino and conventional lambs (page 15).

Figure 6. Trained taste panellists scoring meat samples for eating quality

Do genetics play an important role in meat quality?

The Meat & Wool New Zealand Central Progeny Test (Central Progeny Test) has been run for a number of years to evaluate the genetic performance of rams by comparing their progeny.

Rams used in the Central Progeny Test are leading rams supplied by breeding groups from all over New Zealand. They represent a wide variety of breeds and as such, they are an excellent resource for evaluating genetics of unselected traits, such as meat quality.

Trial details

The Central Progeny Test is run at three sites, Poukawa (Hawkes Bay), Lincoln (Canterbury) and Woodlands (Southland). Alliance Group collected meat quality data from all three sites from two cycles (2007-born: 930 progeny from 25 rams; 2008-born 761 progeny from 26 rams).

Results

Results from the Central Progeny Test evaluation have built up a picture of the contribution of genetics to variation in meat quality traits. The heritability and genetic variation of the meat quality traits measured are shown in Table 1. The heritability of a trait defines the proportion of variation in that trait which is attributable to genetics (not environment). Generally, a trait with a moderate to high (>0.3) heritability will respond faster to selection than a trait with low heritability (<0.2). The response of a trait to selection is also dependent on having good genetic variation (standard deviation) within that trait.

Colour stability and frozen tenderness

Both colour stability and frozen tenderness had moderate to high heritability and good genetic variation, making them suitable targets for selection. The difficulty in selecting for these traits is obtaining the measurements in the first place, as this is time consuming and expensive and has to be done on dead animals.

There are various research programmes in place, both in New Zealand and internationally, evaluating high throughput measurement techniques for meat quality and the potential for the use of DNA markers as a selection tool. With the development of such tools it may be possible to include meat quality traits across a variety of selection programmes in the future. Alliance Group is associated with New Zealand studies in this area and is keeping a watching brief internationally.

Aim: to evaluate the role of genetics in meat quality in a wide range of New Zealand sires.

Traits measured:

- colour stability
- tenderness, chilled and frozen
- pH
- eating quality (scale test)

Key finding: genetic variation occurred in all meat quality traits measured. Colour stability and tenderness would be good candidates for genetic selection.

Chilled tenderness

The tenderness of chilled samples was excellent with no samples out of 930 having a shear force value greater than 8KgF. This confirms that tenderness of chilled meat is not an issue for Alliance Group's international markets.

pH

pH had a moderate heritability but very low genetic variation, reflecting that the majority of samples were within the acceptable pH range (5.4-5.8). From this it was concluded that there would be little to be gained from including pH in a selection programme. Alliance Group continues to regularly measure meat samples to ensure current standards are maintained.

Eating quality

Eating quality traits had low heritability and low genetic variances showing these traits would not be good candidates for genetic selection.

Relationship of meat quality traits with other traits

Analysis of the Central Progeny Test data showed that there were relationships between meat quality and meat yield and growth. To examine these relationships further, a specific trial was set up (page 11).

2009-2010 Central Progeny Test

Meat quality measurements are being taken from the 8th cycle of the Central Progeny Test. This will add to the current dataset as an important resource for improvement of meat quality traits in the future.

Table 1. The heritability and variation of meat quality traits measured.

	Heritability	Variation (std dev)
Colour stability traits		
Redness (a*) at 2hrs	0.18# (moderate)	1.37 (moderate)
Redness (a*) at 24hrs	0.11# (moderate)	1.50 (moderate)
Redness (a*) at 48hrs	0.25# (moderate)	1.21 (moderate)
Redness (a*) at 96 hrs	0.30# (moderate)	1.78 (moderate)
Redness (a*) at 168hrs	0.30# (moderate)	2.30 (high)
Deterioration (a*16) (hrs)	0.17# (moderate)	2.68 (high)
Whiteness/brightness (L*) 2hrs	0.32# (moderate)	1.42 (moderate)
pH	0.21# (moderate)	0.08 (low)
Tenderness traits		
Tenderness (KgF frozen)	0.22 (moderate)	2.19 (high)
Eating quality traits		
Aroma	0.12 (moderate)	0.13 (low)
Flavour	0 (low)	0.17 (low)
Texture	0.05 (low)	0.17 (low)
Succulence	0 (low)	0.17 (low)
Acceptability	0 (low)	0.18 (low)

Note: all trait data is adjusted for sex, birth-rearing rank, Central Progeny Test site, kill date and breed. Colour stability traits are based on two years of data (as indicated by #) and all other traits are based on one year of data .

Do different forage types affect meat quality?

This trial has been done in conjunction with AGRICOM

New Zealand farmers are increasingly using alternative forages, such as brassica, to improve lamb performance. This has raised questions as to whether different forages affect the quality and taste of lamb meat. For the past two years Alliance Group has worked with Agricom to evaluate the performance and meat quality of lambs fed on different forage types.

Trial details

Trials were run over two years at Ceres Research Centre, Canterbury. Stocking rates were reviewed weekly with additional areas opened up, or removed, to ensure pasture covers were maintained between 1000-1200kgDM/ha.

Details of the two years of trials were as follows:

2007 born-perennial ryegrass, Italian ryegrass and plantain

- twin bearing ewes allocated to pasture treatments one week prior to lambing until weaning (98 lambs were processed December 2007)

2008 born-pasture, plantain, turnip, red clover, radish and two types of brassica

- 12 week old lambs were randomly allocated different forage treatments until processing (155 lambs were processed in February 2009)

Results

Lamb performance

Lamb performance differed significantly on the different forage types in terms of liveweight gain, carcase weight and VIAscan® yield -

- in year one the lambs fed plantain significantly outperformed the lambs fed on pasture (Figure 7);
- in year two, the lambs fed on brassica significantly outperformed the lambs fed on other forage types (Figure 8).

The performance of the lambs on plantain in year one reflects that the in-lamb ewes were put onto the forage treatments two weeks prior to birth until weaning. Plantain is recommended by Agricom as ideal for early growth rate. The performance of the lambs on brassica in year two reflects that lambs were put onto the forage later, from weaning until processing. Brassica crops are recommended by Agricom for optimising lamb performance post-weaning.

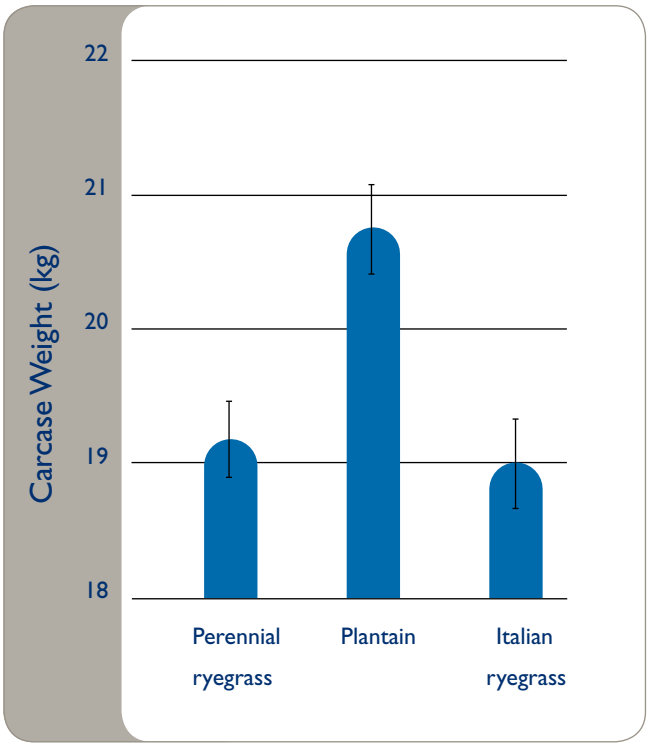
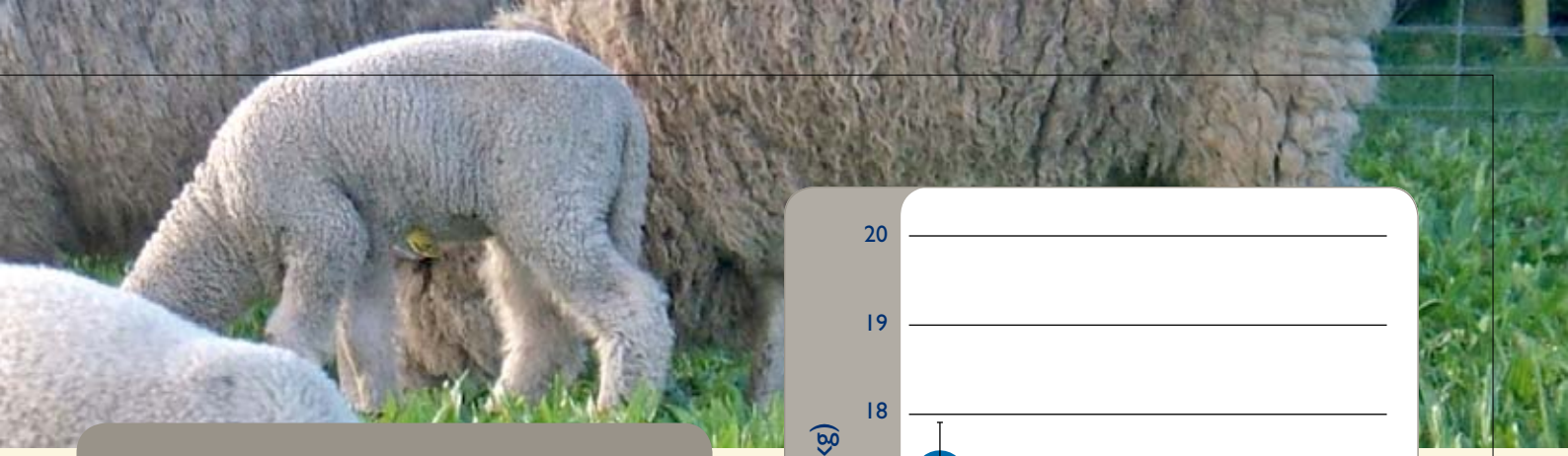


Figure 7. Carcase weights of lambs fed three forage types from birth to weaning (lambs processed December 2007)



Aim: to evaluate the performance and meat quality of lambs fed on different forage types.

Traits measured:

- growth and yield
- colour stability
- pH
- frozen tenderness
- eating quality (scale test)

Key finding: there were no differences in eating quality of meat from lambs fed any of the forage treatments, although there were differences in colour stability, tenderness and pH. Further investigations are underway.

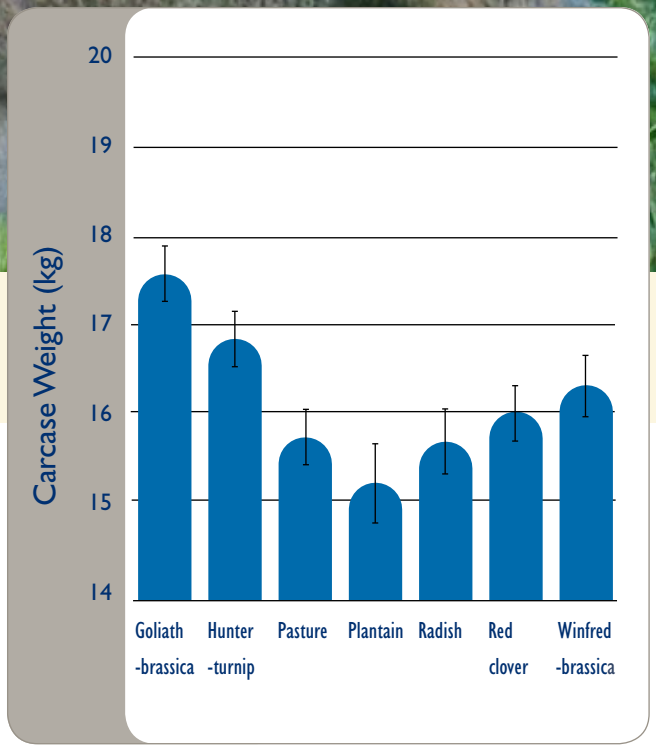


Figure 8. Carcase weights of lambs fed seven forage types from 12 weeks of age until processing (lambs processed February 2008)

Colour stability

Generally colour stability was similar across all treatments. In year one, the colour stability of lambs fed on plantain was significantly poorer, but not in year two. In year two, the colour stability of lambs fed on red clover was significantly poorer (Figure 9). Lambs fed on forage legumes, such as red clover, have a higher proportion of unsaturated to saturated fatty acids which could contribute to oxidative instability and consequently, faster colour degradation. These relationships are being examined further in the 2009-2010 season.

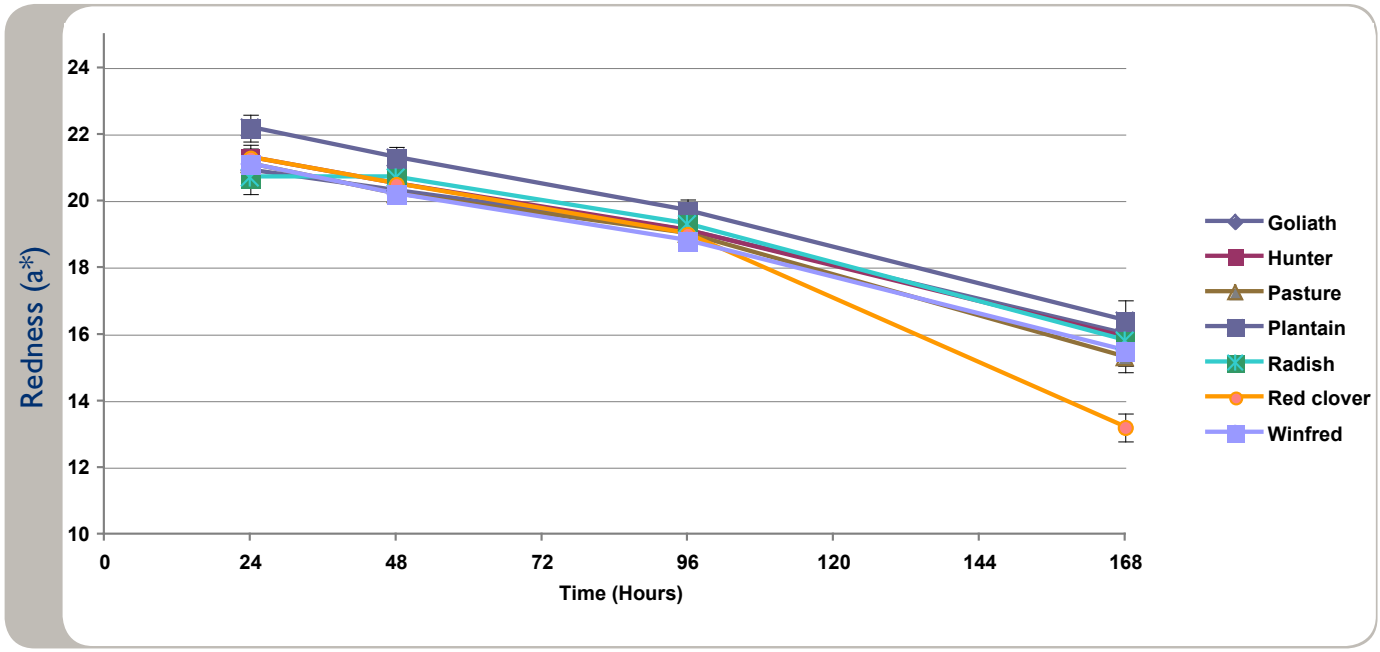


Figure 9. Colour stability (redness a) of lambs fed on differing forage types from 12 weeks of age until processing (February 2008).*

pH

Overall, the pH of the majority of lambs in the trial was excellent with only three lambs having a pH >5.8. Lambs fed on Hunter turnip and radish did have significantly higher pH. The lambs fed on radish performed poorly and higher stress may have contributed to their higher pH.

Frozen tenderness

In both years the tenderness of all samples was generally good. In year one, lambs fed on plantain had significantly more tender meat than lambs fed on perennial ryegrass (Figure 10). In year two however, there was no effect of feed treatment on tenderness measurements (KgF). There were significant effects of liveweight gain and VIAscan® GR on tenderness:

- for every 50g per day improvement in live-weight gain for a lamb, there was a 0.44KgF increase in shear force (less tender);
- for every millimetre increase in GR (VIAscan® GR) there was a 0.30KgF decrease in shear force (more tender).

The relationship between growth rate and meat quality is examined further in a trial described on page 11.

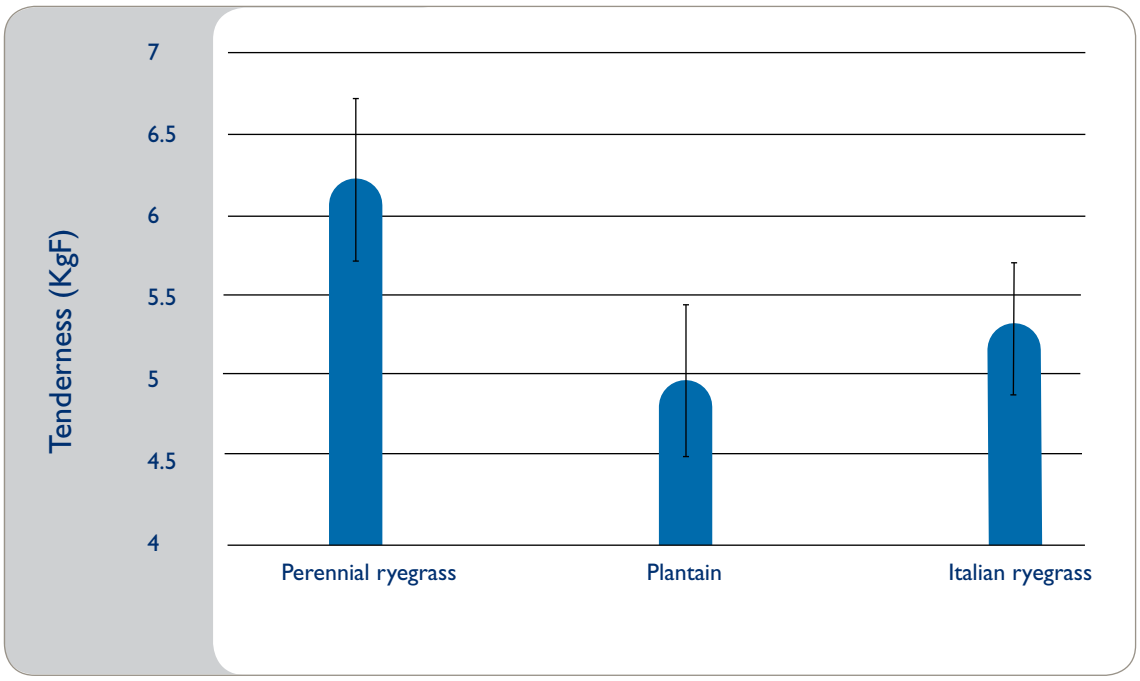


*Figure 10. Tenderness of lambs fed on three feed types from birth to weaning (processed December 2007) *Note the greater the shear force (KgF), the less tender the meat*

Eating quality

Forage types had no significant effect on any of the eating quality traits (aroma, flavour, texture and succulence) as assessed by panellists.

Where to next?

Data is currently being collected from 2008-born lambs. There was some variation in results between years. To further understand the relationship between diet and meat quality, trials are also being set up (in Southland and Canterbury) for 2009-born lambs with more of a focus on farm production and management factors in order to establish how farmers can best use alternative forage crops whilst maintaining good lamb meat quality.

Do growth rate and meat yield have an impact on meat quality?

Currently in New Zealand, sheep breeding programmes have a high emphasis on selection for growth rate and yield. Selection for growth and yield has been shown to negatively affect the meat quality of other meat types including pig, beef and poultry. There is little up-to-date information available about the effect of growth rate and yield on New Zealand lamb meat quality.

Alliance Group initially identified a relationship between growth rate, yield and meat quality from the Meat & Wool New Zealand Central Progeny Test (page 5). It was decided to examine this relationship further.

Trial details

Two hundred lambs from the Donald farm in Southland were tagged at birth and birth rank (single/twin/triplet) and sex were recorded. Lambs were born within 3 days of each other to Coopworth ewes and were from a mixture of sire breeds. All lambs were processed on the same day (February 2009).

Lambs were divided into high and low growth classes, based on their pre-processing liveweight, and high and low yield classes, based on VIAscan® measured total meat yield. In total there were four classes for comparison (1. low growth, low yield; 2. low growth, high yield; 3. high growth, low yield; 4. high growth, high yield).

High growth rate lambs had an 8kg greater weaning weight than slower growing lambs (Figure 11) and high yield lambs had 4% greater yield than the low yield lambs (Figure 12).

Aim: to determine the influence of lamb growth rate and VIAscan® measured yield on meat quality.

Traits measured:

- growth and yield
- pH
- colour stability
- frozen tenderness
- eating quality (paired descriptive test)

Key findings: all lamb was of good eating quality, however, meat from slower growing lambs ranked significantly higher than meat from faster growing lambs.

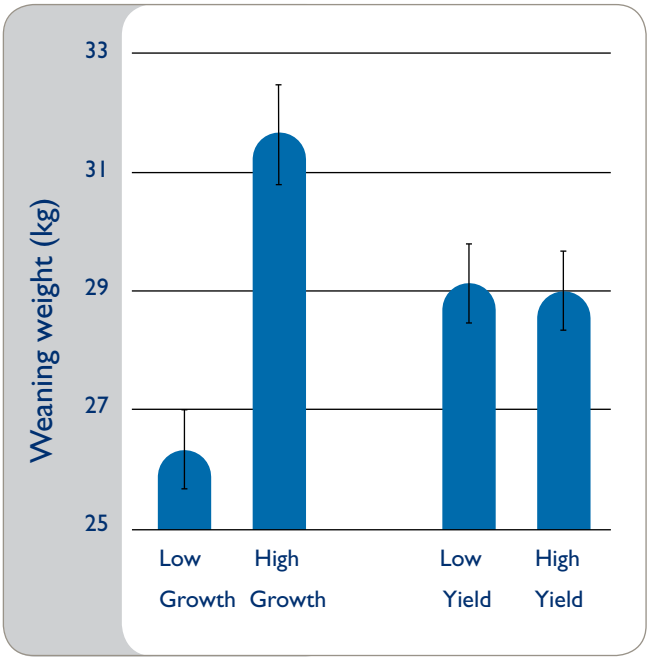


Figure 11. Average weaning weights of lambs in the different growth rate and yield classes

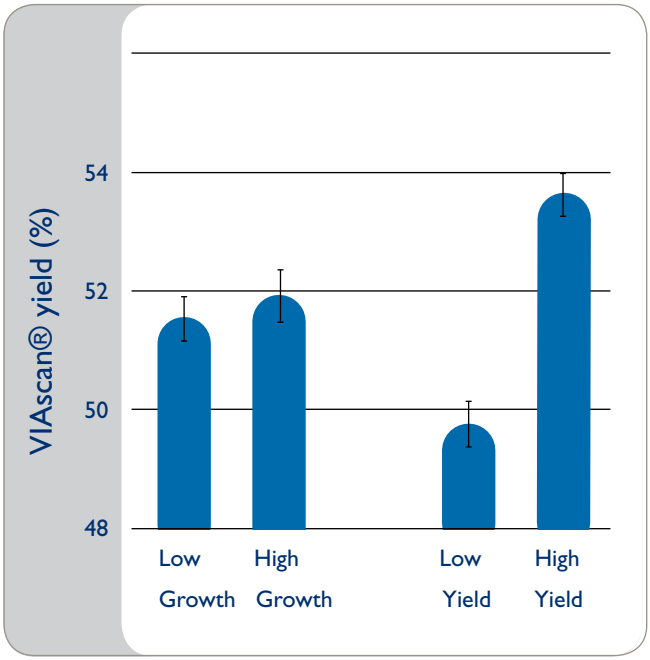


Figure 12. Average VIAscan® measured total yield of lambs in the different growth rate and yield classes

Results

Meat colour stability

There were significant differences in redness (a*) at four days between yield treatments but not at any of the other time points (lower yielding animals having better colour) (Figure 13).

pH

Faster growing lambs had significantly lower pH than slower growing lambs. There was no significant effect of yield on pH (Figure 14).

Eating quality

All meat in the trial was scored by taste panellists as having medium to high acceptability. Growth rate significantly affected most of the taste panel traits (aroma, flavour, succulence and overall acceptability), with the slower growing lambs consistently scored higher by the panellists than the faster growing lambs. There was no effect of yield on any of the eating quality traits.

Texture (as measured by taste panellists) and tenderness (as measured by a tenderometer) were significantly affected by pH and lamb gender, but not growth rate or yield.

Where to next?

Data is currently being collected to compare lambs born at different times (three weeks apart) which reach similar liveweights and are processed on the same day. This will allow evaluation of lambs with the same carcase weights but which have taken different growth trajectories to reach that weight. This will provide more information about the influence of growth rate on meat quality traits.

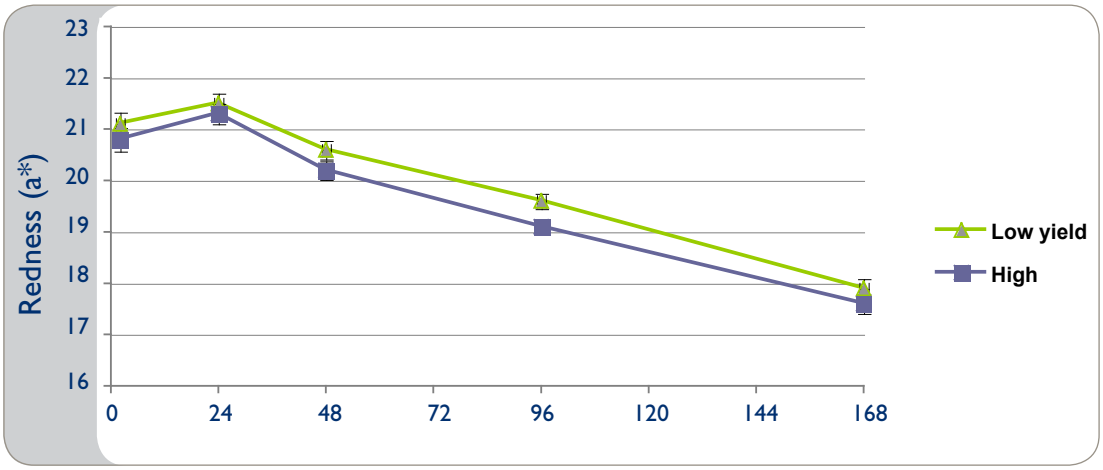


Figure 13. Colour stability of high and low yield lambs

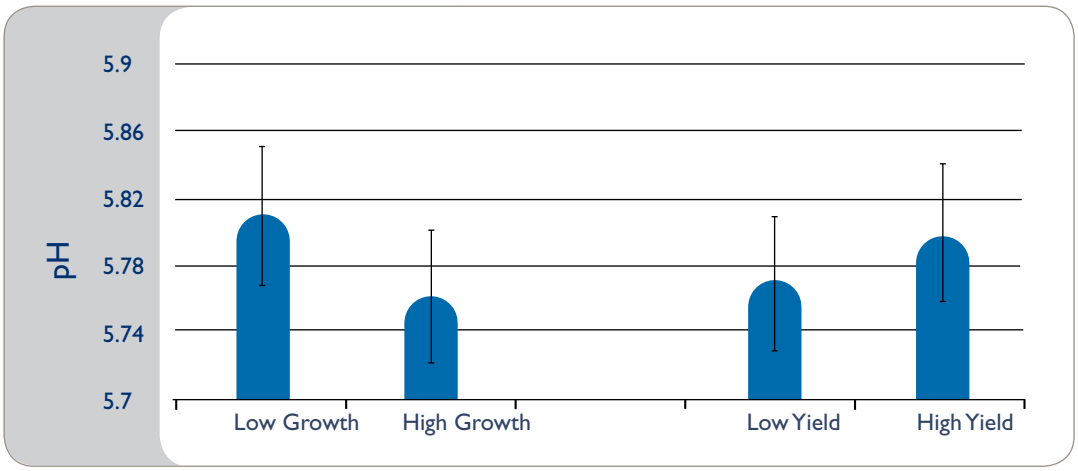


Figure 14. pH of high and low yield land high and low growth rate lambs

While all lamb had good eating quality, slower growing lambs had marginally better eating quality than faster growing lambs.

Alliance Group is exploring this relationship further to ensure its lamb products remain of the highest quality for export markets.

Do ram lambs have poorer meat quality than other lambs?

Alliance Group makes no distinction between carcases from lambs of different genders or castration status (males, females, castrate males, or induced cryptorchids). There have been no complaints from the market and there is no scientific evidence that ram lambs under a certain age and weight have poorer meat quality. However, due to perceived concerns, a trial was carried out to determine the effects of castration status on the meat quality of lambs up to 13 months of age.

Trial details

Two hundred single male lambs, which were a mixture of entire, cryptorchids and wethers were brought onto an Alliance farm. Groups of lambs were processed at 6, 8, 10, 11 and 13 months of age and evaluated for meat quality traits.

Results

VIAscan® yield

Ram lambs had significantly greater VIAscan® yield than wether lambs at 6 and 13 months (Figure 15).

Meat colour stability

There were significant differences among the groups in colour stability at seven days, but not earlier, with the wether lambs having poorer colour stability (Figure 16).

pH

Castration status affected the pH of lamb meat at ages 10 and 11 months. The wether lambs had significantly lower pH than the entire and crypt lambs. There were no significant differences in pH between entire, crypt and wether groups at 6, 8 or 13 months of age (Figure 17).

Aim: to determine if castration status has any adverse effect on meat quality

Traits measured:

- growth and yield
- colour stability
- pH
- frozen tenderness
- eating quality (triangle test)

Key findings: there were significant differences in pH between ram lambs and wether lambs at two ages, however, this did not translate to significant differences in eating quality at any of the ages measured.

Frozen tenderness

There were no significant differences among the groups for tenderness (shear force).

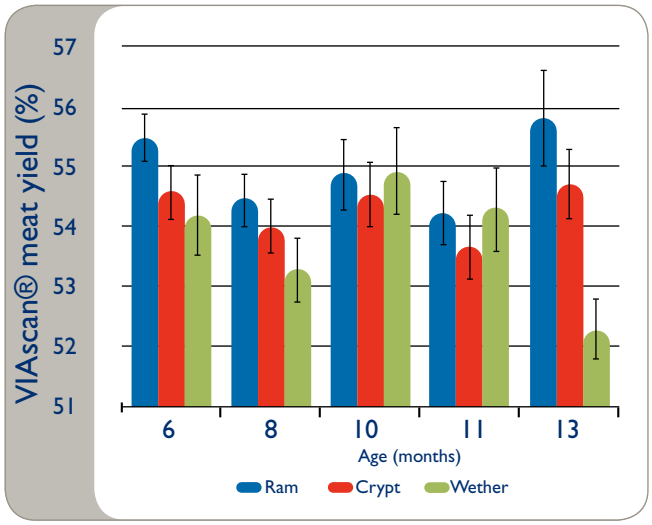


Figure 15. VIAscan® yield of entire, cryptorchid and wether lambs at different processing ages

Eating quality

The taste panellists were unable to distinguish differences among the entire, cryptorchids or wethers in a series of triangle taste panel tests (described on page 4).

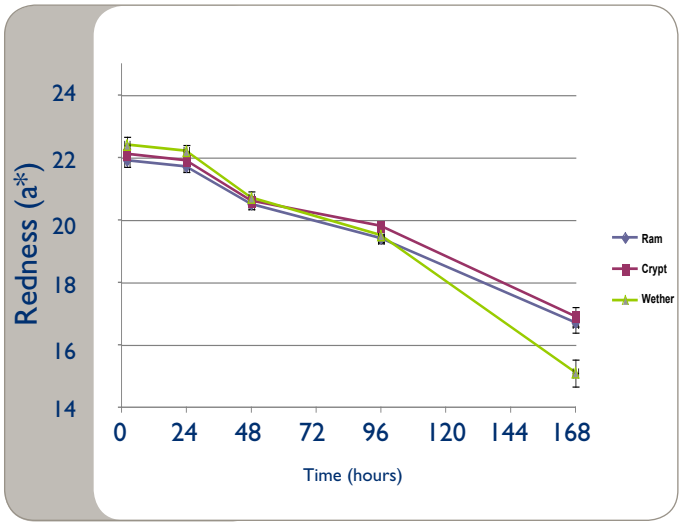


Figure 16. Colour stability of ram, cryptorchid and wether lambs

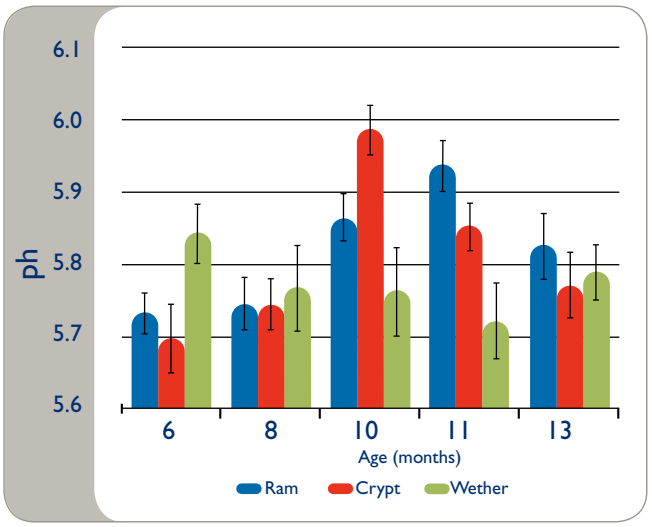


Figure 17. pH of ram, cryptorchid and wether lambs

No change will be made to Alliance Group's procurement policy on ram lambs. Therefore, no distinction will be made among carcases of different sex or castration status provided they are:

- in the required weight range;
- up to 12 months old.

Do Merino lambs have different meat quality?

Alliance Group processes a high number of Merino lambs from April through to November. Merino lambs are slower growing and are reported in scientific literature as having higher pH meat than lambs from other breeds. Alliance Group wanted to determine if there were any differences in the meat quality of Merino lambs compared with other breeds, given the meat goes to the same export markets.

Trial details

Loins were collected from a line of 30 Merino lambs and 30 lambs of conventional meat breeds and processed on the same day (August 2009).

Results

Colour stability and pH

There were significant differences in the colour stability of the meat from the Merino lambs compared with the meat from the conventional meat breeds. The meat from the conventional breeds had a higher a* redness score early on, but deteriorated faster than the meat from the Merino lambs.

There were significant differences in the pH of meat from the two groups, with the Merino lambs having significantly higher pH (6.06 ±0.04) than the lambs from the conventional meat breeds (5.83 ± 0.04).

Eating quality and tenderness

There were no significant differences in tenderness, as measured by a tenderometer, or eating quality, as measured by taste panellists.

Aim: to determine if Merino lamb meat quality is different to lambs from conventional meat breeds in a preliminary trial.

Traits measured:

- colour stability
- frozen tenderness
- pH
- eating quality (triangle tests)

Key findings: meat from Merino lambs had significantly higher pH than meat from other breeds, however, this did not translate to significant differences in eating quality

The eating quality of Merino lambs is as good as other breeds, but to keep pH low, they do require more careful management than other breeds, with key factors being good nutrition and stress minimisation prior to processing.

What does this work mean to you as an Alliance Group shareholder?

Alliance Group has made considerable investment in product quality and food safety through the Meat & Wool New Zealand Central Progeny Test, VIAscan® yield grading, the Farm Assurance Programme and processing technology, including electrical stimulation, packaging systems, X-ray and automation. The trials outlined in this booklet build on these investments to further establish our brands in the market place as guarantees of both product quality and food safety.

The results from these trials show that there are ways in which meat quality can be improved on-farm, either genetically or through diet. In terms of how we could incorporate meat quality improvements in the future, it may be as simple as getting farmers to finish on a particular forage type or to avoid others, or it may involve encouraging breeders to select rams with superior meat quality through a DNA test. We still have more work to do in this area before we signal the best ways to improve meat quality on-farm.

This work builds on our previous investments, and is on-going, ensuring that Alliance Group lamb products remain at the premium end of the market, representing outstanding eating quality and food safety.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