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# Wool characteristics of fine-wool sheep in Xinjiang Uygur Autonomous Region, China

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## ABSTRACT

Wool production characteristics were investigated for fine-wool sheep of different genotypes at Nanshan Stud Farm, Xinjiang Uygur Autonomous Region, China.

Four main sets of data were available. The 1985 ewes were mixed-age Xinjiang Finewool (XF). The 1986 ewe and ram hoggets were XF, $F_1$ Australian Merino (AM) x XF and $F_1$ Chinese Merino (CM) x XF. The 1987 ewes included CM, mixed-age XF, $F_1$ AM x XF 2 year olds and $F_1$ AM x XF hoggets. The 1987 rams included AM, CM and mixed-age XF. Observations were made and samples collected at shearing in June. Measured traits included:-body weight (BW); greasy fleece weight (GFW); clean yield (CY); clean fleece weight (CFW); fibre diameter (FD); crimp frequency (CF); staple length (SL); colour (CL); weathered tip (WT); dirt (DT); dirt penetration (DP); suint (SU), and wax (WX).

Significant differences ($P<0.05$) occurred between hogget genotype and between sexes. AM x XF hoggets produced more wool than CM x XF, or XF, but there were no differences in BW. Ewe and ram hoggets had similar BW's, but ewe hoggets produced more wool of lower FD with greater SL and WT. In the XF ewes, as age increased there were significant ($P<0.05$) changes in GFW, CY, CFW, SL and WX. Clean fleece production of 3-6 year old XF ewes declined by 0.17 kg/yr and SL by 0.33 cm/yr. In the XF rams, there were significant ($P<0.05$) increases in BW and DT with age, whilst wool production increased to 3-4 years and then declined. There were significant ($P<0.05$) differences between years in GFW, FD, SL, WT, DP, DT, WX and SU in hoggets, and CY, CFW, FD and SL in mature ewes. The 5 body sites of XF ewes in 1985 had significant ($P<0.05$) differences in fleece traits for FD, SL, and CL. There were significant ($P<0.001$) correlations between traits for pooled data from all genotypes, ages, sexes, years and sampling sites. Negative correlations included WX with WT, DP, and DT; and DT with CY; whilst DP was positively correlated with WT.

These results have implications for future sheep breeding and wool technology research, and development of programmes for improved clean wool production and quality in China.

**Keywords:** Xinjiang; sheep; genotypes; fine-wool; wool characteristics.

## INTRODUCTION

Xinjiang Uygur Autonomous Region (XUAR) is located in north-western China. The topography is characterised by the Tarim and Jungger basins set amongst snow-clad mountain ranges of Altay (NE), Tianshan (centre) and Kunlun (S) which average 4,000m above sea-level. The grasslands are diversified, vast open steppes which cover 72.3 million ha. (48.2% of the total area of Xinjiang), with about 48 million ha. utilized for grazing. The sheep population is 23.7 million, which includes 9.1 million fine or improved sheep, 2.6 million semi-fine, with the remainder coarse carpet-wool, meat and pelt breeds (AHAS 1992).

Research and extension programmes are conducted at Nanshan Stud Farm by the Xinjiang Academy of Animal Science (XAAS), with headquarters in Urumqi (43°43'N 87°38'E), capital of XUAR. The Academy has an important role in setting production goals through genetic improvement programmes.

This paper reports on the relationships between wool production, clean yield, and other wool characteristics for Xinjiang Finewool and several other fine-wool genotypes of different ages and sex. Data are from an information base with the intended purpose of developing breeding plans to improve clean wool production and wool quality.

## EXPERIMENTAL

### Environment

Nanshan Stud Farm is situated about 85 km south of Urumqi, on the northern slopes of the Tianshan mountains. Topography is hilly with deep gullies and watercourses, and extends from 1,200 to 3,000m above sea-level. Many of the higher slopes are forested in cypress and pine. The continental climate has an annual rainfall between 350 and 500 mm, with 75% falling in the spring-summer months (April-July). Winters are very cold with frequent snowfalls and the temperature may fall below -30°C. Summers are warm to hot and temperatures may rise above 30°C. Constant winds give rise to frequent dust storms. Conserved feeds are important in livestock management, with pastures dry from November to April, and green for the remainder of the year. Sheep of mixed age and genotype are managed in small flocks of 200 to 350 animals per herdsman. Flocks are grazed as one mob on open, unimproved pasture and either yarded (spring, summer, and

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autumn) or housed (winter) at night, and between seasons they are moved to different pastures. At Nanshan, about 4,500 mixed-age breeding ewes are mated by artificial insemination for lambing in March-April. Lambs are classed for performance, initially at weaning, and again at hogget shearing. Approximately 1,200 ewe hogget progeny are required as annual replacements for the breeding flock. Rams not selected for breeding at Nanshan are sold for commercial use on other farms.

## Measurements

Fleece measurements from the Wool Technology Laboratory, XAAS, were all from sheep run at Nanshan Stud Farm. Field records and midside samples were taken at shearing in June of each year. The investigation included breeding ewes, rams and hoggets. In 1985, 20 Xinjiang Finewool (XF) 2-8 years old ewes were each wool sampled at five body regions. In 1987, mixed age ewes comprised 100 XF 3-8 year olds; 9 Chinese Merino (CM) of unspecified age, 24 $F_1$ Australian Merino (AM) x XF 2 year olds, and 28 $F_1$ AM x XF hoggets. In 1987, rams included 27 XF 2-5 year olds, with 1 CM, 2 XF, and 4 AM of unspecified ages. In 1986, hoggets comprised 20 XF ewes, 20 XF rams, 20 $F_1$ AM x XF ewes, 20 $F_1$ AM x XF rams, 10 $F_1$ CM x XF ewes, and 10 $F_1$ CM x XF rams.

The following traits were measured in midside samples, though not all were measured in each year: body weight (BW), greasy fleece weight (GFW), clean yield (CY), clean fleece weight (CFW), mean fibre diameter (FD), crimp frequency (CF), staple length (SL), colour (CL), weathered tip (WT), dirt penetration (DP), dirt (DT), suint (SU), and wax (WX). BW was recorded empty and offshears. GFW included bellies, but excluded floor locks, and CY was determined with vegetable fault removed.

Dirt was measured as percentage insoluble aqueous extract (which may have included less than 1% vegetable fault) from greasy wool for a mean of 3 subsamples. Dirt penetration was the distance from the staple tip to the visual boundary of dirt penetration expressed as a percentage of SL for a mean of 5 staples. Weathered tip was the distance from the staple tip to the visual boundary of weathered wool expressed as a percentage of SL for a mean of 5 staples. Wax was measured from the organic solvent extract expressed as percentage of greasy wool weight for a mean of 3 subsamples. Suint was measured as the soluble fraction from the aqueous extract expressed as a percentage of greasy wool weight for a mean of 3 subsamples. Colour was measured as percentage light transmission (ie unrelated to X,Y,Z tristimulus reflectance values) for a mean of 3 subsamples.

## Data Analysis

Differences between sampling site, sex, age and genotype were measured by least squares analyses for each set of records. The significance of differences between means for multiple comparisons were assessed by Tukey-Kramer HSD tests. Variation between years was measured by separate analyses for AM x XF ewe hoggets and XF mixed-age ewes. Relationships among the wool traits were assessed by regression analyses of data pooled over genotypes, ages, sexes, years and sampling sites.

## RESULTS AND DISCUSSION

## Genotype and Sex

Measurements taken on ewe and ram hoggets at the 1986 shearing are summarised by breed and sex categories in Table 1. AM x XF hoggets produced significantly (P<0.05) more wool than CM x XF or XF hoggets, but there were no significant differences in BW between the genotypes. The higher wool production of AM x XF hoggets was very likely associated with greater wool bearing skin area and/or higher wool follicle density, since there were no significant differences between genotypes in either FD or SL, and differences in fibre volume (FV) (expressed as $(FD)^2$ x SL) were negligible. Investigation of factors affecting wool production in medium-wool Merinos (Turner, 1956, 1958; Dun, 1958; Young and Chapman, 1958; Brown *et al.*, 1966; Turner *et al.*, 1968) confirmed that the largest influence on clean wool production was fibre density, with SL somewhat less, and

**TABLE 1:** Body weight and fleece characteristics (least squares mean ± SEM) for hoggets in 1986, by genotype and sex.

| Main effects[1] | Genotype | | | Sex | |
|---|---|---|---|---|---|
| Trait | XF | AM x XF | CM x XF | Ewe | Ram |
| Number recorded[2] | 33 - 40 | 38 - 40 | 19 - 20 | 46 - 50 | 43 - 50 |
| Body weight (kg) | 31.9±0.5 | 33.1±0.5 | 31.3±0.7 | 31.8±0.5 | 32.3±0.5 |
| Greasy fleece weight (kg) | 3.6±0.1[a] | 4.0±0.1[b] | 3.5±0.1[a] | 4.0±0.1[a] | 3.4±0.1[b] |
| Clean yield (%) | 52.6±1.0[a] | 55.6±1.0[ab] | 57.5±1.5[b] | 54.5±1.0 | 56.0±0.9 |
| Clean fleece weight (kg) | 1.9±0.1[a] | 2.2±0.1[b] | 2.0±0.1[ab] | 2.2±0.1[a] | 1.9±0.1[b] |
| Fibre diameter (µm) | 19.9±0.2 | 20.0±0.2 | 19.4±0.3 | 19.4±0.2[a] | 20.2±0.2[b] |
| Staple length (cm) | 9.3±0.1 | 9.2±0.1 | 9.5±0.2 | 9.6±0.1[a] | 9.1±0.2[b] |
| Weathered tip (%) | 15.2±1.0 | 16.9±1.0 | 16.9±1.4 | 17.8±0.9[a] | 14.8±0.9[b] |
| Dirt penetration (%) | 38.6±1.2 | 39.8±1.2 | 42.2±1.7 | 39.4±1.1 | 41.0±1.1 |
| Dirt (%) | 24.9±1.0 | 25.0±1.0 | 22.2±1.4 | 24.7±1.0 | 23.3±0.9 |
| Wax (%) | 12.5±0.4 | 11.2±0.4 | 12.6±0.6 | 12.3±0.4 | 11.9±0.4 |
| Suint (%) | 9.9±0.3[a] | 7.9±0.3[b] | 7.7±0.5[b] | 8.4±0.3 | 8.5±0.3 |

XF=Xinjiang Finewool; AM=Australian Merino; CM=Chinese Merino.
Main effects with different superscripts are significantly (P<0.05) different.
[1] There were no significant genotype x sex interactions.
[2] Numbers contributing to each mean vary because of missing values.

fibre cross-sectional area the least. As increased wool production increases, SL assumes greater importance, fibre cross-sectional area begins to have an effect (and hence FV) and the influence of fibre density lessens. Clean yield was significantly ($P<0.05$) higher in CM x XF than XF hoggets, which was attributed to a difference in SU content. There were no significant differences between genotypes in WT, DP, DT or WX.

Ewe hoggets were not significantly different from ram hoggets for BW, but produced significantly ($P<0.05$) more wool with lower FD and greater SL. This pattern was probably a reflection of different rearing conditions, rather than differences in wool follicle development in early life. Ewe hoggets had significantly ($P<0.05$) longer WT than ram hoggets, but differences in CY and wool contaminants were only minor and non-significant.

## Ewe and Ram Age

Body weight and measurements of ewe and ram fleece samples collected at the 1987 shearing were analysed in genotype x age categories for each sex. Several CM ewes, and AM, CM and XF rams were excluded from the analyses because of unknown ages and likely different rearing environment.

**TABLE 2:** Body weight and fleece characteristics (least squares mean ± SEM) for four age groups of Xinjiang Finewool ewes in 1987.

| Trait | Age (years) | | | |
|---|---|---|---|---|
| | 3 | 4 | 5 | 6 |
| Number recorded[1] | 26 - 28 | 21 - 25 | 20 - 23 | 14 - 18 |
| Body weight (kg) | 45.1±0.9 | 47.5±1.0 | 44.9±1.0 | 46.7±1.2 |
| Greasy fleece weight (kg) | 4.8±0.1$^{a}$ | 4.6±0.2$^{ab}$ | 4.3±0.2$^{b}$ | 4.0±0.2$^{b}$ |
| Clean yield (%) | 52.1±1.3$^{a}$ | 51.3±1.4$^{ab}$ | 46.9±1.4$^{b}$ | 49.4±1.7$^{ab}$ |
| Clean fleece weight (kg) | 2.5±0.1$^{a}$ | 2.3±0.1$^{ab}$ | 2.0±0.1$^{b}$ | 2.0±0.1$^{b}$ |
| Fibre diameter (µm) | 19.6±0.2 | 19.1±0.2 | 19.4±0.3 | 19.2±0.3 |
| Crimp frequency (/2.5cm) | 11.1±0.4 | 10.7±0.5 | 11.1±0.5 | 10.8±0.5 |
| Staple length (cm) | 9.0±0.2$^{a}$ | 8.6±0.2$^{ab}$ | 8.4±0.2$^{ab}$ | 8.0±0.3$^{b}$ |
| Weathered tip (%) | 7.2±0.5 | 7.6±0.5 | 6.7±0.6 | 6.7±0.6 |
| Dirt penetration (%) | 36.4±1.4 | 36.2±1.5 | 36.1±1.6 | 37.9±1.8 |
| Dirt (%) | 23.8±1.4 | 26.1±1.5 | 26.7±1.5 | 27.0±1.7 |
| Wax (%) | 15.5±0.7$^{ab}$ | 14.3±0.8$^{a}$ | 17.7±0.8$^{b}$ | 14.8±0.9$^{ab}$ |
| Suint (%) | 8.7±0.5 | 8.2±0.6 | 8.7±0.6 | 8.8±0.7 |

Means within rows with different superscripts are significantly ($P<0.05$) different.

[1] Numbers contributing to each mean vary because of missing values.

Body weight, fleece production and SL of XF ewes reached a peak at 3-4 years and then declined (Table 2). As age increased, there were significant ($P<0.05$) decreases in GFW, CY, CFW and SL. Clean fleece production declined by an average of 0.17 kg/year, whilst SL decreased by 0.33 cm/year. Despite significant differences ($P<0.05$) in WX content between age groups there was no obvious pattern. No other traits showed significant changes, although FD tended to decrease, whilst CF varied between years. However, the increase in DT in actual terms by an average of 1.1 %/year, could at least in part, account for the significant decline in CY with age. This decline in clean fleece production with age was similar to results reported by Brown *et al.* (1966) for Australian medium-wool Merino ewes, but their decline in SL was 0.20 cm/year.

Variation between age groups in XF rams (data not shown) had broadly similar trends to those already observed in the results for the ewes, except production peaked at a later age. Significant ($P<0.05$) age trends included increases in BW up to 4-5 years, and in wool production up to 3-4 years before a decline, which was broadly similar to the expected patterns for Australian and New Zealand Merinos. There was a tendency in the XF rams for DT to increase with age. There was no obvious explanation for the significant ($P<0.05$) variation in SU between age groups.

## Variation between Years

**TABLE 3:** Body weight and fleece characteristics (least squares mean ± SEM) for AM x XF ewe hoggets and XF mature ewes measured in two years.

| | Ewe hoggets AM x XF | | Mature ewes XF | |
|---|---|---|---|---|
| Year measured | 1986 | 1987 | 1985 | 1987 |
| Number recorded[1] | 20 | 14 - 28 | 19 - 20 | 85 - 100 |
| Body weight (kg) | 32.7±0.9 | 33.2±1.0 | 47.6±1.0 | 45.9±0.5 |
| Greasy fleece weight (kg) | 4.2±0.1$^{a}$ | 3.8±0.2$^{b}$ | 4.7±0.2 | 4.5±0.1 |
| Clean yield (%) | 53.9±1.3 | 54.0±1.1 | 55.1±1.6$^{a}$ | 49.9±0.7$^{b}$ |
| Clean fleece weight (kg) | 2.3±0.1 | 2.1±0.1 | 2.6±0.1$^{a}$ | 2.3±0.1$^{b}$ |
| Fibre diameter (µm) | 19.4±0.3$^{a}$ | 18.5±0.2$^{b}$ | 20.3±0.3$^{a}$ | 19.3±0.1$^{b}$ |
| Crimp frequency (/2.5cm) | NR | 9.5±0.3 | 11.2±0.5 | 11.1±0.2 |
| Staple length (cm) | 9.1±0.3$^{a}$ | 11.2±0.3$^{b}$ | 7.2±0.3$^{a}$ | 8.5±0.1$^{b}$ |
| Weathered tip (%) | 18.4±1.2$^{a}$ | 9.6±1.0$^{b}$ | NR | 7.1±0.3 |
| Dirt penetration (%) | 38.0±1.9$^{a}$ | 43.5±1.6$^{b}$ | NR | 36.6±0.8 |
| Dirt (%) | 26.9±1.4$^{a}$ | 22.1±1.2$^{b}$ | NR | 25.9±0.7 |
| Wax (%) | 11.7±0.8$^{a}$ | 14.3±0.7$^{b}$ | 16.2±0.9 | 15.7±0.4 |
| Suint (%) | 7.5±0.5$^{a}$ | 9.7±0.4$^{b}$ | NR | 8.5±0.3 |

AM=Australian Merino; XF=Xinjiang Finewool.

Means within genotype/age groups with different superscripts are significantly ($P<0.05$) different.

[1] Numbers contributing to each mean vary because of missing values.

NR=not recorded.

Data from AM x XF ewe hoggets and mature XF ewes, measured in more than one year are summarised by years in Table 3. Ewe hoggets in 1986 compared with 1987, produced significantly ($P<0.05$) more greasy wool, which had a higher FD, but shorter SL. Clean yield did not differ significantly between years, but DT and WT were significantly ($P<0.05$) greater in 1986, whereas DP, WX, and SU were significantly ($P<0.05$) lower, than in 1987. Mature ewes produced significantly ($P<0.05$) more clean wool in 1985 than in 1987, with higher wool production associated with higher FD and shorter SL, as in the hoggets. Clean yield was significantly ($P<0.05$) higher in 1985, but comparisons for wool contaminants were unavailable except for WX, which did not differ significantly between years.

Environmental variation between years, in particular rainfall, can be expected to influence both biological (eg nutrition) and physical (eg dust prevalence) conditions and hence measured wool traits. The limited data presented in Table 3 demonstrate that such variation exists, but the data were insufficient to define the full extent of possible between-year variation in wool traits at Nanshan Stud Farm.

## Relationships between Wool Traits

The correlations among measured traits for pooled data (unadjusted for age, sex or genotype) are presented in Table 4. Those relationships with possible relevance to future wool technology investigations are discussed here.

Clean yield and wool contaminants: High average amounts of DT (Tables 1-3) and a highly significant (P<0.001) negative correlation between DT and CY (r=-0.70) (Table 4), makes it clear that dirt is the major wool contaminant contributing to the common problem of low CY. Few estimates of environmental effects on fleece traits, such as WT, DP and coefficient of variation of FD appear to have been published. However, investigations by Atkins (1987) and Mortimer (1987) indicate that heritability of DP and its genetic correlation with GFW, CFW and FD in medium Merinos are low. Selection for one, or two traits (eg CFW and FD), is likely to have a negligible impact on DP. Improved CY is likely to be achieved by better management practices during sheep handling, such as the use of protective sheep coats and the installation of slatted flooring in sheep houses.

As expected, WX through its protective function had significant (P<0.001) negative correlations with WT, DP and DT. Optimum levels of WX and SU for the Nanshan Stud Farm are being addressed through the inclusion of CFW in the selection index used for the ram improvement programme.

Fibre diameter and crimp frequency: The negligible correlation between FD and CF found in these data is not unusual for fine-wool and some strains of medium-wool Merino sheep. Evidence of low negative correlations between the two traits, and the poor performance of CF as a predictor of fineness has been widely reported in Australian Merinos (Roberts and Dunlop, 1957; Dunlop, 1962; Brown and Turner, 1968; Mortimer, 1987), and in fine-wool New Zealand Merinos (Wuliji *et al.*, 1991). Within strains the average CF is considered more resistant than FD to modification by the effects of age or environment (Roberts and Dunlop, 1957; Dunlop, 1962). The implication is that Nanshan can safely follow Australasian wool classing recommendations of preparing only two lines on the basis of CF with the main line comprising three quality counts centred around the predominant count, and a second smaller line of wool with lower crimp frequency than the main line.

Our preliminary estimates show that CF was significantly (P<0.001) correlated with DT (r=0.42) and CY (r=-0.42), but it is important that the database is expanded to confirm these estimates so that the CF:FD relationships can be examined in more detail.

Dirt penetration and weathered tip: There was a significant (P<0.001) positive correlation between DP and WT (r=0.47), but neither trait was significantly correlated with CY or other important wool production traits, except WX which has already been referred to. Fleeces with high DP and WT are likely to be open and have a low fibre density. The negligible correlation between DP and DT may be influenced by the efficiency of the extraction process used to estimate DT. Complex physical and chemical interactions affect the aqueous scouring process. Most of the "soil" of DT, WX and SU is bound to the fibre tip by a mechanically strong complex (Stewart, 1988) which is broken-up by squeeze rollers in the industrial scour. Environmental factors such as rainfall could influence the relationship between DP and DT by leaching of DT from the staples. Measurements of fibre/follicle density should allow further elucidation.

Fibre/follicle density: Omission of fibre/follicle density measurements has prevented a thorough investigation of the contribution of low density to low wool production in the XF genotype; it has also prevented evaluation of the potential of increased density to improving CY through reduced DT contamination. Measurement of secondary/primary follicle ratios and information about their association with density would also enhance the understanding of variation in WX and SU contents, and of variation in FD within individual fleeces. In the short-term, the ram selection programme at Nanshan is not expected to be affected by any delay in the introduction of these measurements, because selection for CFW should also ensure an associated inherent increase in fibre density, and improved fleece structure (Dun, 1958; Turner, 1958; Brown, *et al.*, 1966; Brown and Turner, 1968).

## Body Sampling Sites

Wool samples from shoulder, back, midside, rump and belly sites were collected for measurement from each of 20 mature XF ewes with full length fleeces prior to the 1985

**TABLE 4:** Correlation coefficients among measured wool traits for all sheep[1].

| Trait | CY | FD | CF | SL | DP | WT | WX | SU |
|---|---|---|---|---|---|---|---|---|
| FD | -0.08 | | | | | | | |
| CF | -0.42*** | -0.04 | | | | | | |
| SL | 0.24*** | 0.17** | -0.37*** | | | | | |
| DP | 0.08 | -0.08 | -0.17* | 0.06 | | | | |
| WT | 0.11 | 0.07 | -0.06 | 0.09 | 0.47*** | | | |
| WX | -0.40*** | 0.45*** | 0.18* | 0.15* | -0.26*** | -0.38*** | | |
| SU | -0.07 | -0.33*** | -0.07 | -0.04 | -0.19** | -0.12 | -0.24*** | |
| DT | -0.70*** | -0.14* | 0.42*** | -0.43*** | 0.12 | 0.12 | -0.26*** | -0.16** |

CY: clean yield; FD: fibre diameter; CF: crimp frequency; SL: staple length; DP: dirt penetration; WT: weathered tip; WX: wax; SU: suint; DT: dirt.
[1] Pooled without adjustment for genotype, age, sex, year, or sampling site.
* P<0.05; ** P<0.01; *** P<0.001.

shearing. Body weight and midside fleece characteristics are reported in Table 3, except for CL which was 50.0 ± 0.8%.

Differences were apparent for FD and SL at the different body sites (data not shown). Midside, shoulder and back positions were significantly ($P<0.05$) finer by an average of 1.3 µm than the average (21.6 µm) for rump and belly sites. Staples at the back and belly sites were significantly ($P<0.05$) shorter by 1.4 cm compared with the average for shoulder, midside and rump sites (7.3 cm).

Variation in FD and SL at the different sampling sites of XF ewes tended to follow the pattern described for Australian Merinos (Turner, 1956; Young and Chapman, 1958; Quinnell *et al.*, 1973). In these studies FD increased in an antero-posterior gradient, whereas the dorso-ventral pattern for FD involved a decrease from the back and midside to the belly, although this was less distinct. Quinnell *et al.* (1973) noted that the variation in FD between sites, was less than that between sheep at the same body site. However, the trend in XF sheep for FD to increase, rather than decrease from back through midside to belly was contrary to expectation. Reasons for coarser rather than finer belly wool in these sheep are not clear, but it may be related to the origins of the XF breed, or because the sample site was not representative. Back and belly sites of strong-wool South Australian Merinos had FD's that were similar (Young and Chapman, 1958; Quinnell *et al.*, 1973), whilst Turner (1956) noted the occurrence of coarser belly wool in American Rambouillets and South African Merinos. As observed with XF ewes, SL of Australian Merinos tend to decrease from head to breech with values in the dorso-ventral direction often higher at the midside than the back and belly, but there were variations to this pattern and in the magnitude of changes (Turner, 1956; Young and Chapman, 1958).

Crimp frequency for XF sheep did not vary significantly between sampling sites. Back and belly wool was significantly ($P<0.05$) more coloured, than the other sites by an average of 3.5%.

There were insufficient data to assess variation in CY and wool contaminants (WX, SU, DT and vegetable fault) for different body positions, and therefore we are unable to establish whether the midside is the most appropriate sampling site for CY determination and CFW calculation in the Xinjiang environment.

## CONCLUSION

Analysis of this database and interpretation of the findings has provided an objective basis to address the issue of wool production, and has assisted the development of new programmes for management and wool quality improvement in the Chinese sheep industry.

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