

# **Measures of behavioural reactivity and their relationships to carcass and meat quality in sheep**

*by*

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## Table of Contents

Table of Contents.....	ii
Abstract.....	v
Declaration.....	vii
Author contributions .....	viii
Manuscripts included as chapters .....	ix
Acknowledgements.....	x
Chapter 1. Introduction .....	1
1.1 Context.....	2
1.2 Aims and objectives .....	4
1.3 Research approach .....	5
1.4 Relevance of thesis .....	7
Chapter 2. Literature review.....	9
Chapter 3. Optimising the measurement of flight speed in sheep .....	27
3.1 Introduction .....	30
3.2 Methods.....	31
3.2.1 Animals and measurements .....	31
3.2.2 Statistical analysis .....	32
3.3 Results.....	33
3.4 Discussion.....	35
Chapter 4. Flight speed and agitation in the Information Nucleus Flock.....	39
Chapter 5. Relationships of flight speed and agitation with carcass and meat quality in the Information Nucleus Flock.....	45
Chapter 6. Test type and age of testing affect assessment of behavioural reactivity in lambs.....	57
6.1 Introduction .....	61
6.2 Methods.....	64
6.2.1 Animals.....	64
6.2.2 Behavioural assessments.....	65
6.2.3 Cortisol assay .....	67
6.2.4 Statistical analysis .....	68
6.3 Results.....	70

6.4 Discussion .....	74
6.5 Conclusion.....	81
Chapter 7. Facial hair patterning is not a useful indicator trait for behavioural reactivity in lambs.....	83
7.1 Introduction .....	86
7.2 Methods.....	87
7.2.1 Animals.....	87
7.2.2 Measurements.....	88
7.2.3 Statistical analyses .....	91
7.3 Results.....	93
7.4 Discussion .....	94
Chapter 8. Behavioural reactivity is predictive of stress at slaughter and subsequent meat quality in lambs .....	99
8.1 Introduction .....	102
8.2 Methods.....	103
8.2.1 Animals.....	103
8.2.2 Measurements.....	104
8.2.3 Metabolite analyses.....	107
8.2.4 Statistical analysis .....	107
8.3 Results.....	109
8.4 Discussion .....	112
8.5 Conclusion.....	114
Chapter 9. Facilities, breed and experience affect ease of sheep handling: the livestock transporter’s perspective .....	117
9.1 Introduction .....	120
9.2 Methods.....	121
9.2.1 Selection of participants .....	121
9.2.2 Qualitative semi-structured interviews .....	122
9.2.3 Transcript analysis .....	123
9.3 Results.....	124
9.3.1 People .....	126
9.3.2 Environment .....	132

9.3.3 Dogs .....	135
9.3.4 Sheep .....	136
9.3.5 Training .....	140
9.4 Discussion.....	141
9.4.1 People .....	141
9.4.2 Environment.....	142
9.4.3 Sheep factors .....	143
9.4.4 Training .....	146
9.4.5 Limitations.....	146
9.5 Summary .....	148
Chapter 10. Impact and conclusions.....	151
10.1 Introduction .....	152
10.2 Support for the concept of temperament and behavioural reactivity.....	153
10.3 Age and experience.....	159
10.4 Flight speed and restrained tests measure different aspects of temperament .....	160
10.5 Females are more reactive than males .....	161
10.6 Behavioural reactivity is related to meat quality as indicated by loin pH.....	162
10.7 Management group affects reactivity .....	163
10.8 Methodological advances .....	165
10.9 Theoretical and practical implications.....	166
Appendix 1. Flight speed measurement .....	169
Appendix 2. Face cover scoring .....	170
Appendix 3. Interview schedule.....	171
References .....	173

## **Abstract**

The ability to measure behaviour and knowledge of the relationships between temperament, stress and productivity in livestock can be utilised in improving livestock production systems, minimising stress and maximising ease of handling and efficiency of production. This research aimed to further the understanding of behavioural reactivity in sheep and investigate links between reactivity, carcass composition and meat quality. This was achieved with a combination of experimental trials and interviews of livestock transporters.

Evidence to support the concept of temperament and behavioural reactivity was gathered across the studies. Repeatable differences between sheep were demonstrated, with moderate to strong correlations between some behavioural tests and links between reactivity and physiological indices of stress. Heritability estimates of up to 0.20 were reported; combined with significant breed effects on reactivity this provides evidence of an inherent genetic component of behavioural reactivity.

Sheep experience was rated as very important by livestock transporters. Age and experience, although confounded, also appeared to be important in the experimental trials. Older, more experienced lambs were less reactive and their behaviour more repeatable than when measured at a younger age.

Although all of the behaviours investigated contributed to overall reactivity, restrained and unrestrained tests are only weakly correlated, indicating that these tests measure distinctly different components of behaviour. A consistent finding in the literature review and experimental chapters was greater reactivity in ewes compared to wethers, although livestock transporters indicated that sex was of minimal

importance and ewes and wethers were behaviourally indistinguishable when handled as a mob.

Few phenotypic or genetic relationships were found between the behaviours and carcass traits in initial analysis of an industry research flock dataset. However, in an experimental trial behavioural reactivity was related to carcass quality, albeit opposite to the relationship expected, with higher reactivity being associated with better loin pH. Lambs that were more reactive at behavioural testing appeared to be stressed in lairage, most likely as they were moved to the stunning area, triggering lactic acid production, resulting in lower loin pH 24 hours post slaughter.

Methodological advances were made during this research. The first of these was in regards to the measurement of flight speed, validating this behavioural test in sheep and assessing the appropriate distance for use in this species. This thesis also assessed the usefulness of face cover score and hairline position as indicators for a variety of measures of behavioural reactivity. The results give strong evidence against the future use of facial hair patterning as an indicator for behaviour in this species.

These results show that behavioural reactivity on farm, combining flight speed and restrained tests and measured later in life (after weaning), can be used to predict the reaction of the sheep at slaughter. The complex phenomenon of reactivity was successfully divided into its components, significantly advancing the understanding of behaviour in sheep. Further work is necessary to confirm these results in a variety of flocks and to establish the links between individual behavioural tests and stress. Greater understanding of the relationships between the behavioural and physiological responses to stress will improve both farm productivity and animal welfare.

## Declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to this copy of my thesis when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968. The author acknowledges that copyright of published works contained within this thesis (as listed below) resides with the copyright holders of those works.

Dodd, C.L., Pitchford, W.S., Hocking Edwards, J.E. and Hazel, S.J. 2012., Measures of behavioural reactivity and their relationships with production traits in sheep: a review. *Applied Animal Behaviour Science*, vol. 140, pp.1-15.

Dodd, C.L., Hocking Edwards, J.E., Hazel, S.J. and Pitchford, W.S., 2013. Genetic and non-genetic effects on flight speed and agitation in weaned lambs. *Association for the Advancement of Animal Breeding and Genetics*, Napier, New Zealand, vol. 20, pp. 114-117.

Dodd, C.L., Hocking Edwards, J.E., Hazel, S.J. and Pitchford, W.S., 2014. Flight speed and agitation in weaned lambs: Genetic and non-genetic effects and relationships with carcass quality. *Livestock Science*, vol. 160, pp. 12-20.

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23<sup>rd</sup> June 2014

## Author contributions

This thesis contains three peer-reviewed articles (Chapters 2, 4 and 5) and one manuscript submitted for publication (Chapter 3). Chapters 6 to 9 have been prepared for publication but not yet submitted. All of these articles and manuscripts are multi-authored but I am the lead author on each. Descriptions of the involvement of each author and their agreement to the inclusion of the manuscript in this thesis are provided in the authorship statement at the start of each chapter. A brief overview of the involvement of the authors in each article is provided below.

Associate Professor Wayne Pitchford, Dr Susan Hazel and Dr Janelle Hocking Edwards provided advice and editorial assistance for all manuscripts. Associate Professor Wayne Pitchford provided statistical advice for Chapters 3-8. Dr Susan Hazel provided assistance in qualitative analysis for Chapter 9.

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## **Manuscripts included as chapters**

The following publications have arisen from research conducted during PhD candidature and are included in the thesis as individual chapters. Contributions of co-authors are described in authorship statements that appear prior to each article.

### **Published**

#### **Chapter 2. Literature review**

Dodd, C.L., Pitchford, W.S., Hocking Edwards, J.E. and Hazel, S.J. 2012., Measures of behavioural reactivity and their relationships with production traits in sheep: a review. *Applied Animal Behaviour Science*, vol. 140, pp.1-15.

#### **Chapter 4. Flight speed and agitation in the Information Nucleus Flock**

Dodd, C.L., Hocking Edwards, J.E., Hazel, S.J. and Pitchford, W.S., 2013. Genetic and non-genetic effects on flight speed and agitation in weaned lambs. *Association for the Advancement of Animal Breeding and Genetics*, Napier, New Zealand, vol. 20, pp. 114-117.

#### **Chapter 5. Relationships of flight speed and agitation with carcass and meat quality in the Information Nucleus Flock**

Dodd, C.L., Hocking Edwards, J.E., Hazel, S.J. and Pitchford, W.S., 2014. Flight speed and agitation in weaned lambs: Genetic and non-genetic effects and relationships with carcass quality. *Livestock Science*, vol. 160, pp. 12-20.

### **Submitted**

#### **Chapter 3. Optimising the measurement of flight speed in sheep**

Burnard, C.L., Hocking Edwards, J.E., Hazel, S.J. and Pitchford, W.S., Optimising the measurement of flight speed in sheep. *Submitted to Applied Animal Behaviour Science*.

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