Dark Fibre Risk Prediction

*This article is an edited version of a paper on Dark Fibre Risk Analysis presented to the CSIRO Woolspec seminar in Sydney in 1994, by **A. Burbidge** and **C.B. McInnes**. It reported the culmination of work the CSIRO Division of Wool Technology had been pursuing throughout the 1980's in an attempt to provide wool buyers and processors with information that could be used to reduce their exposure to risk from contamination by pigmented and urine stained fibres. The Dark Fibre Risk Scheme (DFRS) was not developed to cater for risks of contamination from exotic sheep breeds but could easily be expanded to do so.*

Roger Foulds, another CSIRO scientist, first introduced the scheme to an earlier seminar on Sale by Description in 1988. It received a warm reception at the time by the buyers present. Rene Vandervaere from Vanlaine Pty Ltd said:

"Congratulations on a fascinating paper. Freedom from dark fibre is vital to the success of Australian wool and I would strongly urge that this paper be circulated to all wool growers in Australia. I suggested, five years ago, that growers who followed the recommended crutching/preparation procedure be allowed to indicate this by a sign in the catalogue. Most of us would pay a heavy premium for the likelihood of a reduced dark fibre content. This grading from 1 to 8 is a far more sophisticated technique and I ask, 'can it be introduced now?'. There is no need to wait for additional measurements because the information is available now and could be collected and put into the catalogue. If this were done there would be a price premium.

The benefits of this scheme would outweigh anything else we have heard at this Seminar."

The scheme was never implemented by the industry, probably because other priorities were more pressing at the time. However, the principles elucidated by the research leading to the development of the scheme remain as valid today as they were then.

Introduction

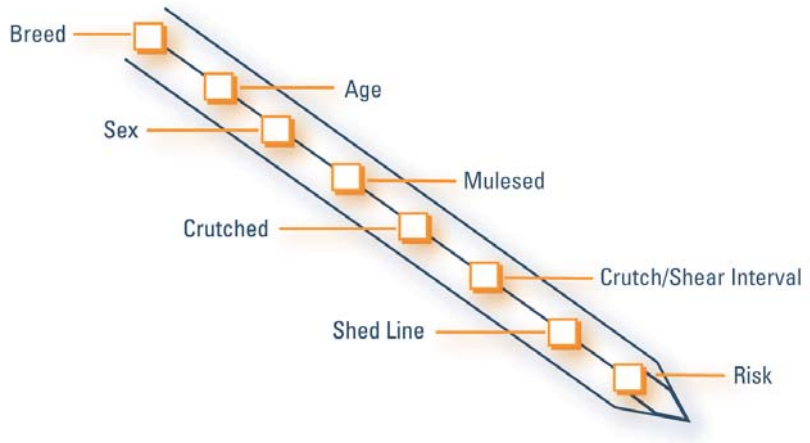
The provision of a measurement of dark fibre content that can be used as a basis for the trading of greasy wool is not practicable in every instance. The main limitation is that only a minute amount of urine stained or pigmented wool in a consignment is sufficient to exceed the topmakers' limit, particularly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

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 CSIRO devised a Dark Fibre Risk Scheme (DFRS), 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 can be provided on the Clip Report at shearing time.

Dark Fibre Risk Scheme: how does it work?

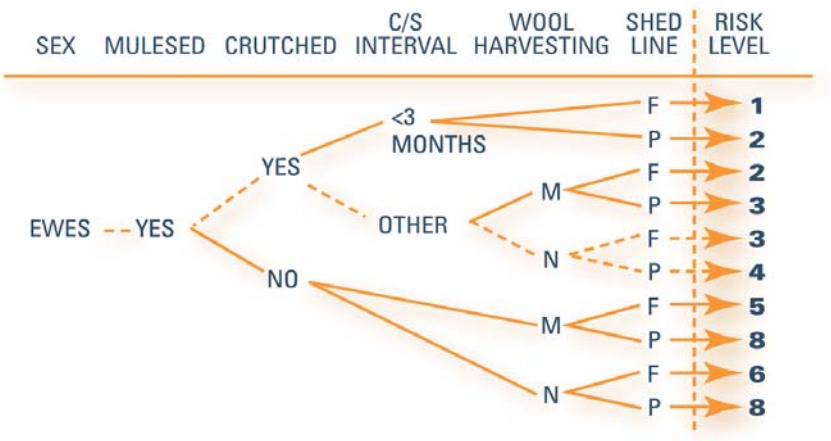
During the 1980's research by CSIRO provided information, which was used to develop a predictive method for the determination of dark fibre risk, in sale lots initially, and also for later use at the consignment level.

Figure 1: Factors Influencing Dark Fibre Risk Prediction



At the time of shearing, the wool classer fills 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 (see Figure 1).

Figure 2: Part of a decision tree, showing the decisions for stain control of ewes



Such information is used in the formation of a decision tree (see Figure 2) and hence the Dark Fibre Risk Scheme (DFRS) [1]. Using the information for a particular mob, the tree

format requires a yes/no decision to be made at each point, and from these answers the risk of contamination from dark fibre is predicted. Different combinations of the factors used in the tree produce different risk values, from a low risk level of 1 to a high risk of 8 [2]. **The analysis of this information to determine the risk level can be computerised and carried out independently of the grower.**

Identifying the factors determining risk of contamination

Since measurement of pigmented fibre in sale lots is very difficult in every case, the research work identifying the risk factors leading to the development of the DFRS was based on measurements on tops produced by processing fleeces or sale lots. The blending that occurs in processing removes much of the heterogeneity in the distribution of the contaminating fibres, thereby simplifying the sampling.

Age

There has always been a high awareness of the possible risk of contamination from patches of pigmented fibres or 'black wool'. What was once not given such a high profile was the risk from isolated pigmented fibres scattered throughout the fleece. The best indicators of these fibres in young sheep [3] are 'halo-hair on the lamb coat and pigmented fibres on the legs and horn sites'. Isolated pigmented fibres in the fleece tend to 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.

The results of two trials that demonstrated that there is a dependency on age on the levels of dark fibre are shown in Table 1.

Table 1.
The relationship between increasing age and df/kg

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

Similar analyses, based on sale lots, have supported this trend.

Sex

Tops produced from sale lots of adult merino ewes and wethers were also examined 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 were the most common conditions in industry and so reflect the majority of the clip.

The results from these sale lots are displayed in Table 2.

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 2.
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

Interval between crutching and shearing

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 supported this. Dark fibre measurements on tops produced from sheep crutched 1 month before shearing showed little or no stain. However, when the period was extended to 4 months the number of measured urine stained fibres increased noticeably. The mean values of urine stained fibres for pieces wools from the 6 participating groups were 1 per kilogram for the crutch-to-shear interval of 1 month and 190 per kilogram for the 4 month period.

Mean values for urine stained fibre in processed sale lots crutched at 3 months or less, compared with those crutched at more than 3 months are shown in Table 3. Results from various trials involving uncrutched sheep are also shown in Table 3. ➤

Table 3.
Comparison of mean results of urine stained fibres for crutch-shear Interval <= and > 3 months for fleece and piece wools

	Stain fibres /kg		
	<=3 months	> 3 months	Uncrutched
FLC	15	70	302
PCS	11	251	2366

Inclusion of high-risk lots such as PCS, BLS or LMS in mill consignments

The importance of knowing the probability of dark fibre contamination in sale lots was 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 4 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.

Table 4. Mean values for urine stained and pigmented fibres within wool categories and blends

	df/kg		
Category	**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); and

D+M = dark and medium colour.

Visual assessment for urine stain is difficult and unreliable

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 Table 5.

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

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

Risk levels, percentages and probability

When it was originally conceived the DFRS scheme made provision for 8 risk levels [1]. It was subsequently determined that only 5 levels are really necessary.

All available information including the dark fibre results from processed sale lots were formed into a database. These data provided an opportunity to look at the percentage of sale lots tested that had fewer than 100 dark fibres per kilogram of top from each of the risk levels assigned by the DFRS.

Table 6. Mean df/kg and percentage of sale lots with < = 100 df/kg for each risk level

Risk Level	Number of lots	Mean df/kg	Sale lot % <=100/kg	Probability that a sale lot has <100 df/kg	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

The probability, created with a 95% confidence level (CL), of a sale lot having less than 100 df/kg was derived for each risk 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 DFRS predicted 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.

Conclusions

In the 1980's, for contamination due to spots or urine stain, it was not possible to sample for dark fibre in the greasy stage. This has not changed in ensuing years. Therefore, a method to predict the probability of the risk of dark fibre contamination in sale lots was developed using information, which can be made available from the clip report. This showed 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 were evaluated and highlighted several points, including the following:

- there is greater risk from ewes than from wethers.
- Mulesing and crutching are important in stain reduction.
- The interval between crutching and shearing is important in urine stain formation.
- There is a relationship between isolated pigmented fibres and age.
- There is a dark fibre risk from blending of different wool categories.
- Visual inspection of sheep for urine stain is difficult.

Effective implementation of the Dark Fibre Risk requires that the necessary information is provided about the clip and that this information is in an accessible format.

References

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