Mr D Blacktop
Bell Gully
171 Featherston Street,
Wellington
New Zealand

28 March 2011

Dear Mr Blacktop

You have asked me to provide my independent opinion on the following questions related to the measurement of wool colour during the wool scouring process with an emphasis on base Y, or the brightness of wool. You have specifically asked:

- whether base Y can be improved through the commercial scouring process;
- what conclusions can be drawn from Figures 6, 7 and 8 of CWH's application for authorisation;
- about Dr Carnaby's statements about the precision of the data underlying Figures 6, 7 and 8;
- whether the modifications CWH have made to its scour lines have resulted in an increase in base Y;
- about the value of base Y; and
- whether it is possible for a merchant/exporter/domestic customer to buy greasy wool for scouring with a lower Y value while holding all wool other parameters constant.

In providing my opinion on these questions I have been provided with and have reviewed a public version of CWH's authorisation application, a copy of Figure 8 of that application (which is redacted from the public version of the application) and a public version of Dr Carnaby's letter to Mr Stock dated 19 February 2011.

I am a Senior Scientist in the Bio-based Products and Textiles section of AgResearch Limited. I have a B.Sc from the University of Canterbury majoring in Operations Research and have been practicing as a researcher for 30 years. A copy of my CV is **attached**.

I confirm that I have not previously been personally contracted to, or been employed by CWH or any of its shareholders.

I have been provided with a copy of the Code of Conduct for Expert Witnesses (Schedule 4 of the High Court Rules) and I have read and agree to comply with the code. The issues I address in this report are within my area of expertise.

The views I express are my own based on my experience and expertise in this area. My views are not the views of my employer AgResearch Limited.

1. Improvement of base Y through scouring processes

In my opinion base Y can be improved through commercial scouring processes.

It is clear from published literature that it is possible to change base Y in the scour through managed chemical processes.[1]

It is well known that bleaching processes (and some other proprietary methods available to the New Zealand scouring industry) will lift the base colour of wool and there are technical reports and industry practices that demonstrate this fact.

There are other chemical treatments other than use of bleach that will adjust base Y. For example careful use of some acid treatments on "well prepared wool" will result in shifts in base Y.

"Well prepared wool" is defined as wool that has been well opened and cleaned using unique sequences of machines and is passed through the scour plant at densities that are optimised for the best colour outcome using proprietary chemical treatments.[2]

Generally, it is acknowledged that if no "add-in" chemistry processes take place in the scour, other than the use of detergents, then the greasy base Y of a wool consignment should be the same as the base Y result for the scoured wool consignment. The test method used to verify this is the IWTO 56 test procedure.

However, if the extraneous matter removal technology has been advanced and these advances are combined with established chemical treatment engineering it could result in a shift in base Y. This has been discussed, to some extent, by Dr Carnaby in his letter to Mr Stock.

It is well known that metal ion levels in water will affect the colour of wool. For example Iron ions and Copper ions are known to affect wool colour. The control of metal ions during the cleaning process will impact the colour of wool.[3] Only a modest level of scientific work has been carried out in this area which presents further opportunities for commercial development particularly on the topic of dirt management before and during the scouring process.[4]

In summary:

- if the chemical processes in the scouring bowls are controlled, then the base Y colour measurements can be adjusted; and
- such control extends to the levels of machining and extraneous matter removal prior to scour entry as dirt management will affect the cleaning process and in combination with the use of industrial chemical processes, can specifically adjust brightness during the cleaning process.

2. What conclusions can be drawn from Figures 6, 7 and 8 of the CWH application?

I have been asked for my opinion on what conclusions can be drawn from Figures 6, 7 and 8 of the CWH application.

In my opinion, Figures 6, 7 and 8 of the CWH application illustrate:

- The base Y value for commercially scoured wool cleaned in the Hawkes Bay Woolscourers (**HBW**) plant between 2002 and 2010 trends upwards indicating wool processed in the plant has a higher base Y compared to 8 years earlier.
- The base Y values for a large population of greasy wool lots from the North Island, measured over a 10 year period, do not trend upwards at the same rate as the base Y values for wool processed in the HBW plant.
- The slope of the trend for the rate of peroxide use (litres per greasy tonne) in the HBW plant over a 9 year period is close to zero

From this, it can be concluded that changes in either plant operating conditions and/or raw materials procurement strategies have resulted in the base Y increase for commercially scoured wool from the HBW plant over time.

Dr Carnaby suggests in his report that the "shift of 1 unit or less over 10 years could just reflect the progressive purchase of a slightly whiter subset of North Island wools over that 10 year period".

This implies that greasy wool of low brightness is scoured in one plant while greasy wool with high brightness is scoured in another on a systematic basis. Most New Zealand greasy wool is scoured for carpet manufacturing and wool buyers will source similar wool types to supply mills for this purpose. Given that some large wool buyers (at least historically) will scour at two different scours for similar types of deliveries, this is likely to result in a similar representation (with regard to base Y) of greasy wool inputs at scours.

It should be noted that the commission scouring model attracts a wide range of North Island produced strong and mid micron wool types for processing and is likely to converge on the average greasy base Y results as shown for the North Island, although this requires verification.

However, in my opinion it is unlikely that greasy wool procurement strategies alone account for the observed trends in base Y over time given the scour operates on a commission basis with a wide range of strong and mid micron wool types being processed through the plant.

If the base Y results from the greasy wool used to build a consignment that is subsequently scoured at the HBW plant show a similar trend to the graph of all North Island greasy results, then it could be concluded that plant operating conditions are leading to higher base Y results.

3. Precision of the base Y test

You have asked me to comment on Dr Carnaby's statements about the precision of the base Y test.

A review of the terminology that is used by Dr Carnaby to describe the statistical performance of the international colour test (IWTO-56[5]) reveals that more rigour might assist when describing statistical parameters. The 95% confidence interval for base Y on a single wool test certificate (i.e., a single test) is ± 2.1 tri-stimulus units. That is, if one certificate is produced for a greasy farm lot, then the 95% confidence interval for the Y colour value corresponding to the wool lot is ± 2.1 units. This is often referred to in the wool trade as, "precision".

The base Y parameter of 3 units referred to by Dr Carnaby is defined as the Maximum Probable Difference (**MPD**) and relates to the difference used when comparing base Y results from two lots of wool, for example, two greasy farm lots of wool, or, base Y results from two test results used to test different portions of scoured wool consignments. It is derived from the precision section of IWTO-56. It is referenced in the IWTO Colour Test Regulations for Raw Wool and is used to determine the maximum retest range between two test results.

In the New Zealand industry, generally more than one test result is used to determine the colour result used on a test certificate for a commercially scoured wool consignment as described in the IWTO Colour Test Regulations for Raw Wool.[6]

The MPD is linked to the 95% confidence interval by the fact that when two measured numbers (each with a 95% confidence interval) are compared the square root of 2 is used as a multiplier to obtain the MPD. In the case of base Y, 2.1*square root of 2 = 3.

However, in CWH's application it is not two lots, or two consignments, of wool that are being compared but rather trends over time that are derived from many lots used to make up consignments.

Trend analysis carried out on a large database covering a number of years is acknowledged as a very powerful statistical technique and is often used to analyse quality parameters. The trend analysis contained in the CWH submission compares scoured wool base colour for the Awatoto plant to greasy wool base colour for the North Island over an 8 to 10 year period.

It is appropriate to investigate regression performance parameters and I believe this will demonstrate whether slopes for the graphs published in the submission are statistically different from zero. I understand that the regression slope for CWH's base Y trend over time is significantly different from zero.

When many measurements are taken, as is the case when trends over time are analysed, very small differences in Y can be statistically significant and these can be used in combination with accepted relative economic values (REV) for a quality parameter, such as the base Y parameter for wool, to provide an estimate of the change in wool value correlated with changes in base Y.

It should be noted that the relative economic value of wool is determined by objective measurement, and not by eye. Therefore the human detection limits for wool colour are less important with regard to econometrics.

4. Have the modifications CWH have resulted in an increase in base Y?

I have been asked to provide my opinion on the likely explanations for the changes in CWH's clean base Y as indicated in Figures 6, 7 and 8 of the CWH application and specifically whether the modifications CWH has made to its scour lines are a likely explanation.

As I outlined above, it is unlikely that greasy wool procurement strategies alone account for the trends in CWH's base Y as the scour operates on a commission basis with a wide range of strong and mid micron wool types being processed through the plant.

Accordingly, in my opinion the likely explanations for the changes in CWH's clean base Y as indicated in Figures 6, 7 and 8 of the CWH application are the modifications made to the scour plant, which includes chemical engineering practices combined with practices for machining the wool specifically aimed at dirt management in the scour.

5. The value of base Y

I have been asked whether in my experience, customers and merchants/exporters place a value on base Y and whether they would value a 1 unit increase in the base Y value.

My opinion is that a systematic 1 unit lift in base Y is valued as recorded in literature which reviews the relative economic values of a range of wool quality parameters. Wool contracts are negotiated using quite discrete numbers so a shift from, say, 64 to 65 provides additional opportunities.

I have also been asked to comment on Dr Carnaby's opinion that "a long term average value of 4c/kg per unit increase in base Y is a conservative figure and could be used to reliably calculate economic value".

I agree this is a conservative figure. The relative economic value for each unit shift in Y will change in line with the market.

6. Is it possible to buy greasy wool for scouring with a lower base Y value while holding all wool other parameters constant

When using multi dimensional analysis of the wool quality parameters that make up the New Zealand clip, such as colour, fibre diameter, fibre length, vegetable matter, etc, there will be portions of the clip where the fibre quality parameters, other than base Y, remain the same even though base Y changes by 1 unit.

As the tonnage of the national clip decreases this becomes more difficult to achieve however it is generally possible to build a consignment for typical carpet blends with a base Y value of 1 unit lower while maintaining all other quality parameters at a level that meets the specification required by the wool trade.

S. L. Ranford
25/03/2011

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[1] Wool Scouring and Allied Technology, R.G Stewart, Third Edition, WRONZ, 1988, ISBN 0-908699-23-9.

[2] An Investigation into Rinse Bowl Performance in Continuous Woolscouring, K.W. Whall, WRONZ Report No. R190, 1991.

[3] Relationship Between the Whiteness of Scoured Wool and the Level of residual Nitrogen Containing Contaminants, B. O. Bateup, Textile Research Journal, 1984, 54, 299-307.

[4] Residual Dirt on Scoured Wool : Part II Origin of Residual Dirt, J. R. McLaughlin and M. M. Leonard, WRONZ Report No. R168, 1989.

[5] IWT0-56, Method for the Measurement of Colour of Raw Wool, 2007.

[6] IWTO Colour Test Regulations.