

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.

**A study of two genetic methods for increasing the performance
of sheep in New Zealand:**

- Crossbreeding between the Romney, Finnish Landrace and East Friesian.
- Use of number of foetuses scanned as a selection predictor.

A thesis presented in partial fulfilment
of the requirements for the degree of:
Master of Applied Science in Animal Science
at Massey University

Georgie J. Walker

1997

Acknowledgments.

Thank you to my family who have been a huge support in so many different ways. Both morally and financially they have got me through my time at Massey, which I do really appreciate Mum and Dad! Here's hoping the financial part stops here though! Thanks also for the phone card, car registration and insurance, clothes (especially linen shirts), school printers, computer breakdown help and Invercargill holidays! To Hamish and Angus - I think your statistic department at Otago needs reviewing!

I would like to thank my supervisor - Professor Hugh Blair for his academic support, and easy to approach and friendly manner. I would also like to express my gratitude for his understanding of my unfortunate and frustrating neck injury. Thank you also to the staff in the Animal Science office.

I would also like to thank Andy and Hamish Ramsden, the studmasters' of DIBO Genetics.

I would like to thank a number of old Lincoln friends, and new Massey friends who were scattered all around the country. They gave me a lot of encouragement, support and much valued friendships that will never be forgotten. To Megs, thanks for the endless letters, cards, Northern and Frog'n'Firkin visits, and 2am Saturday night phone calls! To Rach, thanks for all of the holidays and visits - they will be reciprocated in the South Island! To Greg, thanks for the huge support, gear changing in my car (when I hurt my neck), and hot chocolates! To Sue, thanks for the visits, drink therapy, and phone calls! To Craig and Paula, thanks for everything else! Thank-you also to my library friend - Ken.

Thank-you lastly to Krista and Lloyd for their wonderful hospitality at the start of the '96 year. I didn't know a single person when I came to Palmerston North, and they made things so much easier - and possible.

Table of Contents.

	Page
Acknowledgments.....	i
Table of contents.....	ii
List of tables.....	vi
List of figures.....	viii
List of Abbreviations.....	ix
Chapter One. Introduction.....	1
Chapter Two. Literature Review.....	3
✧ 2.1. Breeding Objectives, Selection Indexes, and Breeding Programmes.....	3
✧ 2.1.1. Breeding Objectives.....	3
✧ 2.1.2. Selection Indexes.....	5
2.1.2.1. Ultrasound Pregnancy Scanning.....	6
2.1.3. Formation of Breeding Systems.....	9
2.2. Crossbreeding.....	15
2.2.1. Crossbred Sires.....	17
2.2.2. Heterosis.....	18
2.2.2.1. Types of heterosis.....	20
2.2.3. Crossbreeding Systems.....	22
2.2.4. Crossbreeding in Australia and the United Kingdom.....	24
* 2.3. History of the Finnish Landrace and the East Friesian in New Zealand.....	24
* 2.4. Performance data on the Finnish Landrace and East Friesian.....	26
Chapter Three. Materials and Method.....	29
3.1. Finn and East Friesian analysis.....	29
3.1.1 Part 1: 23 Ram types crossed to Romney ewes.....	29
3.1.1.1 Ram types.....	30
3.1.1.2. Crosses.....	33

3.1.1.3. Traits studied	34
3.1.1.4. Calculations of expected phenotypic performances	36
3.1.2. Part 2: Effect of 8 ram types on a breeding flock	40
3.1.2.1. Ram types chosen	40
3.1.2.2. Annual calculations	41
3.1.2.3. Traits studied	44
3.1.3. Part 3: Predicted changes in flock performance and analysis of lamb and wool production rate per kilogram of ewe liveweight.....	42
3.2. Number of foetuses scanned as a selection predictor	46
3.2.1. Calculation of the figures used for the analysis.....	46
3.2.2. Comparison of the two different selection predictors.....	49
3.2.2.1. Expected genetic gain in the objective, objective traits, and index characters.....	49
3.2.2.2. Calculating estimated selection index values	52
3.2.2.3. Flock details.....	52
Chapter Four. RESULTS.....	55
4.1. Finn and East Friesian Results.....	55
4.1.1. Predicted of phenotypic measurements for the 4 crosses of each of the 23 rams types.....	55
4.1.2. Effect of 8 selected rams on a breeding flock over a 5 year period.....	58
4.1.3. Expected changes in the average flock performances and efficiency of lambs and wool production for corresponding ewe liveweight	62
4.1.3.1. Expected changes in flock performance.....	62
4.1.3.2. Efficiency of lamb production and ewe fleeceweight	64
4.2. Number of Foetuses Scanned as a Selection Predictor Results.....	72
4.2.2. Genetic responses in the breeding objective, traits, and characters.....	72
4.2.3. Ewe hogget indexes.....	73

Chapter Five. DISCUSSION	75
5.1. Finnish Landrace and East Friesian.....	75
5.1.2. Ram composite production	76
5.1.3. Ram type analysis	77
5.1.4. Introduction of genes to commercial flocks.....	79
5.1.5. Profit Analysis.....	81
5.1.5. Appearance of new breeds	82
5.1.6. How study results can be used	82
5.1.7. Ram type choice	83
5.2. Ultrasound Pregnancy Scanning.....	85
 Chapter Six. CONCLUSION	 87
 References	 89

APPENDIXES.

Appendix I.

Example of estimating phenotypic measurements for the 4 crosses of a ram type (Ram type 6), using the 6 tables, the effect on a simulated breeding flock, and the expected changes.

Appendix II.

Fraction method for calculating percentage of original heterosis expressed.

Appendix III.

Simultaneous equations and tables used in methods for NFS analysis.

Appendix IV.

Phenotypic performance predictions for the 4 crosses of the 23 ram types.

Appendix V.

Results tables from the predicted changes in the average flock performances of the 8 ram types for the 8 ram types.

Appendix IV.

The ratio figures of Lamb and Wool production rates of the 8 ram types.

List of tables.

	Page
<u>Table 2.4.1.</u> Average trait performances for Finn crosses	28
<u>Table 3.1.1.1.1.</u> 23 ram types and methods of production	30
<u>Table 3.1.1.4.1.</u> Additive gene effects of the breeds	36
<u>Table 3.1.1.4.2.</u> Non-additive genetic interactions between the breeds	37
<u>Table 3.1.2.2.1.</u> Standard age structure of flock for options a and b for each ram type	42
<u>Table 3.1.2.2.2.</u> Type of progeny in each age group in each year for the traits: weaning percentage for hogget and MA ewes, birth weight, weaning weight, and slaughter weight.....	44
<u>Table 3.1.2.2.3.</u> Type of progeny in each age group in each year for the traits: hogget and MA ewe liveweights, hogget and MA ewe fleece weights and average fibre diameter	44
<u>Table 3.2.1.</u> Genetic and Phenotypic parameters for sheep	48
<u>Table 3.2.2.3.1.</u> The flock means for the selection characters.....	53
<u>Table 3.2.2.3.2.</u> Selection differentials for ewes.....	53
<u>Table 3.2.2.3.3.</u> Selection differentials for rams	53
<u>Table 3.2.2.3.4.</u> Generation interval of ewes.....	54
<u>Table 4.1.1.1.</u> Highest phenotypic values for the 10 traits (for ram types with all 3 breeds in their composition)	57
<u>Table 4.1.1.2.</u> Lowest phenotypic values for the 10 traits (for ram types with all 3 breeds in their composition).....	57
<u>Table 4.1.2.1.</u> Summary Table of Yearly Performance for Option 6a - Ram 1: R.....	58
<u>Table 4.1.2.2.</u> Summary Table of Yearly Performance for Option 6b - Ram 1: R.....	58
<u>Table 4.1.2.3.</u> Summary Table of Yearly Performance for Option 7a - Ram 11: 2/3R1/3F	59
<u>Table 4.1.2.4.</u> Summary Table of Yearly Performance for Option 7b - Ram 11: 2/3R1/3F	59
<u>Table 4.1.2.5.</u> Summary Table of Yearly Performance for Option 1a - Ram 6: 1/2R1/4F1/4EF	59

<u>Table 4.1.2.6.</u> Summary Table of Yearly Performance for Option 1b - Ram 6: 1/2R1/4F1/4EF	59
<u>Table 4.1.2.7.</u> Summary Table of Yearly Performance for Option 5a - Ram 3: 1/2R1/2F	60
<u>Table 4.1.2.8.</u> Summary Table of Yearly Performance for Option 5b - Ram 6: 1/2R1/2F	60
<u>Table 4.1.2.9.</u> Summary Table of Yearly Performance for Option 2a - Ram 7: 1/4R1/2F1/4EF	60
<u>Table 4.1.2.10.</u> Summary Table of Yearly Performance for Option 2b - Ram 7: 1/4R1/2F1/4EF	60
<u>Table 4.1.2.11.</u> Summary Table of Yearly Performance for Option 3a - Ram 8: 1/4R1/4F1/2EF	61
<u>Table 4.1.2.12.</u> Summary Table of Yearly Performance for Option 3b - Ram 8: 1/4R1/4F1/2EF	61
<u>Table 4.1.2.13.</u> Summary Table of Yearly Performance for Option 8a - Ram 17: 2/7R4/7F1/7EF	61
<u>Table 4.1.2.14.</u> Summary Table of Yearly Performance for Option 8b - Ram 17: 2/7R4/7F1/7EF	61
<u>Table 4.1.2.15.</u> Summary Table of Yearly Performance for Option 4a - Ram 19: 1/7R4/7F2/7EF	62
<u>Table 4.1.2.16.</u> Summary Table of Yearly Performance for Option 4b - Ram 19: 1/7R4/7F2/7EF	62
<u>Table 4.2.1.1.</u> Weighting factors for two selection indexes - NLB and NFS.....	72
<u>Table 4.2.1.2.</u> Predicted annual genetic response/ewe for the two selection indexes -NLB and NFS.....	73

List of Figures.

	Page
<u>Figure 4.1.3.2.1</u> : Ratio of weight of lambs weaned per ewe liveweight in the base Year 0.....	66
<u>Figure 4.1.3.2.2</u> : Ratio of weight of lambs weaned per ewe liveweight in Year 1.....	66
<u>Figure 4.1.3.2.3</u> : Ratio of weight of lambs weaned per ewe liveweight in Year 2.....	67
<u>Figure 4.1.3.2.4</u> : Ratio of weight of lambs weaned per ewe liveweight in Year 3.....	67
<u>Figure 4.1.3.2.5</u> : Ratio of weight of lambs weaned per ewe liveweight in Year 4.....	68
<u>Figure 4.1.3.2.6</u> : Ratio of weight of lambs weaned per ewe liveweight in Year 5.....	68
<u>Figure 4.1.3.2.7</u> : Ratio of ewe fleeceweight per ewe liveweight in Years 1 and 2 and the base Year 0.....	70
<u>Figure 4.1.3.2.8</u> : Ratio of ewe fleeceweight per ewe liveweight in Year 3.....	70
<u>Figure 4.1.3.2.9</u> : Ratio of ewe fleeceweight per ewe liveweight in Year 4.....	71
<u>Figure 4.1.3.2.10</u> : Ratio of ewe fleeceweight per ewe liveweight in Year 5.....	71
<u>Figure 4.2.2.1</u> : Expected genetic gain in breeding objective for different options and a flock size of 1000 ewes.....	74

List of Abbreviations.

B.WT	Birth weight.
D1 -D4	First, second, third, and fourth dams.
DM	Dry Matter
E.FW	Ewe fleece weight.
E.WT	Ewe liveweight
EF	East Friesian sheep breed.
ES	Embryo survival
F	Finnish Landrace sheep breed.
FD	Average fibre diameter of wool.
H.FW	Hogget fleece weight.
H.WT	Hogget liveweight.
HNLB	Number of lambs born to hogget ewes.
kg	kilograms
NFS	Number of foetuses scanned per ewe.
NLB	Number of lambs born per ewe.
NLW	Number of lambs weaned per ewe.
OR	Ovulation rate
P1 - P4	First, second, third, and fourth cross progeny.
R	Romney sheep breed.
S.WT	Slaughter weight.
STW	Survival to weaning.
u	microns
W.WT	Weaning weight.