

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

VARIATION AND COVARIATION IN BIRTHCOAT
AND FLEECE TRAITS
OF DRYSDALE SHEEP
WITH REFERENCE TO EARLY SELECTION
AND SAMPLING POSITIONS

A thesis submitted in partial fulfilment
of the requirements for the degree of
Doctor of Philosophy
in
Animal Science
at

Massey University
New Zealand

Hassanein Mohamed Elgabbas

1986

ABSTRACT

Samples from different body regions were obtained from the birthcoat, first, second and third fleeces of sheep in two Drysdale flocks. Fibre type arrays of birthcoat samples were analysed and various wool traits were assessed and measured in samples obtained at three shearings.

Sampling position was the main source of variation in most traits studied. Sex, birth rank, and age of dam generally made little contribution to the total variance. Shearing, flock and sire effects were also important sources of variation for many traits. The interaction of shearing X position and the interactions of sire with each of shearing, sex and birth rank were significant for many traits.

Phenotypic correlations among fleece traits were estimated from shoulder and mid-side positions as well as among fleece averages calculated from all positions. Correlations among fleece averages showed that higher kemp score (KS) was associated with higher bulk; BUL (0.24 to 0.64), resilience; RES (0.03 to 0.48) and tristimulus colour values; X, Y and Z (0.08 to 0.46). Softer handle grade tended to be correlated with lower BUL (-0.22 to -0.66) and RES (-0.16 to -0.53) and higher lustre; LG (0.10 to 0.62). Higher medullation index (MI) was generally associated with higher BUL (-0.15 to 0.49) and tristimulus colour values (-0.01 to 0.60) and lower LG (-0.65 to 0.08). Correlations among tristimulus colour values were the highest between X and Y reflectances (0.93 to 1.00). Greasy and clean wool per unit area (GWA and CWA) were highly correlated (0.93 to 0.96). Heavier first greasy fleece weight (GFW1) correlated positively with GWA (0.59) and CWA (0.56). Staple length (STL) tended to be longer as GWA (0.37 to 0.60), CWA (0.39 to 0.60) and GFW1 (0.64) increased and as BUL decreased (-0.01 to -0.54). BUL and RES were highly correlated (0.82 to 0.95). LG was negatively correlated with BUL (-0.12 to -0.66) and RES (-0.10 to -0.41).

Very few sickle fibres were found in Drysdale materials; most arrays were plateau. Coarser arrays were associated with higher proportions of hairy-tip curly-tip fibres (HTCT). GFW1 increased as HTCTs increased (0.33 to 0.46). Generally, the correlations among

birthcoat and third fleece traits were not strong which implies that birthcoat traits are not reliable indications to selection for various traits in later fleeces of Drysdale sheep. Higher MI was associated with coarser arrays (-0.07 to -0.55) and higher proportions of super-sickle A fibres (0.22 to 0.41). Finer arrays were associated with higher yield (0.01 to 0.38). In one flock, sheep with a higher proportion of halo-hair (HH) fibres had higher GWA (0.25 to 0.33), CWA (0.17 to 0.30) and heavier third fleece weights (0.09 to 0.33) while sheep with coarser birthcoat arrays showed a slight tendency to have more bulky fleeces (-0.22 to -0.29).

Medullation index of the third fleece (MI3) as well as greasy and clean third fleece weights (GFW3 and CFW3) can be predicted, with limited accuracy ($R^2 = 0.50$) from the first shearing shoulder (SH1) traits by using the following multiple regression equations:

Within flock-sex groups

$$MI3 = 9.15 + 0.45MI (SH1) + 1.84KS (SH1)$$

For rams

$$GFW3 = -1.47 + 0.04HH\% (SH1) + 0.14X (SH1) - 0.09Z (SH1)$$

$$CFW3 = -1.53 + 0.03HH\% (SH1) + 0.14X (SH1) - 0.09Z (SH1)$$

It appeared that the shoulder is the best position from which to sample fleeces when a number of traits are to be assessed for ranking Drysdale sheep.

GENERAL INTRODUCTION

Systematic selection and culling of sheep to improve the quantity and quality of wool produced has been practised for many generations. A careful analysis of the fleece is usually first made on the hogget fleece when often many animals have already been culled. Birthcoat fibre type array analyses have been suggested as an early indication of adult fleece traits. The present study investigated the use of birthcoat fibre type arrays as an aid to early selection for various fleece traits. The variations of adult fleece traits were also studied in Drysdale fleeces.

It is important to determine the optimum position for sampling wool traits when assessment of these samples is to be used for selection. Very few studies dealt with that subject. These studies defined the best sampling position as the most representative to the whole fleece. The present study expanded this definition to also consider utility for breeding purposes in an attempt to reach an overall decision of what is the best sampling position for Drysdale sheep.

Phenotypic correlation coefficients among various wool traits were calculated from shoulder and mid-side samples in the three shearings. These correlations were derived to gain some information on the use of these samples to predict the average of the present fleece and later fleeces. These correlations are presented in Appendix 2.

ACKNOWLEDGEMENTS

I wish to express my indebtedness to my supervisors Dr. G.A. Wickham and Professor A.L. Rae for their guidance, help and advice and for invaluable comments on the manuscript. I owe them my deepest gratitude and appreciation.

I would like to acknowledge the outstanding efforts made by the late Dr. F.W. Dry during the last years of his eminent career in wool science to arrange a scholarship for me to study at Massey University. Dr. Dry's efforts will always be remembered. It is a great pleasure to me to dedicate this thesis to his memory.

This study depended on the co-operation of many people in several research units. I wish to express my grateful thanks to those who assisted in many ways, particularly Mr. W.R. Regnault of the Wool Department at Massey University during the scouring and the measurements of bulk and colour; Dr. J. Bedford and Dr. J. Lappage of the Wool Research Organisation of New Zealand during the use of the WRONZ-medullameter; Dr. M.L. Bigham of Whatawhata Hill Country Research Station during the work on the CSIRO-Fibre Fineness Distribution Analyser and Mr. D.H. Hopcroft of the Electron Microscope Unit at DSIR, Palmerston North for preparing the scanning electron microscope graphs.

I would like also to record my gratitude to Mr. P.H. Whitehead and his staff for the management of the sheep at Massey University. Special thanks are also due to the owner of Flock B and his farm staff.

My grateful thanks are also extended to all the technical staff, especially the late Mr. B. Thatcher who assisted in the subjective assessments of wool samples and Mr. M.G. Divehall and Mr. M.A. Wycherley who assisted in the collection of the samples.

I am also indebted to all the staff and post-graduate colleagues in the Animal Science Department for many stimulating and rewarding discussions, especially Mr. D.J. Garrick who helped to familiarise me with computing.

My sincere gratitude is due to the administrators of the Colombo Plan, under whose auspices I came to New Zealand. Financial support from the Egyptian Government is also greatly acknowledged.

To Mrs. E. Baxter for the care and attention given to the typing of this thesis, my sincere thanks.

My wife, Salwa, while suffering my frequent depression and frustration, has provided inspiration and support. Her help and encouragement enabled me to complete this study. My sincere gratitude is also expressed in recognition of the ever-ready sacrifices and support of my parents.

TABLE OF CONTENTS

	Page
ABSTRACT	i
GENERAL INTRODUCTION	iii
ACKNOWLEDGEMENTS	iv
List of Figures	x
List of Tables	xi
List of Abbreviations	xvii
CHAPTER 1. VARIATION AND COVARIATION IN BIRTHCOAT AND FLEECE TRAITS OF DRYSDALE SHEEP WITH REFERENCE TO EARLY SELECTION	
1.1 INTRODUCTION	1
1.2 REVIEW OF LITERATURE	2
1.2.1 Carpet Wool Traits: their Importance Particularly in Relation to Manufacture and Selection Objectives	2
1.2.1.1 The commercial importance of carpet wool traits	2
1.2.1.2 Selection objectives in carpet- woolled sheep	8
1.2.2 The Morphology and Inheritance of the Birthcoat	10
1.2.2.1 Birthcoat fibre type arrays	10
A. Variation over the body	11
B. Theories explaining birthcoat fibre forms	12

	Page
1.2.2.2 Genetic effects on halo-hair abundance and birthcoat fibre types and arrays	14
1.2.3 Relationship of Lamb Traits to Other Traits	17
1.2.3.1 Birthcoat and survival	17
1.2.3.2 Birthcoat and adult fleece traits	17
1.2.3.3 Lamb fleece and later traits	21
1.3 MATERIALS AND METHODS	22
1.3.1 The Sheep and their Management	22
1.3.2 Birthcoat Analysis	24
1.3.3 Fleece Analysis	28
1.3.4 Statistical Procedures	30
1.3.4.1 Analysis of variance studies	30
1.3.4.2 Multiple regression studies	33
1.3.4.3 Correlations studies	34
1.4 RESULTS AND DISCUSSION	35
1.4.1 Factors Affecting Fleece Traits	35
1.4.1.1 Kemp score	35
1.4.1.2 Handle grade	45
1.4.1.3 Medullation index	48
1.4.1.4 Colour appraisals and measurements	48
1.4.1.5 Staple length	56
1.4.1.6 Yield	58
1.4.1.7 Bulk and resilience	60
1.4.1.8 Lustre grade	63
1.4.1.9 Greasy and clean wool per unit area	63
1.4.1.10 Fleece weight	68

	Page
1.4.2 Relations among Fleece Traits	70
1.4.2.1 Kemp score	70
1.4.2.2 Handle grade	70
1.4.2.3 Medullation index	75
1.4.2.4 Colour appraisals and measurements	76
1.4.2.5 Staple length and wool per unit area	77
1.4.2.6 Lustre, bulk and resilience	78
1.4.2.7 Flock A fleece weight	78
1.4.3 Relations among Birthcoat Traits	81
1.4.4 Birthcoat-Adult Fleece Relationships	87
1.4.5 Predicting some Third Fleece Traits from Lamb Traits using Multiple Regression Analysis	91
1.4.5.1 Predicting third fleece medullation index	91
1.4.5.2 Predicting third fleece bulk	94
1.4.5.3 Predicting fleece weights GFW3 and CFW3	94
1.5 CONCLUSIONS	97
 CHAPTER 2. STUDY OF THE SAMPLING POSITIONS IN DRYSDALE SHEEP	
2.1 INTRODUCTION	100
2.2 MATERIALS AND METHODS	102
2.2.1 Random Positions Study	102
2.2.2 Fixed Positions Study	102
2.3 RESULTS AND DISCUSSION	105
2.4 CONCLUSIONS	116

	Page
APPENDIX 1. SOME OBSERVATIONS ON A DYEBANDING TECHNIQUE	117
APPENDIX 2. CORRELATIONS OF SHOULDER AND MID-SIDE WOOL TRAITS WITH FLEECE AVERAGES AT SHEARINGS 1, 2 AND 3 IN BOTH FLOCKS	119
REFERENCES	126

LIST OF FIGURES

<u>Figure</u>	Page
1. Fixed positions sampled for birthcoat and fleece traits.	23
2. Birthcoat fibre types.	25
3. Random positions sampled for various wool traits.	103

LIST OF TABLES

<u>Table</u>	Page
1.3.1 Birthcoat fibre types in different arrays.	27
1.3.2 Conditions of each bowl in the scouring method.	29a
1.3.3 Degrees of freedom of factors included in different models analysing fleece traits.	32
1.4.1 Least squares means and effects for first fleece traits in Flock A (A1).	36
1.4.2 Least squares means and effects for second fleece traits in Flock A (A2).	37
1.4.3 Least squares means and effects for third fleece traits in Flock A (A3).	38
1.4.4 Least squares means and effects for first fleece traits in Flock B (B1).	39
1.4.5 Least squares means and effects for second fleece traits in Flock B (B2).	40
1.4.6 Least squares means and effects for third fleece traits in Flock B (B3).	41
1.4.7 Least squares means and effects for first fleece traits in both flocks (AB1).	42
1.4.8 Least squares means and effects for second fleece traits in both flocks (AB2).	43
1.4.9 Percentages of total variance due to different factors (with significance): <i>Kemp Score</i> .	44
1.4.10 Percentages of total variance due to different factors (with significance): <i>Handle Grade</i> .	46

<u>Table</u>	Page
1.4.11 Percentages of total variance due to different factors (with significance): <i>Medullation Index</i>	47
1.4.12 Percentages of total variance due to different factors (with significance): <i>Greasy Colour Grade</i>	49
1.4.13 Percentages of total variance due to different factors (with significance): <i>Scoured Colour Grade</i>	50
1.4.14 Percentages of total variance due to different factors (with significance): <i>x</i>	51
1.4.15 Percentages of total variance due to different factors (with significance): <i>y</i>	52
1.4.16 Percentages of total variance due to different factors (with significance): <i>z</i>	53
1.4.17 Percentages of total variance due to different factors (with significance): <i>y-z</i>	54
1.4.18 Percentages of total variance due to different factors (with significance): <i>Staple Length</i>	57
1.4.19 Percentages of total variance due to different factors (with significance): <i>Yield</i>	59
1.4.20 Percentages of total variance due to different factors (with significance): <i>Bulk</i>	61
1.4.21 Percentages of total variance due to different factors (with significance): <i>Resilience</i>	62
1.4.22 Percentages of total variance due to different factors (with significance): <i>Lustre Grade</i>	64

<u>Table</u>	Page
1.4.23 Percentages of total variance due to different factors (with significance): <i>Greasy wool per unit area</i>	66
1.4.24 Percentages of total variance due to different factors (with significance): <i>Clean wool per unit area</i>	67
1.4.25 Least squares means and effects for first and third fleece weights in Flock A.	69
1.4.26 Percentages of total variance due to different factors in Flock A (with significance): <i>GFW1, GFW3 and CFW3</i>	69
1.4.27 Correlations between <i>shoulder</i> wool traits at shearings 1, 2 and 3 (pooled over sexes and flocks).	71
1.4.28 Correlations between <i>mid-side</i> wool traits at shearings 1, 2 and 3 (pooled over sexes and flocks).	72
1.4.29 Correlations between <i>averages of</i> wool traits at shearings 1, 2 and 3 in Flock A (pooled over sexes).	73
1.4.30 Correlations between <i>averages of</i> wool traits at shearings 1, 2 and 3 in Flock B (pooled over sexes).	74
1.4.31 Correlations of the <i>first and third fleece weights</i> with the first and third shearing traits in Flock A (pooled over sexes).	79
1.4.32 Least squares means and effects for birthcoat fibre types in Flock A.	82

<u>Table</u>	Page
1.4.33 Least squares means and effects for birthcoat fibre types in both flocks.	83
1.4.34 Percentages of fibre type arrays according to position and flock.	84
1.4.35 Correlations between shoulder and mid-side birthcoat traits (pooled over sexes and flocks).	85
1.4.36 Correlations between averages of the third shearing traits and birthcoat traits taken from SH and MS positions in Flock A (pooled over sexes).	88
1.4.37 Correlations between averages of the third shearing traits and birthcoat traits taken from SH and MS positions in Flock B ewes.	89
1.4.38 Multiple regression models to predict <i>third shearing medullation index</i> from lamb traits within flock-sex groups.	92
1.4.39 Multiple regression models to predict <i>third shearing bulk</i> from lamb traits within flock-sex groups.	93
1.4.40 Multiple regression models to predict <i>GFW3</i> and <i>CFW3</i> from <i>shoulder</i> lamb traits within Flock A <i>rams</i> .	95
1.4.41 Multiple regression models to predict <i>GFW3</i> and <i>CFW3</i> from <i>back</i> lamb traits within Flock A <i>ewes</i> .	95
2.3.1 <i>Sire variance ratio</i> [$\sigma^2s/(\sigma^2s + \sigma^2e)$] for various wool traits estimated from different positions in the three shearings	106

<u>Table</u>	Page
2.3.2 <i>Phenotypic variance</i> ($\sigma^2s + \sigma^2e$) for various wool traits estimated from different positions in the three shearings.	107
2.3.3 Correlations of various wool traits taken from different positions with fleece average estimated from <i>fixed positions</i> in the three shearings.	108
2.3.4 Correlations of various wool traits taken from different positions with fleece average estimated from <i>random positions</i> in the three shearings.	109
2.3.5 Correlations of various wool traits taken from different positions in the first and second shearings with the <i>later fleece averages</i> estimated from fixed positions.	110
2.3.6 Least squares means and position effects for various traits.	111
A1 Correlations between shoulder wool traits and fleece average at shearings 1, 2 and 3 in Flock A (pooled over sexes).	120
A2 Correlations between mid-side wool traits and fleece average at shearings 1, 2 and 3 in Flock A (pooled over sexes).	121
A3 Correlations between shoulder wool traits and fleece average at shearings 1, 2 and 3 in Flock B (pooled over sexes).	122
A4 Correlations between mid-side wool traits and fleece average at shearings 1, 2 and 3 in Flock B (pooled over sexes).	123

Table

Page

A5	Correlations of the average of the third fleece with various wool traits estimated from shoulder and mid-side and the all positions average of the first fleece in Flock A, pooled over sexes.	124
A6	Correlations of the average of the third fleece with various wool traits estimated from shoulder and mid-side and the all positions average of the first fleece in Flock B, pooled over sexes.	125

LIST OF ABBREVIATIONS

1. Positions

BK	back
BL	belly
BR	britch
MS	mid-side
RP	rump
SH	shoulder
SP	shoulder patch
WH	withers

2. Shearings

FL1	first shearing
FL2	second shearing
FL3	third shearing
Av	average of the fleece
Av1	average of the first fleece
Av2	average of the second fleece
Av3	average of the third fleece

3. Traitsa) Birthcoat traits

ARY	birthcoat fibre type array
Ch-CT	checked curly-tip fibres
CT	curly-tip fibres (CT1 + CT2)
CT1	the coarsest curly-tip fibres
CT2	the thinnest curly-tip fibres
F-SK	fine sickle-fibres
HH	halo-hair fibres
Hi	histerotrich fibres
HTCT	hairy-tip curly-tip fibres (HTCT1 + HTCT2)
HTCT1	the coarsest hair-tip curly-tip fibres
HTCT2	the thinnest hairy-tip curly-tip fibres
Pre-CT	pre-curly-tip fibres (HH + SS + SK + F.SK)

Abbreviations continued.

SK	sickle fibres
SS	super-sickle fibres (SSA + SSA' + SSB)
SSA	super-sickle A fibres
SSA'	super-sickle A' fibres
SSB	super-sickle B fibres

b) fleece traits

BUL	bulk
CWA	clean wool per unit area
CFW3	clean third fleece weight
GCG	greasy colour grade
GFW1	greasy first fleece weight
GFW3	greasy third fleece weight
GWA	greasy wool per unit area
HG	handle grade
KS	kemp score
LG	lustre grade
MI	medullation index
RES	resilience
SCG	scoured colour grade
STL	staple length
X	tristimulus X value (red)
Y	tristimulus Y value (green)
YLD	yield
Z	tristimulus Z value (blue)