

DARK FIBRE RISK AND PREDICTION

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Abstract

Australian wool has the reputation of being relatively free of dark fibre. However, dark fibre contamination is still a contentious issue within the wool industry. Research has enabled us to develop an instrument and a technique to determine the dark fibre contamination content of wool top. This examination point, however, may be too late for topmakers who have made commitments for light coloured end use of their product.

The provision of a measurement of dark fibre content that can be used as a basis for the trading of greasy wool is not practicable. The major impediment is that only a minute amount of urine stained or pigmented wool in a consignment is sufficient to exceed the topmakers' limit.

Our research has shown that the major source of dark fibre contamination in Australian merino wools is from urine stained fibres with pigmented fibres being of secondary importance. On this basis we have devised a Dark Fibre Risk Scheme, which is a predictive method that gives an estimate of the risk from urine stained or pigmented fibre contamination in a sale lot. It utilises information available from the classer's specification form filled out at the time of shearing.

A database of processed sale lots has been collected and utilised in refining the decision scheme, and the probabilities of a sale lot being placed in a particular risk category have been assessed.

Trials have been carried out to determine the relationship between age and pigmented fibre numbers in sheep. These trials highlight the problem of identifying sheep with a high risk of having isolated pigmented fibres as opposed to the general awareness of visible "black wool" on the sheep. This same awareness does not always apply to urine stained wool, where the importance of the interval between crutching and shearing has been demonstrated.

This seminar presentation will discuss trials leading to the re-evaluation of the Dark Fibre Risk Scheme. It will address the question of the possible inclusion of a dark fibre risk level in the sale catalogue, and its possible use by brokers and exporters in the support of existing quality assurance programs for the benefit of industry.

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1. Introduction

The provision of a measurement of dark fibre content that can be used as a basis for the trading of greasy wool is not practicable. The main limitation is that only a minute amount of urine stained or pigmented wool in a consignment is sufficient to exceed the topmakers' limit, particularly for light coloured end uses.

Research has shown that the major source of dark fibre contamination in Australian adult merino wools is from urine stained fibres, with pigmented fibres being of secondary importance. On this basis a Dark Fibre Risk Scheme has been devised, which as a predictive method gives an estimate of the risk from urine stained or pigmented fibre contamination in a sale lot. It uses information which is provided on the Clip Report at shearing time.

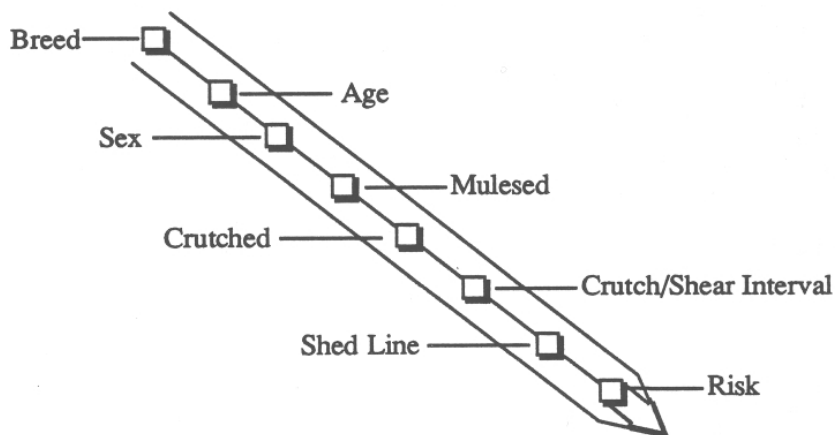
This paper is concerned with the research leading to the identification of the sources of these contaminants and with developing a method of predicting the probable level of contamination in individual sale lots and consignments from these sources.

2. Development of the Dark Fibre Risk Scheme

Research has provided information which has been used to develop a predictive method for the determination of dark fibre risk, in sale lots initially, and also for later use at the consignment level.

At the time of shearing, the wool classer is required to fill out a form with information about the sheep being shorn at that time. The information necessary to provide a dark fibre risk level 'on the sale lot includes the breed, age and sex of the sheep along with details of various husbandry practices covering crutching and mulesing.

Figure 1. Factors Influencing Dark Fibre Risk Prediction



2.2 Processing and Measurement

Validation of the predictions requires that the sale lots be processed, as measurement of dark fibre at the greasy stage is not practicable. One hundred and sixty-three sale lots have been processed and measured for dark fibre content using the definitions as recommended in the IWTO Draft Standard [5]. Results from the wool tops showed that when the total dark fibre number was below or very near the benchmark of 100 dark fibres per kilogram, the proportions of pigment and stain were approximately the same. However, when the dark fibre total exceeded the benchmark, the majority of those fibres were usually of urine stained origin. There were exceptions, and these were mainly sale lots from young sheep where the pigment count was usually in excess of the average level of 23 df/kg for sale lots of adult merino fleece wool.

3. Experimental Support for Risk Factors

The decision scheme was developed on the basis of early research work and observation under certain conditions. Recent experimentation has provided the opportunity to expand the processing data of sale lots, and for the results to be used in redefining the DFRS.

3.1 Age and pigmented fibres

There has always been a high awareness of the possible risk of contamination from patches of pigmented fibres or "black wool". What had not been given such a high profile was the risk from isolated pigmented fibres scattered throughout the fleece. According to M. Fleet [3], the best indicators of these fibres in young sheep are "halo-hair on the lamb coat and pigmented fibres on the legs and horn sites". The trend appears to be that isolated pigmented fibres in the fleece decline in number as the sheep age. However, there is the risk of some pigmented fibres or hair on the legs or head, and possibly within the fleece, being present throughout the lifetime of the sheep.

A trial (A) on a group of sheep over a period of years supported this earlier work. There was a substantial reduction in the number of pigmented fibres detected in the fleece wool after the third shearing (≥ 2 years) as opposed to the number recorded after the first shearing (≤ 1 year old). A second ongoing trial (B) with six groups of sheep of different bloodlines running together over a period of years provided similar results in that there was a substantial reduction in the mean pigmented fibre numbers for piece wools. Results of both trials are depicted in Table 1.

Table 1. Independent trials showing the relationship between increasing age and pigmented fibres per kilogram

		Age (Years)		
		≤ 1	1-2	≥ 2
A (1 group)	FLC	188	19	6
B (Mean of 6 groups)	PCS	182	71	36

Age-related results from 161 sale lots are shown in Table 2. Between the first and

third shearings, (sheep ages of less than or equal to one year and greater than or equal to two years) there were significant reductions in the amount of pigmented fibres detected in the top with a marked reduction between the first and second shearings (≤ 1 year and between 1 to 2 years).

Table 2. The relationship between increasing age and pigmented fibres per kilogram

	Age (Years)		
	≤ 1	1-2	≥ 2
FLC	204	44	23
PCs	251	91	57

3.2 Sex and shed line comparisons

Research work examined sale lots of adult merino ewes and wethers for any difference in urine stain dark fibre values between fleece and skirting wools. Only sheep that had experienced similar husbandry conditions were used for the analysis. These conditions included mulesing and a crutch-to-shear interval of greater than three months with conventional clip preparation. These criteria were chosen as they are the most common conditions in industry and so reflect the majority of the clip.

The results from these sale lots are displayed in Table 3. The low pigment values are similar for the fleece and skirting wool for wethers but there is a significant difference between the pigment values for fleece and skirting wool from the ewes. There is also a noticeable difference in the urine stain fibre values. In both ewes and wethers the number of urine stained fibres is greater in the skirtings than in the fleece wool. A further difference is shown in the results between ewe and wether skirtings. The location of stain on the sheep in relation to the shearing process means the risk of contamination is greater from ewes than from wethers.

Table 3. Comparison between sex and shed line (df/kg)

		Stain	Pigment	Total
Wethers	FLC	43	29	72
	PCS	115	20	135
Ewes	FLC	55	17	72
	PCS	267	106	373

3.3 Crutching and the crutch-to-shear interval

Sheep that have not been crutched or rung have been excluded from the low-to-medium risk levels because of their potential to produce high levels of urine stain. An important factor in the DFRS is the interval between crutching and shearing. Early trials [1] indicated the importance of this interval, with the probability of contamination being reduced as the interval between crutching and shearing narrowed. This work showed that for sheep to have the lowest level of dark fibre risk, the interval between crutching and shearing needed to be three months or less.

Within this time frame, fibres stained by urine would not be of sufficient colour intensity or colour length to be counted during testing for coloured fibres [1,2,4,5].

Trials on groups of sheep over recent years support the earlier research. Dark fibre measurements from sheep crutched one month before shearing showed little or no stain in the top. However, when the period was extended to four months the number of measured urine stained fibres increased noticeably. The mean values of urine stained fibres for piece wools from the six participating groups were one per kilogram for the crutch-to-shear interval of one month and 190 per kilogram for the four-month period.

The DFRS database mean values for urine stained fibre in processed sale lots crutched at three months or less with those crutched at more than three months are shown in Table 4. Results from various trials involving uncrutched sheep are also shown in the table.

Table 4. Comparison of mean results of urine stained fibres for crutch-shear Interval \leq and $>$ 3 months for fleece and piece wools

	Stain fibres /kg		
	\leq 3 months	$>$ 3 months	Uncrutched
FLC	15	70	302
PCS	11	251	2366

3.4 Visual assessment for urine stain

Visual assessment has been proposed [6] as a way of determining the presence or absence of urine stain on sheep before shearing. Shed trials designed to determine the value of this assessment were undertaken where sheep were examined before shearing and the unskirted fleeces collected, processed individually and tested for dark fibre content. Two examples that demonstrate the different results obtained are detailed in the following table.

Table 5. Results from 2 sheds for visual assessment and dark fibre/kg values in top for 6 single fleeces

Visual Assessment	Shed A		Shed B	
	Top Measurement	Visual Assessment	Top Measurement	Visual Assessment
No	0	No	0	
No	0	Yes	0	
No	58	Yes	0	
Yes	0	Yes	0	Yes = Stain observed
Yes	693	Yes	0	No = No stain observed
Yes	13643	Yes	5	

The difficulty of visually assessing sheep for stain before shearing is demonstrated by the results from these two sheds. The relationship between urine stain observed on

the sheep and that measured in the top was reasonable for four out of the six fleeces sampled for individual processing from Shed A. Sheep from Shed B were covered with a significant amount of red dust which made dark fibre assessment in the yard difficult and resulted in a positive urine stain recording for all but one animal. Processed top from these sheep showed little or no dark fibre contamination present. The "observed" urine stained wool was not recovered in the card waste so it was assumed the original visual assessment was misled by the presence of dust. It should also be taken into consideration that only 0.025 g of stain in a 4 kilogram fleece is equivalent to the benchmark value of 100 df/kg.

3.5 Consignments and blending

The importance of knowing the probability of dark fibre contamination in sale lots is highlighted with the formation of consignments. The possible contamination level of a consignment cannot be considered in the same way as objective measurements for diameter or staple strength as the objective measurement to form these judgements is not available. Table 6 shows the mean results of examination of some commercial consignments [7]. They indicate the contamination values that are possible from various combinations. The figures highlight the areas that cause concern, such as young sheep with pigmented fibres, and bellies and skirtings for urine stain. The table shows the increased trend with regard to dark fibre contamination if high-risk lots such as PCS, BLS or LMS are combined in a blend.

Table 6. Mean values for urine stained and pigmented fibres within wool categories and blends

Category	df/kg		
	S	P	S+P
FLC	53	37	90
PCS	246	71	317
FLC/PCS/LMS	121	806	927
PCS/LMS/BLS	1031	509	1540
PCS/BLS	1051	120	1171
WNR/FLC	126	126	252
XB	196	1919	2115

where S = urine stained fibres of dark or medium intensity (D+M)

P = pigmented fibres of dark or medium intensity (D+M)

D+M = dark and medium colour as per the IWTO-TME [4]

3.6 Risk levels, percentages and probability

The prediction scheme originally made provision for eight risk levels. However, with re-evaluation of the data based on trade requirements, it was determined that separation of Risk levels 5 through 8 was no longer necessary. The distinction between these levels was not critical as there was a high probability that any of these levels would have a dark fibre content greater than 100 df/kg.

All available information including the dark fibre results from processed sale lots have been formed into a database. The data have provided an opportunity to look at the percentage of sale lots tested that have fewer than 100 dark fibres per kilogram of top from each of the risk levels (Table 7).

Table 7. Mean df/kg and percentage of sale lots with < = 100 df/kg for each level

Risk Level	Number of lots	Mean df/kg	Sale lot % <=100/kg	Probability	95% CL
1	5	43	100	1.00	0.54
2	35	72	77	0.77	0.62
3	56	112	68	0.68	0.56
4	35	254	43	0.43	0.28
5	30	802	20	0.20	0.09

Note: The 2 crossbred lots in the database have not been included in this table

The probability, created with a 95% confidence level (CL), of a sale lot having less than 100 df/kg can be derived from the database for each level. For example, analysis of Risk level 3 sale lots showed that 68% of sale lots had a dark fibre level less than 100 (P = 0.68). However, if a 95% confidence level is created about this value (and only the lower one is used) a value of 56% (P = 0.56) would be used as a guide to possible contamination risk. A random selection of a Level 3 sale lot would therefore have at least a 56% chance of having a dark fibre number of less than 100 (Table 6). Similar calculations can be carried out on specific wools within levels, such as fleece or piece lots as well as for lots where the wool came from sheep less than two years old. Calculation of the probability of lot combinations from different levels can be approached in the same way.

Therefore, rather than trying to predict a dark fibre value for a lot the prediction is of the probability of a sale lot being under the limit. The sale lot would have to be processed as a single entity and then the top measured to find the actual dark fibre value.

4. Discussion

4.1 Support from quality assurance programs

Various on-farm factors are called into use with the DFRS, allowing classers and growers to use this information to lower the dark fibre risk level of a clip. A major criterion of some quality assurance groups is to ensure that the sheep have been crutched at three months or less before shearing.

It is estimated that the pool of wool required for use in the white and pastel trade is around 30% of the clip. The wether population of Australian merino sheep is approximately 30% and research has determined this 30% could adequately cover the needs of this portion of the trade [1]. With the emergence of quality assurance programs the pool of wool available to this section of the trade is estimated to have increased to around 40%.

4.2 Dark Fibre Risk Scheme benefits

There is a distinct market for all types of wool. Any tool that can assist the industry to predict contamination levels in sale lots should be used. Using the DFRS will increase the buyers' confidence in supporting a particular sale lot. The DFRS is a method of determining the risk of a particular sale lot and indicates the probability of that lot containing less than 100 df/kg.

The increased confidence in knowing the probability of dark fibre contamination in a sale lot has the potential to increase the demand for these types of wool and this in turn could lead to increased competition at wool sales with a potential increase in prices.

The information used for the derivation of the Dark Fibre Risk Scheme and the risk level of each sale lot can be used by exporters. By being able to see a number indicating the risk level of a lot in the catalogue, the probability of contamination from a dark fibre source can be easily calculated.

5. Conclusions

It is not possible to sample for dark fibre in the greasy stage; therefore, a method to predict the probability of the risk of dark fibre contamination in sale lots has been developed using information which can be made available from the clip report. This research has shown that as the risk level increases, the probability of the lot being under the limit decreases.

Trials to assess the various on-farm factors involved in the evolution of the DFRS have been evaluated and have highlighted several points, including the following:

1. there is greater risk from ewes than from wethers;
2. mulesing and crutching are important in stain reduction;
3. the interval between crutching and shearing is important in urine stain formation;
4. there is a relationship between isolated pigmented fibres and age;
5. there is a dark fibre risk from blending of different wool categories;
6. visual inspection of sheep for urine stain is difficult; and
7. quality management helps increase the pool of low-risk Australian merino wool.

For the Dark Fibre Risk Scheme to be taken further and the research results used and accepted, it is important that the Clip Report be completed accurately and the information from the reports be in an accessible format. The next step towards acceptance would be consignment sized trials in collaboration with commercial enterprises.

The acceptance of the DFRS by industry in conjunction with quality assurance

schemes will benefit industry as every effort to prevent and identify the risk of contamination by dark fibre is essential. It is adding value to a saleable commodity by reducing the risk pre-sale and by highlighting the potential risk in the catalogue.

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