

the Wool Press

The Newsletter of the Cooperative Research Centre for Premium Quality Wool

Breakthrough in wool biology

During a routine search for wool fibre genes, Dr Simon Bawden, Research Fellow, has found a new gene that turns out to be one for a protein that forms filaments, never before described, and which occurs exclusively in the inner root sheath cells of the follicle and not the fibre.

Wool follicle cells that produce the wool fibre are truly remarkable in that they manufacture about 70 different types of proteins that end up forming the fibre structure and they do so at a rate that is faster than most other tissues. There are at least eight different kinds of proteins that make the filaments of the fibre's fibrous backbone and convey strength and elasticity.

The wool follicle cells also produce the inner root sheath, a rather complex sheath of cells that surrounds the wool fibre as it grows in its follicle and it becomes hard, acting rather like a rolling pin compressing the surface of the fibre to give the flattened shape to the fibre cuticle (Figure 1). It is lost when the fibre leaves the follicle above the skin. Although it has been known that the sheath contains filaments, they have not, to date, been identified.

The research on this new filament gene has shown that it is turned on (Figure 2) at a vital time during the formation of the fibre in the follicle and the protein it produces contributes to the hardness of the sheath. What is particularly interesting is that this protein is markedly different from any other so far described. It clearly plays a distinctive role in the formation of wool. The results have been submitted for publication.

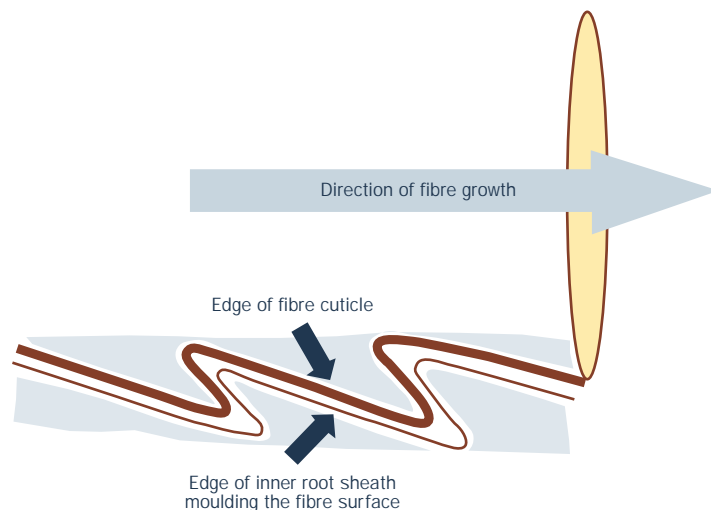
What's new in producing transgenic wools?

The last transgenes that have been inserted into a sheep and expressed in its follicles were designed to express two proteins in the follicles that should give rise to a higher content of intermediate filaments in the wool fibre cortex. Of several transgenic lambs born, one is expressing both genes and potentially it should be

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Figure 1

Line diagram illustrating the apposed surfaces of the wool fibre cuticle and the adjacent inner root sheath that impresses the shape of the cuticle as the two layers together grow upwards in the follicle.



CRC student wins national award

At the beginning of February I attended the 16th Australian Conference on Electron Microscopy (MicrOZcopy 2000) in Canberra.

As part of the Scanning Probe Microscopy session, I gave a presentation titled 'Nano-mechanical properties of polymers using the scanning probe microscope'.


My co-authors were Dr M.G. Huson and Dr X.J. Dai, both of CSIRO Textile and Fibre Technology.

As part of my PhD I am using the Scanning Probe Microscope (SPM) to gather information about various components of normal and modified wool fibres. The SPM, however, is a relatively new piece of equipment and therefore its applications are still developing. Some controversy also exists over the best ways in which to calibrate various components of the machine. I have therefore spent some time developing preferred methods of use and investigated numerous calibration procedures. The presentation I gave at the conference covered this initial work as well as some results obtained on polymer-coated wool fibres.

While at the conference, I was awarded one of three Australian Microbeam Analysis Society (AMAS) student awards. The award is designed to assist students to attend and give presentations at the Second Meeting

of the International Union of Microbeam Analysis Societies (IUMAS 2000) to be held in Hawaii during July 2000. The award covers the cost of airfares and conference registration.

The presentation I will give at IUMAS 2000 is titled 'Effects of humidity on biological fibres measured using the scanning probe microscope'. The presentation will cover work investigating the role of various cellular components of the wool fibre during water uptake, determination of the humidity at which each component passes through its glass transition and the 'hardness' of the fibre surface.

These will be determined using the SPM, which, as suggested by the title, can be operated under a range of environmental conditions to obtain both topographical and nano-mechanical information about a sample. 

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Breakthrough in wool biology

making more filaments. Preliminary examination of the wool of the lamb indicates that there is no 'dumping' of the proteins in the fibre cells so it is possible that more filaments are present. More experiments are planned including collaboration with the CRC's Program 3 ('Fibre formation, fibre properties and processing performance') to complete the analysis.

At the same time progress has been made by our SARDI collaborators in the production of pregnancies from nuclear transfers. This work will continue beyond the end of the Wool CRC as will the transgenic studies. The intention is to evaluate the application of nuclear transfer instead of microinjection as the preferred route to increasing the efficiency of transgenesis. 

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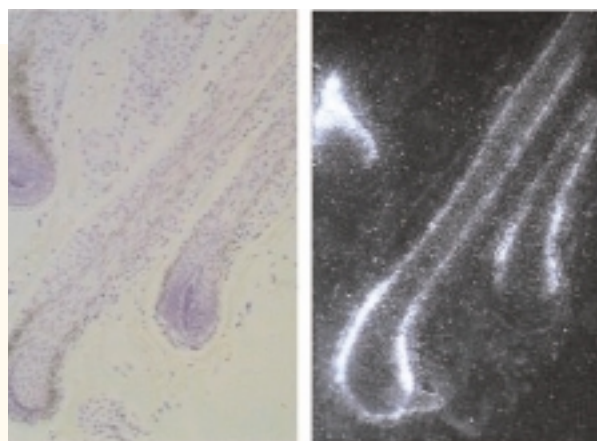


Figure 2

The light micrographs (in situ hybridization with a radiolabelled probe) show follicles with details of the cellular structure (left panel) and the same follicles (right) viewed in dark-field by which the presence of filaments in the inner root sheath is revealed as the bright regions.

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Same genetics for staple strength



Ian Pervis and Johan Greeff examine wool of weaners involved in trials near Katanning, WA.

in autumn and spring-shorn wool

Staple strength is the second most important wool quality trait after fibre diameter and can be improved by selection. Coefficient of variation of fibre diameter (CV_D) is highly correlated with staple strength and is a practical selection tool for breeders, whatever time of year they shear, according to new research by Johan Greeff from Agriculture Western Australia.

Agriculture Western Australia research has shown that rams with lower CV_D (range of fibre diameters in the fleece) will breed progeny with higher staple strength than their peers. Because CV_D results are provided routinely by wool testing laboratories when measuring fibre diameter, they provide a very economical selection tool for stud breeders compared with the more costly separate measurement of staple strength.

Until recently, most research involved spring-shorn sheep and there was concern about how widely such results could be applied to animals shorn at other times. An example would be stud breeders who generally shear in autumn and use the fleece testing results for selection purposes.

Different environmental factors can evoke different gene actions, and it is known that tenderness in wool could be caused by different environmental events. For example, shortage of good quality grazing for a limited period may result in tender wool because of the decrease in fibre diameter, but other factors such as trauma may have the same effect. Hence the underlying genes affecting the same trait might be different.

Trials were conducted at the Great Southern Animal Research Institute near Katanning in which half of the male progeny of a group of 121 Merino sires were allocated randomly to be shorn in autumn or in spring, while a third of the female progeny were shorn in spring and the rest in autumn. Full pedigrees were collected on each animal.

Analysis showed that clean fleece weight, fibre diameter, staple strength and CV_D were all heritable traits (i.e. a proportion of the variation within a flock will be transferred to the next generation) but heritability varied between seasons. The genetic correlation between these traits in spring and autumn-shorn wool did not differ significantly from unity and are shown in Table 1. This indicated that the traits measured in the different seasons were genetically the same.

The phenotypic and genetic relationship between staple strength and CV_D within seasons and across seasons varied from medium to strongly negative (see Table 2) and confirmed earlier results. This implies that rams with lower CV_D than their contemporaries should sire progeny with sounder wool. However, the genetic and phenotypic correlation between staple strength and CV_D in autumn-shorn wool was lower than in spring-shorn wool and may be related to the position of the break being near the end of the staple. This indicates that CV_D in autumn-shorn wool is not as good a predictor of staple strength as in spring wool but it is still a very useful result.

The results confirm that staple strength and CV_D are both heritable traits and can be improved by selection. They also show that CV_D is a very useful indirect selection criterion to improve staple strength irrespective of when animals are shorn, but especially in spring-shorn wool.

Table 1 – Genetic parameters of staple strength and coefficient of variation of fibre diameter (CV_D)

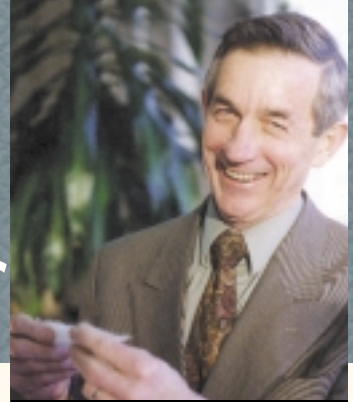
Trait	h^2		rg \pm se
	autumn	spring	
Clean fleece weight	0.32	0.37	0.86 \pm 0.15
Fibre diameter	0.61	0.62	1.05 \pm 0.06
Staple strength	0.33	0.27	1.07 \pm 0.14
CV_D	0.46	0.40	0.89 \pm 0.11

Table 2 – Correlations between staple strength and coefficient of variation of fibre diameter (CV_D)

Traits	Genetic	Phenotypic
Staple strength in autumn vs CV_D autumn	-0.30	-0.31
Staple strength autumn vs CV_D spring	-0.59	-
Staple strength spring vs CV_D autumn	-0.45	-
Staple strength spring vs CV_D spring	-0.65	-0.46

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From the Director



*Dr Lionel Ward,
Wool CRC Director*

The results of the grower ballot (closed 3 March) announced on 14 March, showed that, on the basis of preferential votes, 61% favoured a 2% levy, and 39% preferred the 3% levy option (compared to the current 3.5% for promotion and 0.5% for research).

fallout from the levy vote

The likely outcome

With Commonwealth funding of the Wool CRC (\$2.6 million per year) about to cease in June 2000, the potential fall in levy funding comes at a critical time for the wool industry. It is small comfort that, during the debate of recent months, growers have tended to favour support for R&D.

The important message is, however, that each R&D dollar has to be backed up by several dollars for extension, product development and product marketing (the McLachlan Taskforce recognised the logic of one composite levy).

In the case of post-farm research that claim may seem more obvious (Figure 1), but even on-farm research has to be consumer oriented one way or another.

Leverage effects

A 2% drop in levy funding for research and promotion can be readily estimated at over \$50 million (at current prices), but the implications of the vote do not end there. For example, the industry seems to have grossly underestimated the implications for the research effort sourced from other quarters due to the loss of leverage created by grower funds.

A good example is CSIRO's Textile and Fibre Technology (TFT) Division, known as the Wool Technology Division until last year. Its wool levy funding has declined from around \$15 million in the late 1980's (over 60% of its total income) to \$5 million in 1999/2000, roughly 24% of its budget.

CSIRO (TFT) is already shifting its research emphasis. As a participant in the new Cotton CRC it expects to see its external funding for cotton research rise to \$0.5 million by next year. In addition, TFT is a lead party in putting together a bid for a new CRC (Round 6), 'Technical Textiles', in which the opportunities for wool are limited.

Unfortunately, the examples don't end there. CSIRO Animal Production in 1999/2000 will receive \$400,000 from levy funds well down from the \$6.1million peak and only 1.8% of their total expenditure. As CSIRO's research emphasis shifts markedly, the same is occurring at universities and departments of agriculture throughout Australia. The implications are particularly significant for postgraduate research, the source of our future wool scientists.

contact *The Wool Press*



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This will be the second last issue of *The Wool Press*. As most readers would know, the CRC for Premium Quality Wool was not granted a second term last year. Consequently, it will wind up mid-year. If you wish to express a parting comment for publication in the final issue you are encouraged to contact the Editor. We look forward to hearing from you.

Moreover the shift is worldwide. Figure 2 shows the sort of global wool research structure that previously existed and the central role played by the (then) IWS in the extension of research outcomes. Today, Australia conducts most research relating to apparel wool and New Zealand carries the burden for interior textiles. In South Africa, for example, there is no longer a wool levy and expenditure on post-farm wool research has dropped in a few years from 0.87% to 0.24% of the value of production (which itself has declined markedly).

What needs to be done?

It would be too defeatist to accept a further contraction of wool R&D funding as inevitable. The wool research community will need to double its efforts to convey to government, the wool industry and the successor to The Woolmark Company, the serious risks posed by the grower vote and to argue for a more commercially responsible decision based on an objective assessment of the industry's research requirements.

The inclination of growers to lower their levy payments is understandable. They probably take for granted the numerous technologies that have enabled wool to compete internationally as a textile fibre. They tend also to see an ongoing levy as a cost rather than as an investment in future competitiveness. Moreover, growers are seen as bearing that cost on their own, whereas in reality the costs AND benefits are shared along the pipeline – not to mention the considerable investment in wool R&D by private companies themselves.


Maybe this coming year could be spent communicating to growers more effectively the essential nature of wool R&D, its inextricable links to extension and marketing and its critical role in the future of the wool industry. A decision whether to lift the levy again could then be determined through a straw poll rather than an expensive ballot. 

Figure 1

Flow of post-farm research to technology transfer and back

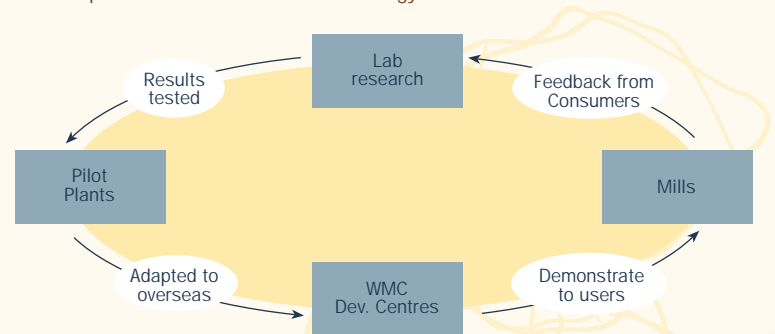


Figure 2

Historic structure and funding of post-farm wool research and development



Longer wool

processes better!

Quotes from cooperating mills

Lanificio Fratelli Cerruti 1881: "Our company was well impressed by the results and performance from the long Hauteur wool in spinning. We are wishing for similar performance in the remaining important stages of the fabric-making process which will provide final proof that longer Hauteur wools can reach our quality level."

Fabrica de Casmires Rivetex: "We obtained better spinning results with only one lot and very similar values in the other. We want to conduct several more trials in order to measure and analyse wastage in each step, higher spinning speeds, efficiency in spinning and weaving and if less twist can be used."

Toabo: "We were delighted to collaborate with other international mills and learnt a lot from the trial. The results were better than expected, and spinning ends down were very good. We are seeking to know more about the limits possible using longer fibres."

Kurabo: "We had very good results in yarn properties and spinning performance, but can't yet say for fabric and garment properties. We see this trial as big advantage for wool research."

Woolworths: "Long Hauteur wool produces good quality yarn and improved handle of the fabric."


An update on the long Hauteur project

In the May 1999 issue of *The Wool Press* we reported preliminary results from a project aimed at determining whether or not the belief that longer-stapled wools perform poorly in early and late-stage processing is sound. The results of these trials indicated clearly that longer wools produced less romaine after carding and combing. We can now report that such wools also performed better in spinning and weaving.

In October 1999, representatives of the mills met with researchers in Perth. The spinners agreed that in all trials the long Hauteur wool performed at least as well as conventional length top, and in some cases proved to be a much more efficient performer. The number of 'ends down', that is yarn breaks in spinning, was reduced substantially in most mills using longer wools of 18.5 and 20.5 micron diameter. It was found necessary to adjust machinery settings for longer wools but no changes to spinning frames were made.

A total of eight pairs of fabrics from three of the mills have now been objectively and subjectively compared. The paired comparison was with a wool of normal length but the same diameter, except in one case, where the wool was 1mm finer. The judging panels and measurements were in good agreement and showed that, although the fabrics were nearly identical, those from longer fibres were slightly preferred in terms of 'silky softness' but not as much as 1mm finer fibres.

The final report is still in preparation, however, the key result is that the results were broadly consistent with the stated advantages of longer wools. The mill that did not observe a clear advantage is undertaking further trials. An additional result was that one mill spun two fine count knitting yarns and observed very much improved performance in terms of reduced breaks in knitting. A list of potential suppliers of long Hauteur tops has been given to mills, most of whom appear to have sought further supplies, but seem to have had difficulty in coming to suitable arrangements.

As expected, the mills did not encounter detrimental effects from the high or low CV(H) values of the two wools. However, the strong industry beliefs in the importance of CV(H) are still penalising long wools by not allowing them to be of lower staple strength or to be blended with shorter wools. A follow-up project to address CV(H) issues has been prepared. 

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Wool Day Update



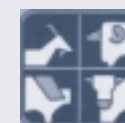
As announced in the last issue of *The Wool Press*, the Wool CRC will host a day devoted to wool at the AAAP-ASAP Conference in Sydney in July 2000.

Registration details for this one-day program are available from the web site for the AAAP-ASAP (Australian Society of Animal Production/Asian-Australasian Association of Animal Production) at: www.asap.asn.au

Registration fee is \$150 and \$60 for students.

Quality wool production and the CRC for Premium Quality Wool 1993-2000

Time	Titles	Chairs/ Speakers
0945 – 1030	Finer wool <ul style="list-style-type: none"> Accelerated gains for finer wool and higher fleece weight Going finer in traditionally non-fine areas Processing implications of research outcomes 	Dr I Purvis Dr A Swan Dr K Atkins Dr P Lamb
1030 – 1100	Morning tea	
1100 – 1145	Staple strength <ul style="list-style-type: none"> Biology of staple strength Potential for growers to improve staple strength Relationships to processing results 	Dr N Adams Dr A Schlink Dr A Peterson Dr C Oldham
1145 – 1245	Biotechnology <ul style="list-style-type: none"> Cloning of sheep: why and how Transgenic wool: objectives and approaches for altering wool properties Discovering quality related genes Public attitudes to genetic engineering 	Prof G Rogers Dr T Peura Dr S Bawden Dr I Franklin Dr K Ward
1245 – 1400	Lunch	
1400 – 1445	Education and Technology Transfer <ul style="list-style-type: none"> The Evolution of education and training for the wool industry Development of a web-based wool education resource database Extension in the wool industry: what works, what doesn't, and how do we measure it? 	Prof P Hynd Dr P Cregan Prof P Hynd Dr S Williams
1445 – 1530	Posters	
1530 – 1600	Afternoon tea	
1600 – 1645	Posters	
1645 – 1725	Question time Panel Overview	Prof L Piper CRC personnel Prof L Piper
1725 – 1730	Concluding remarks	Dr L Ward



Wool Day Program

Student Profile



Mohamad Yamin

Mohamad Yamin

Environment interactions in Merino sheep The University of Adelaide

Yamin is an overseas student from Indonesia studying for his PhD under the supervision of Prof Phil Hynd and Dr Wayne Pitchford from the University of Adelaide, and Dr Raul Ponzone from SARDI Livestock Systems. A combined scholarship from the Indonesian Government and the Wool CRC is funding the program. Yamin already holds a Masters degree from the University of Queensland, in the field of Meat Quality in Beef Cattle. His PhD project is investigating genotype by environment interactions in Merino sheep particularly in relation to the impact such interactions have on fibre diameter variability in response to changing nutritional conditions. Yamin hopes to complete his studies by the end of July this year.

Variations in mean fibre diameter, in response to changing nutritional conditions and with age of the animal, present major problems for the production of high quality wool fibres, from the point of view of 'blowout' in fibre diameter and reduced staple strength. Unfortunately, the most productive sheep (genetically) are those that respond most to the environment, so that, for example, sheep with high estimated breeding values for clean fleece weights have greatest variations in fibre diameter as seasonal nutrition changes. Are there sheep which are highly productive in terms of clean fleece weight but which also produce fibres that vary little in response to changing environmental conditions? And how is it that some animals (eg those producing finer fibres) are less responsive to changing nutrition in terms of fibre diameter variation? These questions are being addressed in Yamin's project.

Finer wool fibres in general contain a higher level of paracortical cells, which are distinguished from orthocortical cells in that they contain a higher ratio of matrix proteins to intermediate filament proteins. The former contain more cysteine residues and therefore these fibres have higher levels of sulphur, as cysteine is a sulphur-containing amino acid. Yamin is testing the hypothesis that sheep producing these fine fibres are less responsive to nutrition because when more cysteine becomes available (eg after the break of the season in southern Australia) they pump this additional cysteine into higher-cysteine proteins (the so-called ultrahigh sulphur proteins). This would mean that the cysteine cannot be used to produce more wool, just 'richer' wool. 'Higher diameter' sheep, in contrast, can respond to the additional cysteine because they either do not contain the genes for the ultrahigh sulphur proteins, or these genes are less responsive to the amino acid. It would be very interesting to know if there are sheep that produce low fibre diameter wools which are low in cysteine (sulphur) content, or that do not turn on their ultrahigh sulphur genes in response to nutrition.

To test this hypothesis Yamin is examining the responsiveness of different sheep genotypes (in terms of fleece weight and fibre diameter) to cysteine infusion. The four groups selected were as follows:

1. fine wool (14.9-17.0 mm); low sulphur content (2.52-2.67%)
2. fine wool (14.9-17.0 mm); high sulphur content (3.15-3.40%)
3. medium wool (21.2-23.1 mm); low sulphur content (2.63-2.78%)
4. medium wool (21.2-23.1 mm); high sulphur content (3.19-3.21%)

The sheep were placed in metabolism crates and offered a low protein ration and then supplemented with a high level of cysteine (4.0g/day by intravenous infusion) for 21 days. Wool growth rate, fibre diameter, wool sulphur content, paracortex percentage, the level of expression of the keratin gene family, and the relative production of various keratin proteins in wool are being measured.

This research will help us to gain an understanding of the interaction between genotype and nutritional environment and the possibility of manipulating this interaction to reduce fibre diameter variability in highly-productive sheep.



Mohamad with the 24 infused sheep in the Wool Sulphur Study.