Production of quality wool - a case study

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Background

The case study property, "Blackford". is located approximately 20 kilometres inland from Kingston in the South East of South Australia. Merino breeding and woolgrowing is the only enterprise and the annual wool clip averages 300 to 350 bales.

Blackford is approximately 2,400 ha in size, of which 1.700 ha has been cleared and sown to pasture. Total effective grazing area is a little over 1,800 ha, comprising:

- 400 ha of good, well drained gum country
- 300 ha of deep sand with limestone
- 1.100 ha of ground-water rendzina flats, subject to inundation during winter and early spring.

The pastures on Blackford at present fall into five categories:

(i) Good well-drained gum country (400 ha)
Productive subterranean clover-based pastures, with a carrying capacity of approximately 12 d.s.e./ha. Contains some perennial grasses and a broad mixture of volunteer annuals, especially capeweed and wild geranium.

(ii) Deep sand with dryland lucerne (100 ha)
Carrying capacity approximately 7 d.s.e./ha, with pasture including subterranean clover, capeweed mixed annual grasses and some sown perennial grasses.

(iii) Deep sand without lucerne (200 ha)
Carrying capacity approximately 5 d.s.e./ha. with the pasture mix predominantly subterranean clover, capeweed and mixed annual grasses.

(iv) Good quality ground-water rendzina flats (600 ha)
Vigorous subterranean clover-based pastures (Trikkala and Yarloop) with strawberry clover and vigorous barley grass. Subject to shallow inundation only, and carries approximately 10 d.s.e./ha. Approximately half of this area now has reasonably dense balansa clover, following oversowing by a broadcaster three years ago.

(v) Poor quality ground-water rendzina flats (500 ha)
Very high pH and subject to moderate winter inundation. Barley grass is the main pasture species, supported by strawberry clover and some sown perennial grasses, especially tall wheat grass. Wettest areas support only barley grass of low productivity. Average carrying capacity of approximately 5 d.s.e./ha.

The sheep enterprise, carried on the 1,800 ha effective grazing area, comprises:

- 4,000 to 4,500 breeding Merino ewes, mated to Merino rams
- 3,500 to 4,000 weaners or hoggets
- 4,000 dry adult sheep, mainly wethers
- 200 rams (approximately).

Total stock carried varies over the year, with most sales of surplus sheep occurring during summer. Overall, stocking rate peaks at 8 to 9 d.s.e./ha in spring and early summer, coinciding with peak feed availability. Autumn/winter stocking rate is normally set at approximately 6.5 d.s.e./ha.

Average annual production and sales comprise:

- 60,000 to 65,000 kg of greasy wool (i.e. approximately 35 kg/ha)
- 150 to 200 Merino rams
- 3,000 to 3,500 surplus mixed sheep.

Objectives in wool production

Profit maximisation in the long term is the principal objective of our wool growing enterprise.

Maximum Profit = High Output x High Price - Optimum Inputs
where "High Price" reflects optimum quality. Maximum profit in the long term necessitates investment in both productivity increase and quality improvement (especially through genetic improvement) and also in enhancement (or at least maintenance) of physical resources. High quality wool is thus part of the overall objective, but maximisation of quality is definitely not our main goal.

What is wool quality?

In essence, wool quality is a large set of attributes of raw wool each of which contributes to consumer satisfaction and makes wool more marketable. Factors influencing processing costs as well as end-product quality are important, since processing costs are inevitably reflected in end-product prices and therefore in the competitiveness of wool against alternative fibres. Furthermore, some wool quality attributes affect on-farm production costs, as well as processing costs. For example, greasy colour and variability of fibre diameter are both strongly associated with susceptibility to fleece rot and fly strike.

Average fibre diameter is generally considered to be the quality attribute of greatest significance in wool, and accordingly accounts for approximately half of the variation in prices across the Australian wool clip. Other quality attributes of significant importance are length, tensile strength and position of break, vegetable matter contamination, dark fibre contamination or other non-removable contaminants, greasy colour, and style.

Market premiums and discounts for variations in wool quality (fourth quarter 1992/93)
Fibre Diameter. Large premiums can be achieved by lowering fibre diameter (Table 1).

Table I. Premiums for reducing fibre diameter, at 25 June 1993. (Source: Australian Wool Corporation Weekly Market Report, week ended 25 June 1993)

Ave. fibre diameter (microns)	Clean price (c/kg)	Premium for micron reduction (c/kg clean for each micron)
19	680	} 82
20	598	} 91
21	507	} 49
22	458	} 39
23	419	} 27
24	392	} 12
25	380	

Prospective future quality premiums

I believe that the medium to long term price of greasy wool in Australia will reflect:

- significant and sustained premiums for lower fibre diameter

- significant penalties or discounts for tender wool (reflecting increasing "discovery" and quantification of tenderness as more and more buyers insist on pre-sale length and strength measurement)
- larger premiums for increases in tensile strength of "sound" wool
- increased penalties for "hard to remove" contaminants and for pigmented fibre, urine stain and unscourable colour
- small but increasing premiums for style, handle and lower coefficient of variation (especially freedom from coarse edge).

Table 2. Discounts for quality shortcomings in Merino fleece wool, fourth quarter 1992-93. (Source: Australian Wool Corporation - Analysis of Price Relativities and Discounts)

Quality attribute	Average size of discount (c/kg clean)		
	Fine wool (18.6-20.5 µm)	Medium wool (20.6-22.5 µm)	Strong wool (22.6-24.5µm)
Tensile strength			
slightly tender (25-30 N/ktex)	44	26	10
moderately tender (18-24 N/ktex)	91	57	30
very tender (< 18 N/ktex)	128	68	52
Vegetable matter (burr/seed or shrive)			
light (1.1-3.0%)	10/10	8/9	6/7
moderate (3.1-7.0%)	85/73	50/42	42/45
heavy (>7.0%)	156/211	98/63	80/62
Length			
slightly short (B length)	10	4	3
moderately short (C length)	43	24	16
Colour			
light unscourable colour (H1)	32	18	11
medium unscourable colour (H2)	61	39	26
heavy unscourable colour (H3)	n.a.	45	31
Style			
premium for best topmaking over average topmaking	66	31	15

Other Quality Characteristics. Table 2 summarises the average discounts applying to fleece wools suffering various quality shortcomings.

Scope for improving wool production and quality

There are many different ways in which we can attempt to manage or improve wool quality. Table 3 summarises my assessment of the likely impact of the main management strategies on a wide array of wool quality attributes, on wool production and ultimately on woolgrowing profitability. A quick scan of Table 3 shows that selection and breeding offer considerable scope for the improvement of all the significant wool quality attributes listed, with the exception of vegetable matter. However, genetic change is relatively slow unless achieved through buying in replacement sheep of the preferred type, which is expensive.

Amongst the strategies which offer quicker improvement in wool quality. I have targeted the following as being most effective with respect to the key wool quality attributes.

Table 3. Strategies to improve wool production, quality and profitability in high rainfall south-eastern Australia and the likely impact on wool quality, production and profitability.

Attribute	Strategy available						
	Increase pasture production	Higher stocking rate	Late lambing + higher stocking rate	Autumn shearing	Supplementary feeding	Better strategic management	Genetic improvement
(a) Effect on wool quality							
Ave fibre diam.	↑↑↑[a]	↓↓↓↓	↓↓	-	↑	↓	↓↓
Foetal follicle initiation	↑↑	↓?	↑↑	-	↑↑	↑	↑
Tensile strength	↑↑	nil to ↓↓↓	↑↑	↑↑↑↑	↑↑	↑↑	↑↑
Vegetable matter	↑?	↓	↓	↑↑ to ↑↑↑↑	-	↓↓↓	-
Length	↑	↓↓	↓	-	↑	↑	↑
Pigmented fibre	-	-	-	-	-	↓↓	↓↓
Colour and stain	-	-	-	↓↓	-	↓↓	↓↓
Fleece rot & dermatitis	-	-	-	↓	-	↓	↓↓
Variability of fibre diameter	↓	↑ to ↓	↓	-	↓	↓	↓↓
Yield	↑ to ↓	↓	↓	↓↓	-	↑	-
(b) Effect on wool production and profit							
Cut/head	↑↑	↓↓	↓ to nil	-	↑	↑ to nil	↑↑
Cut/ha	↑↑	↑↑↑	↑↑↑	-	↑	↑↑	↑↑
Impact on wool price	↓	↑↑?	↑↑	↑ to ↑↑↑	↓↓ to ↑↑	↑↑	↑↑
Impact on clip value	↑	↑↑↑?	↑↑↑	↑ to ↑↑↑	↑↑?	↑↑	↑↑
Income from surplus sheep	↑↑	↓	↓ to ↑	↓?	↑↑	↑↑	↑↑
Cost of change	moderate to high	high	low to moderate	negligible	high	low	low to moderate
Profit	**variable**	**small to large gain**	**very large gain**	**generally positive**	**small to moderate**	**may be large**	**large gain**
Speed of change	moderate/ quick	quick	quick	moderate	quick	quick	slow/ moderate

[a]↑ or ↓ = slight change upwards or downwards; ↑↑ or ↓↓ = significant change upwards or downwards; ↑↑↑ or ↓↓↓ = moderate changeupwards or downwards; ↑↑↑↑ or ↓↓↓↓ = large change upwards or downwards;. - = little or no change; ? = uncertainty or considerable variability of outcome

Average fibre diameter

Nutritional "management" through increased stocking rate can reduce average fibre diameter by several microns, or by a micron or so if spring stocking rate is increased in conjunction with late lambing. Conversely, heavy supplementary feeding in autumn or increased pasture production can increase average fibre diameter significantly.

Foetal follicle initiation

Because of the effect of under nutrition during late pregnancy and early lactation on secondary follicle initiation, sheep born as twins produce wool typically around half a micron stronger and cut less wool than those born as singles in the same lambing mob. These effects persist throughout their life. Similarly, single lambs born when conditions are tough in autumn are likely to have inferior wool quality (and lower wool cut) than singles born in August/September, unless there is adequate autumn feed in the paddock or there is heavy supplementary feeding. Adequate, high quality feed in late winter/spring may overcome much of the normal wool quality disadvantages found in twins, while separation of twin-bearing ewes for preferential feeding following pregnancy testing is another useful strategy. Heavier stocking rates without adequate nutrition of lambing ewes can significantly depress lifetime performance of the offspring.

Tensile strength

Autumn shearing is a logical way to beat the problem of low tensile strength, basically by living with it instead of fighting against it - i.e. by severing the staple at its thinnest, weakest seasonal point, instead of in the middle of the rapid growth season. Not only is the tensile strength dramatically improved in typical situations with poor quality autumn feed, but also if there is a break, it will tend to be very close to the tip or the base, which is much less significant to processors than the mid-staple break associated with spring shearing.

Late lambing (August/September) when the lambing ewe has good quality paddock feed can also dramatically improve staple strength, while strategic pasture management with preferential grazing of the best quality summer pastures by weaners can also help. Without late lambing or autumn paddock feed of abnormally high quality (lucerne, irrigation, windrowed clover, etc), heavy supplementary feeding may be necessary to maintain staple strength of a spring shorn autumn lambing ewe flock, as the WA data in Table 4 shows.

Table 4. Influence of time of lambing and autumn nutrition on staple strength (I. G. Ralph, unpublished data).

Level of feeding (kg lupin/day)	Staple strength (N/ktex)		
	April lambing	June lambing	Unmated
Nil	23	33	40
0.1	20	32	52
0.2	22	45	52
0.4	28	36	53
0.6	37	47	50

Vegetable matter

Increased levels of vegetable matter is an almost inevitable offset of the higher tensile strength advantages of moving from spring to autumn shearing. The vegetable matter problem can be a major deterrent on some properties, especially where brome grass and silver grass predominate. Barley grass is a much less severe problem, and the overall level of vegetable matter contamination of autumn shorn clips can often be reduced to acceptably low levels by strategic grazing management and by spray topping or mowing of excess spring growth.

Strategies used at Blackford to improve wool production and quality

Apart from genetic improvement and "better strategic management", the wool quality improvement strategies compared in Table 3 all have some negatives as well as positives. However, we have adopted all seven strategies for Blackford as part of an overall wool production system. Omission of any one strategy from our program would diminish the effectiveness of the others.

Late lambing plus high stocking rate

I firmly believe that late lambing is the single most critical feature of our woolgrowing system. It helps us to match the feed requirements of our flock to the pattern of quality feed availability from our pastures. and to run many more dry sheep through the autumn/early winter period when the supply of available nutrients is usually low because of:

- poor quality dry feed residues
- limited early winter growth. especially in years of late break, and
- considerable winter inundation of pastures.

Table 3 shows that the overall result from the late lambing/higher spring stocking rate strategy, compared with conventional autumn lambing, is:

- lower average fibre diameter (less "blow-out" in spring)
- better foetal follicle initiation
- higher tensile strength of ewe fleeces
- slight reduction in vegetable matter fault as a consequence of higher spring stocking rate
- lower variability of fibre diameter along the staple
- little change in wool cut/head
- substantial increase in wool cut /ha
- higher wool price (lower fibre diameter, higher tensile strength)
- much higher clip value
- lower sale sheep prices (late drop)
- more surplus sheep for sale (more ewes, higher lambing %, less pregnancy toxaemia)
- relatively small increase in costs (more money tied up in extra sheep plus extra shearing, etc; the extra weaner feeding is offset by reduced ewe feeding)
- a substantial increase in profit

This has certainly been our experience at Blackford. The outcomes, however, may be slightly different on other farms, and some owners may be reluctant to accept the slight increase in risk of loss in the event of a severe drought. This risk is greater if the extra carrying capacity is taken up as breeding ewes, so at Blackford we keep our dry sheep numbers equal to or above ewe numbers, to provide enough flexibility to take the pressure off the ewes and young sheep if things do get tough.

Autumn shearing

Autumn shearing is another important part of our wool management package at Blackford. Like our late lambing/high stocking rate strategy, autumn shearing is a major divergence from "normal" practice. It has resulted in a substantial increase in the profitability of our wool enterprise overall. mainly through improved wool quality. The benefits from autumn shearing are:

- much higher staple strength
- the position of the break is at or near the end of the staple
- less colour, water stain, fleece rot, etc

- fewer ewe losses (spring shorn sheep are much more vulnerable if lambing in late winter or early spring in waterlogged areas or on sloping ground)
- little wool is lost with the few ewes that die at lambing
- less wool soiling with faeces or mud from wet yards
- fewer wet weather holdups
- greater availability of shearers

The main disadvantages are:

- higher levels of vegetable matter fault
- increased grass seed problems in the skin and eyes, especially with brome and silver grass seeds
- dusty yards and gateway erosion
- increased fire insurance premiums.

Table 5, which compares appropriate fleece lines from the Blackford clip, reveals relatively low staple strength (mid 20s) for spring shorn ram hoggets (12 months of age, wool growth period mid December to 1 September). These measurements understate the position, as in each year an additional two bales were classed out as being markedly tender - probably with a tensile strength around 20 N/ktex. The value of this spring shorn wool is further worsened by a predominance of a mid-staple position of the break.

Table 5. A comparison of autumn and spring shorn fleece lines in the Blackford clip.

Time of shearing and class of sheep	Fleece measurements				
	Yield (%)	Vegetable matter (%)	Fibre diameter (microns)	Length (mm)	Staple strength (N/ktex)
Spring shearing					
Ram hoggets with 8 months of wool growth					
Sept 1990 - 5 bales AAAM	65.7	0.7	18.1	78	27
Sept 1991 - 4 bales AAAM	68.6	0.6	18.3	68	23
Sept 1992 - 4 bales AAAM	68.4	0.4	17.5	64	25
Autumn shearing					
Ewe hoggets (8-9 months old)					
May 1991 - 7 bales AAAM	66.0	1.0	17.6	64	45
- 7 bales AAAWNR	67.1	1.6	17.9	66	37
Breeding ewes with ~11 months wool					
May 1991 - 20 bales AAAM	66.7	1.6	20.9	77	40
- 25 bales AAAM	68.5	1.5	21.7	80	37
Mar 1992 - 21 bales AAAM	70.1	1.2	22.1	91	38
May 1992 - 19 bales AAAM	67.9	1.3	19.8	100	32
Mar 1993 - 10 bales AAAM	70.0	1.9	21.3	86	41
- 18 bales AAAM	70.2	1.5	22.2	86	42
May 1993 - 15 bales AAAM	68.9	1.4	21.2	91	35
- 9 bales AAAM	68.8	1.3	20.2	82	41

By comparison, the wool from weaners (8-9 months old) shorn in May 1991 was very sound, averaging 40 N/ktex, but with considerably higher vegetable matter levels (1.0 and 1.6%). The breeding ewes shorn in autumn also achieved high tensile strength and around 1.5% vegetable matter . The vegetable matter fault levels in most of these autumn-shorn fleece lines fall in the "S" category, i.e. seed/shive fault in the range 1.1-3.0%. The penalty for this fault level over the autumn wool sales has been small, only 9c/kg clean. Thus, on balance, the fleece line's discount for vegetable matter fault is a minor consideration compared to the tender wool discounts (and loss of tensile strength premiums) which the Blackford clip would almost certainly have incurred had we not switched to autumn shearing.

Supplementary feeding

At present wool prices, supplementary feeding for production is unlikely to be profitable, especially when the consequent increase in average fibre diameter is taken into account. However, strategic feeding to improve wool quality (especially for the several critical weeks around the time coinciding with greatest weakness in the staple) and also for foetal secondary follicle initiation, (especially with twin lambs), is, likely to be profitable. But when, how much and for how long? Our Blackford strategy of shearing near the point of staple weakness and lambing when quality feed is assured removes much of the guesswork and feeding costs, but significant supplementation of weaners with high protein grain (lupins) is generally necessary to overcome the poor quality of paddock feed.

Genetic improvement

Genetic improvement of fleece weight, fibre diameter and tensile strength, coupled with reduction/elimination of colour, fleece rot and pigmented fibre faults are a central part of our integrated wool production and quality management program at Blackford. The greater the inherent genetic capacity of a flock towards high tensile strength, low fibre diameter and stylish fault-free white wool, the easier and less expensive it is to produce quality wool when adverse conditions prevail, and the better the wool quality and wool enterprise profitability when conditions are good. Key strategies adopted in the Blackford breeding programme include:

- extensive measurement of hogget rams, hogget ewes and all worker rams each year
- selection under easy-care commercial conditions with above-average stocking rates, no jetting and no supervision at lambing
- rigorous quality control, including selection for stylish white wool and rigorous culling against fleece rot and other genetic faults
- intensive genetic evaluation, including progeny testing of 15-20 high-measuring rams each year plus full pedigree recording of 500 ewes in the elite ram breeding flock.

Selective introduction of genetic material from the other high rainfall performance breeding flocks using laparoscopic artificial insemination.

Participation in the Merinotech breeding programme provides both excellent access to a wide range of genetic material at affordable prices and valuable feedback from a national programme of genetic evaluation.

Looking into the future

A concerted effort to improve wool production and quality at Blackford over the past ten years has yielded handsome dividends in the form of:

- 30% increase in production, from 50,000 to 65,000 kg
- substantial (approximately 2 micron) reduction in average fibre diameter, to an average of 20 to 21 microns over the whole clip
- marked improvement in tensile strength, with the majority of fleece wool now in the 35 to 45 N/ktex category
- maintenance of acceptable levels of vegetable matter fault
- marked improvements in style and freedom from colour and fleece rot
- substantial progress towards an easy-care low input flock.

However, the large benefits from easy-to-adopt changes, especially autumn shearing and high stocking rates with August/September lambing have now largely been captured (apart from some fine tuning). Future efforts will be focused firmly on continuing the genetic improvement of our flock and improvement of our feed base, both in terms of quantity and quality. At this stage, we are achieving almost half of our potential output, as assessed using the Reg French model.

- Apart from drainage, the greatest limitations in our feed base appear to be:
- relatively poor quality of dry summer feed
- lack of early winter production, apart from barley grass and cape weed
- lack of a productive legume component on our high pH wet flats

- possible emergence of a salinity problem on these wet flats
- low productivity of our deep sand areas.

Do the best answers include serradella, lupin-based fodder cropping of deep sands, more tall wheat grass, a better balansa-type clover and a new selection of super barley grass?