CRC for Premium Quality Wool

The Genetics of Skin-based Traits

Produced for the CRC for Premium Quality Wool undergraduate program by;
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Skin Traits: Heritabilities

Trait	*Heritability*
Follicle density	0.18 – 0.62
S:P ratio	0.21 – 0.52
DpDs ratio	0.67
Follicle depth	0.37
Follicle curvature	0.40
Follicle bulb area	0.25 – 0.26
Bulb area variation	0.09 – 0.22
Skin thickness	0.60
Skin quality (pliability)	0.36

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Source: Jackson et al. (1975), Hill et al. (1997), Hynd et al. (1996,1997), Purvis and Swan (1997)

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Skin traits: genetic correlations

	Follicle density	S:P ratio	Follicle depth
S:P ratio	0.70		
Follicle depth	- 0.14	0.09	
Follicle curvature	- 0.38	- 0.02	0.03
DpDs ratio	0.08	- 0.09	
Skin thickness	- 0.08	0.18	
Bulb area	0.03		
Bulb area variation	- 0.23	- 0.32	
Skin quality (pliability)	0.34		

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Source: Jackson et al. (1975), Hill et al. (1997), Hynd et al. (1996,1997), Purvis and Swan (1997),Gregory (1982)

Correlated responses in follicle traits following 20 years selection mainly for increased CFW

Response in selected line expressed as % deviation from control

Skin trait	Selection criterion	
	CFW, limit on FD & folds	CFW, limit on FD, crimp freq. & folds
Follicle depth	5.0	9.3
Follicle curvature	-17.9	-2.6
Follicle density	13.2	8.0
S:P ratio	28.0	17.8

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Source: Davis and McGuirk (1987)

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Predicted correlated responses to single trait selection

Selection criterion	Predicted to increase	Predicted to decrease
↑ follicle density	**Clean fleece weight** Yield Improved crimp definition, visual colour, handle	**Fibre diameter** Diameter variation Staple length Crimp frequency
↑ S:P ratio	**Clean fleece weight** Diameter variation Crimp frequency	**Fibre diameter** Staple length
↑ follicle depth	**Clean fleece weight** Staple length	Crimp frequency
↓ follicle curvature	**Clean fleece weight** Yield Staple length	**Fibre diameter** Crimp frequency
↑ skin thickness	**Clean fleece weight** Staple length Diameter variation	Crimp frequency
↑ skin quality	**Clean fleece weight** Improved visual colour, handle	Crimp frequency

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Source: Jackson et al. (1975), Hill et al. (1997),Purvis and Swan (1997), Gregory (1982)

Skin traits to aim for if you want to achieve:

- **High CFW:**
  - low skin biopsy weight
  - high follicle density
  - low paracortex %
  - high germinative volume
- **Low MFD:**
  - low skin biopsy weight
  - high follicle density
  - low mean bulb area
  - low variability of bulb area
- **High SL:**
  - high skin biopsy weight
  - high mean bulb area
  - low paracortex %
  - high germinative volume
- **High SS:**
  - high skin biopsy weight
  - low paracortex %

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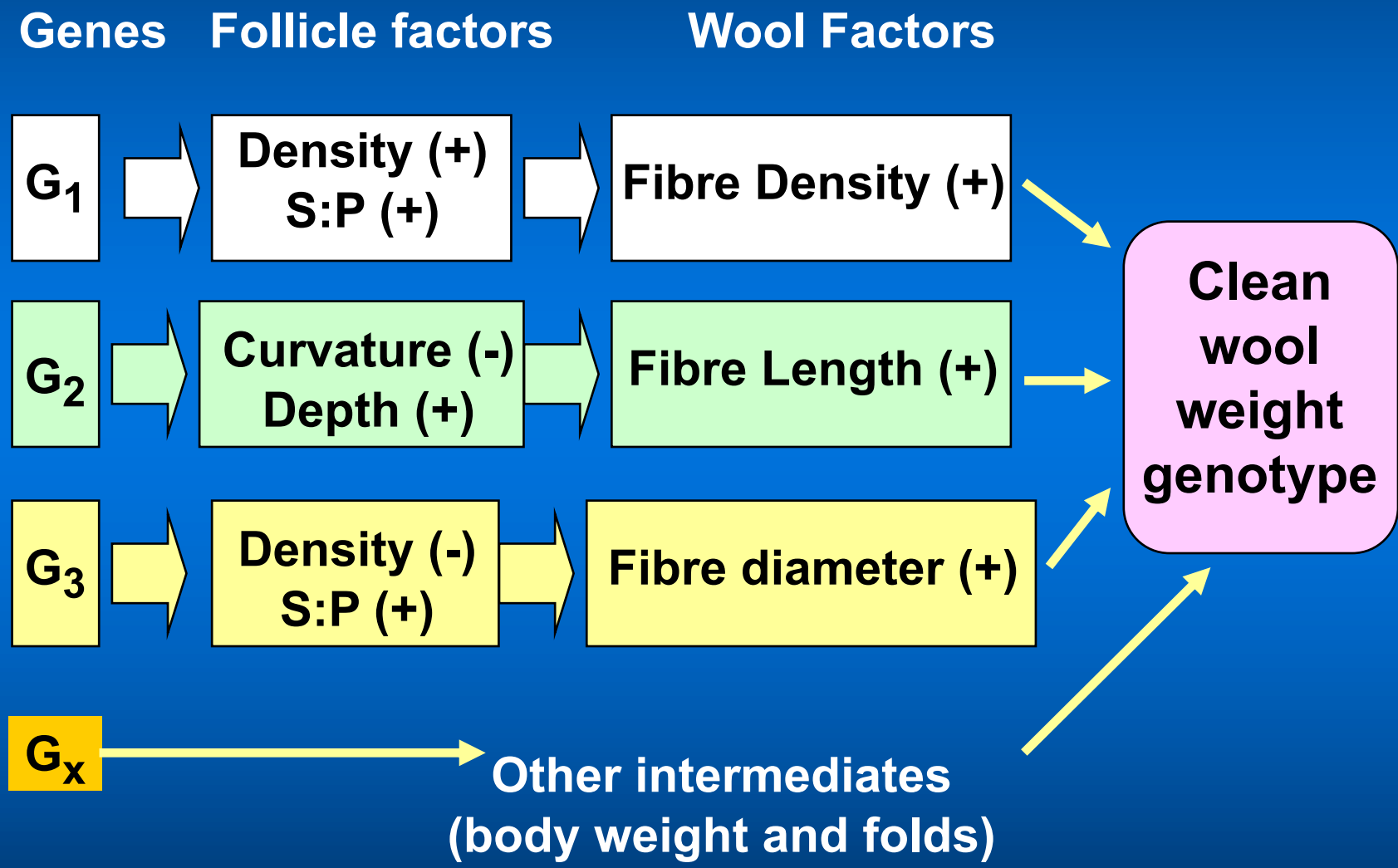
Source: Hynd et al. (1996)

Theoretical model for control of clean wool weight genotype via independent follicle factors and wool factors



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Source: Jackson et al. (1975)

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1956	1959-61	1971-73	CFW (kg)	FD (μm)
S:P	22.03	28.54	2.49	17.98
	20.01	15.46	2.54	21.33
$P_{density}$	3.12	3.54	1.86	18.60
	2.76	2.20	2.02	20.26

→ Selection to increase ⇢ Selection to decrease

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Source: Rendel and Nay (1978)

Deviations in skin traits and clean wool weight in lines selected for various skin traits: expressed as difference from control as a % of control line average

Selection criterion	% deviation of selected line from control		
	Follicle depth	Follicle density	Clean wool weight
Follicle depth	+ 2.6	+ 2.9	- 0.5
Follicle density	- 6.1	+ 12.3	-1.7
Tandem selection (depth + density)	+ 0.4	+ 10.0	+ 3.6

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(cited in Davis and McGuirk, 1987)

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Fleece characteristics of finewool sheep with high CFW or low CFW

	High CFW	*Low CFW*	*P-value*
Mean fibre diameter (µm)	16.7	16.9	P>0.05
Clean fleece weight (kg)	2.9	2.2	P<0.00001
Staple length (mm)	91.6	82.9	P<0.05

- MFD not different
- high CFW EBV group 32% greater CFW
- high CFW EBV group 10% longer staples
- no bloodline effects

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Source: Nancarrow et al. (1998)

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Effects of Follicle Populations of Finewool Sheep on CFW

Skin biopsy results

	High CFW	*Low CFW*	*P-value*
Follicle density (mm^{-2})	91.9	74.6	P<0.01
S:P ratio	35.0	27.6	P<0.01
DpDs	1.13	0.95	P<0.05
Production ratio	0.31	0.32	P>0.05

Skin impression results

	High CFW	*Low CFW*	*P-value*
Density of fibres (mm^{-2})	111.4	87.1	P<0.05
Epidermal follicles (mm^{-2})	38.0	38.6	P>0.05
Branched follicles (%)	56.4	45.9	P<0.01
Follicles/bundle	4.29	3.84	P>0.05
Follicles/epidermal follicle	2.89	2.33	P<0.05
Fraction of bare skin	0.52	0.56	P>0.06

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Source: Nancarrow et al. (1998)

Correlations of Skin and Follicle Characters With CFW and MFD of Finewool Sheep

	CFW	*MFD*
Staple length	0.50	0.09
Follicle density	0.37	-0.24
S:P ratio	0.28	-0.39
DpDs	0.40	-0.19
Density of fibres	0.48	0.01
Branched follicles	0.50	-0.17
Follicles/bundle	0.33	-0.12
Follicles/epidermal follicle	0.43	-0.15
Fraction of bare skin	-0.22	0.05
Total inactive follicles	-0.18	0.03
Production ratio	-0.06	0.17

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Source: Nancarrow et al. (1998)