Breech Flystrike Prevention Genetic RD&E Review

Independent review of Australian Wool Innovation's Breech Flystrike Prevention Genetic Research, Development and Extension Program, June 2025

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Executive Summary

It has long been held that the most sustainable tool for controlling breech strike breeding in the long term will be breeding more resistant sheep. This has become more urgent recently with the development resistance to the most widely used flystrike control chemicals. Research over the past two decades and have demonstrated that genetic gains can be made in breech strike resistance in both traditional and increasingly performance bred flocks by selecting on the basis of correlated, visually assessed traits including wrinkle, dag score, bare area and urine stain. This progress has been reported in previous reviews.

Research more recently, discussed in the current review, has focussed on the development and delivery of tools for use by industry to assist selection for resistance such as selection indices that incorporate flystrike resistance together with production traits and the development of genomically enhanced breeding values for flystrike resistance. These methods can improve the accuracy of selection, thus increasing the rate of improvement in resistance, but can also facilitate the ease of selection and in the longer term potentially make selection for resistance a more practically attractive option in a wider range of flocks. Development of these tools requires relatively large data sets and this is being achieved in a number of projects by the coordinated use of sheep across a wide range of research and commercial flocks with a total of 5,323 struck and 36,204 unstruck sheep genotyped as of March 2025.

A potential new trait to aid in selection is immune resilience which measures a number of elements of the sheep immune response has been defined as a proxy trait for general disease resistance. This is a relatively new potential indicator that could help to explain part of the unexplained variance amongst sheep in susceptibility to flystrike. Early results with this trait were encouraging, but in more recent studies the genetic correlations with flystrike resistance appeared lower. Final determination of the usefulness of this trait in selection flystrike resistance will become clearer from the results of further analysis.

One project investigating the genomics of sheep blowflies was also considered in our review. The main objective of this research is to identify genes and proteins of *Luclia cuprina* that could be of use in the development of future new blowfly control strategies such as new targets for flystrike insecticides or repellents, flystrike vaccines or use in area wide approaches to directly target blowfly populations. Two genes with lethal effects in sheep blowfly larvae that are strong candidates for use in future blowfly control strategies have been identified to date. Knowledge in this area of very specific basic research could provide significant potential benefits towards the development of novel flystrike controls both in the short and longer term.

As part of the overall flystrike RD&E program AWI has developed a particularly comprehensive and woolgrower-targeted extension program consisting of publications, webinars, training modules and online tools to address all aspects flystrike control and in particular, breeding for flystrike resistance. The ongoing efforts to provide producer-oriented extension of programs related to flystrike, on-farm approaches to moving towards a non-mulesing environment and particularly the timely communication of research outcomes to producers and industry is noted and congratulated.

Part of this program is an ongoing collaboration with other partners to fund Paraboss. ParaBoss is a web based extension and decision support website for ruminant parasite control now widely recognised as a key information source for producers and other industry personnel. It is seen as a critical tool into the future as State departments reduce their animal health extension resources. Flyboss contains significant section on breeding more resistant sheep. With the rapid advances now occurring in the area of breeding for flystrike resistance, some of this information is now somewhat dated and deeds to be updated as part of the next iteration of ParaBoss.

Introduction

General consensus is that breeding more resistant sheep will be a critical and, over the longer term, the most sustainable tool to control breech strike in non-mulesed flocks. This has become more urgent recently with the development of widespread resistance to the most commonly used flystrike control chemicals. AWI, in partnership with wool producers, other industry stakeholders and national and State research and extension providers has undertaken a comprehensive research, development and extension program to advance the implementation of optimal breeding programs for breech strike resistance. Major breech flystrike selection flock experiments have been conducted over the past two decades and have demonstrated that genetic gains can be made in breech strike resistance by selecting sheep using visual scores for breech wrinkle, breech cover, dag and urine stain. Outcomes from this research and the use of data collected from both research and, increasingly' commercial flocks have enabled significant gains in reducing breech strike susceptibility in both traditional and performance breeding flocks. This progress has been reported in our previous reviews. Encouragingly, in the recent Merino Practices Husbandry Survey, published in this review period, the most common reason given for ceasing mulesing (45% of growers) was breeding sheep with less body wrinkle. A new updated version of the widely used Visual Sheep Scores Guide was published during the current review period to further facilitate this approach.

Improving the utility and accuracy of breeding programs now increasingly centres on providing more accurate breeding values for flystrike resistance and the development of selection indexes that incorporate flystrike resistance. In particular, the development of new technologies such as genomically enhanced breeding values can significantly improve the accuracy of selection and thus lead to a boost in the rate of genetic gain for breech strike resistance. One potential new approach to aid selection for reduced flystrike susceptibility currently under investigation, is selecting for immune resilience. Further studies of this character were conducted in the review period and are discussed further in our report. During the reporting period there has also been an increased focus on developing and delivering extension programs to increase the adoption and effectiveness of breeding programs that incorporate breech strike resistance and to aid the development of efficient, property specific production systems based on unmulesed sheep.

The 2025 review of the genetic components of AWI's Breech Strike Research Development and Extension program was conducted by reference to research papers and reports, extension materials and information provided at an on-line meeting with Australian Veterinary Association and AWI representatives on the 13th of June 2025. Projects reviewed included in this report relevant to breeding and genetics aspects of flystrike control include:

ON-00775 – AWI – Animal Genetics and Breeding Unit (AGBU) Genetic Analysis

ON-00820 – Planning for a virtual genomic reference flock – BSC Agribusiness

ON-00866 – Merino Genomic Reference Flock – BCS Agribusiness

ON-00860 – Immune Resilience in Merino sheep, including Flystrike – CSIRO

ON-00902 – Novel Targets against Flystrike – University of Melbourne

ON-00765 – Flystrike Extension Package (Its Fly Time and Simplifly development)

ON-00815 – Breeding for Flystrike Resistance Workshop (ClassiFly development)

ON-00818 – Moving to a Non Mulesed Enteprise (StrateFly and AmpliFly extension program development)

ON-00849 – Flystrike Extension Delivery (for the period 2022 to 2026)

ON-00790 - ParaBoss Phase III

Projects

ON-00775 – AWI – AGBU Genetic Analysis 2022-2027 (AGBU)

This project has 3 key topics:

- Merino Lifetime Productivity (MLP) Analysis
- Genetic Evaluation Improvement (Wether Trials, Sire Evaluation, MERINOSELECT)
- Genomic Reference Flock with a focus on Flystrike

Merino Lifetime Productivity (MLP) Analysis

The MLP project had 5 sites, being Balmoral (Victoria), Pingelly (Western Australia) and MerinoLink, Macquarie, and New England (all in New South Wales). Data for flystrike incidence (breech and body strikes) was collected across all sites, as part of a wider pool of data contributed to by the Australian Merino Sire Evaluation Association (AMSEA) sire evaluation sites, individual ram breeders, the AWI breech strike selection project sites managed by CSIRO in NSW and DPIRD in WA and the Information Nucleus Flock, with a total of 5,323 struck and 36,204 unstruck sheep genotyped as of March 2025. This relatively large data set is contributing to analysis work on the genetics of flystrike and in the development and delivery of tools for use by industry, mainly in the form of genomically enhanced breeding values on flystrike and contributions to updated selection indexes that cater for selection emphasis on flystrike resistance.

The MLP data analysis work has a wide focus, including genetic and non-genetic studies of many productivity, quality and welfare traits, including flystrike resistance. Detailed reports and publications on the analysis of this work are not yet available to review. However, we note that 2 journal papers on the genetics of flystrike, based on work utilising data from the MLP, are planned as

part of a special edition on the MLP project in the journal 'Animal Production Science', to be published in 2026.

We strongly support this ongoing work, which again leverages the results from significant past investment by AWI.

Development of breeding values for Fly Strike

There are two breeding values being developed which include flystrike, one for Breech Strike and the other for Body Strike. This work is being carried out in tandem with the development of genomic-enhanced breeding values via the establishment of a genomic reference flock.

The timelines for development and delivery of these breeding values to industry are as follows:

2025 – Project Breeding Values – these are very preliminary estimates of potential genetic values and normally only comparable amongst individual animals bred within the same flock.

2026 – Research Breeding Values (RBVs). These are used in breeding programs as an early indicator of potential genetic value, before the trait is fully established as an Australian Sheep Breeding Value (ASBV). RBVs are subject to change as more data is collected and analytical models are refined

2027 – Australian Sheep Breeding Values (ASBV). These are fully-fledged breeding values with good accuracy levels that are comparable across-flocks and across the entire MERINOSELECT database.

Merino genomic reference flock

Genomic selection for resistance to flystrike offers the prospect of higher accuracy of breeding values and higher rates of genetic gain and is similar to using indirect flystrike indicator traits like breech wrinkle, cover and dag scores. It also offers the considerable advantage of not having to expose sheep to flystrike risk to enable select for flystrike resistance to be incorporated into breeding programs. Ultimately, if the accuracy of genomic breeding values is high enough, the need for phenotyping of flystrike indicator traits will be reduced, if not eliminated.

Genomic selection using genomically-enhanced breeding values requires, as a first step, the creation of a genomic reference flock, where sheep are phenotyped for susceptibility to flystrike, with these results then being statistically associated with genotypes of the animals. This statistical association is then used to predict breeding values for flystrike on genotyped sheep outside of the reference flock. Currently, this genomic data is blended with more conventional phenotypic data for records of breech wrinkle, breech cover and dag score to increase the accuracy of selection by the generation genomic-enhanced breeding values. The current AWI project in this area is reviewed below.

ON-00866 – Merino Genomic Reference Flock.

This project, conducted by BCS Agribusiness, set out to establish a Merino Genomic Reference flock as a pilot project. It is doing this by providing a 50% subsidy for genotyping of all Merino sire evaluation progeny at AMSEA sites and engaging willing ram breeders to collect flystrike data and genotypes.

As of early 2025, 12 ram breeder flocks are contributing data with a further 4 likely to do so. Some breeder sites have had very low levels of strike over the last 6-18 months. Due to the low incidence of strike the project timeline has been extended into 2025/26. Additional steps include the creation of breeding values for urine stain and faecal consistency score.

We strongly support continuation of this work.

Project ON-00860, Immune Resilience in Merino Sheep - including flystrike - CSIRO

Immune resilience has been defined as a proxy trait for general disease resistance, or the ability for an animal to remain productive in the face of disease or diverse environmental challenge (Hine *et al.* 2022). This is a relatively new potential indicator that could help to account for part of the unexplained variance amongst sheep in flystrike susceptibility. If immune resilience can be shown to be both heritable and well genetically correlated with flystrike incidence, it could provide an additional tool for breeders to select sheep that are more resistant to flystrike, as part of a balanced breeding program.

This project is an extension of work commenced under Project 0N-00511 'Improving resilience by breeding for immunity' to enable the more precise estimation of genetic parameters on resilience traits (immune competence) and correlations with health and welfare traits, including resistance to flystrike. The immune competence traits were found to be moderately to highly heritable and preliminary correlations between immune resilience and flystrike were moderate and favourable, which is beneficial if the traits are going to be included in genetic improvement programs. The latest analysis for revised estimates of the genetic correlation between immune resilience and breech strike, and with other indicator characters as not yet been reported. Final comments on the potential of this work cannot be provided until this analysis is complete.

New MERINOSELECT Indexes

In May 2024 Sheep Genetics, as part of the MERINOSELECT service, released 4 new official industry breeding indexes, replacing earlier indexes. Briefly, these new indexes incorporate some selection emphasis on reducing breech wrinkle scores and their use is likely to achieve a genetic reduction in breech wrinkle scores and breech strike susceptibility, whilst improving productivity traits. One of the 4 indexes, the Sustainable Merino index also includes the ability to achieve a reduction in dag scores, which provides significant management benefits in addition to reductions in breech strike susceptibility.

ON-00902 – Novel Targets against Flystrike – University of Melbourne

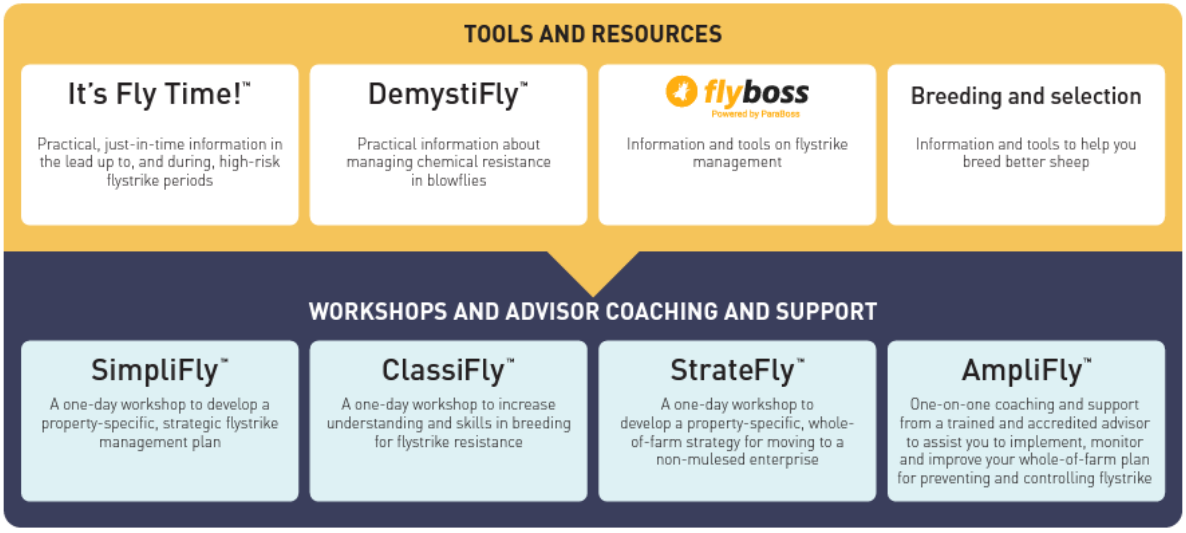
Mapping of the *Lucilia cuprina* genome, accomplished in recent years, has unlocked the possibility of a completely new approaches to flystrike control by targeting or manipulation of sheep blowfly genes. The main objective of this research is to identify genes and proteins that could be of use in the development of future novel blowfly control strategies such as new targets for flystrike control insecticide chemistries, flystrike vaccines or use in area wide approaches to directly target blowfly populations. The most significant finding from the project to date is the identification of two genes with lethal effects in larvae that are strong candidates for use in future blowfly control strategies. This is important basic research, in a relatively new area that could providing significant potential benefits, both in the shorter longer term, and is strongly supported. An application for an Australian Research Council linkage grant is currently underway, aiming to leverage other external funds through contribution of AWI funds. We strongly support this research and the future funding

approach. However, we also recognise that ARC Linkage grant funding is highly contested and ARC funds are often not easy to obtain.

Flystrike extension (ON-00765 ON-00815, ON-00818 and ON-00849 (AWI and Schuster Consulting)

The ongoing efforts of AWI and partners to provide producer-oriented extension of programs related to flystrike, on-farm approaches to moving towards a non-mulesing environment and particularly the timely communication of research outcomes to producers and industry is noted and congratulated. AWI has developed a comprehensive extension program consisting of publications, webinars, training modules and online tools to address all aspects of an integrated approach to flystrike control including strategic wool removal and timing of insecticide treatments, surgical treatments, stress minimisation, and in particular, breeding. An overview table for the AWI-funded flystrike extension program is provided below in Figure 1. Extension and training on breeding and selection for flystrike resistance, as well as practical information on moving towards a non-mulesed flock, is addressed in a number of the elements of this program, specifically Simplifly™, Classifly™ Stratefly™ and Amplifly™.

Figure 1: Overview of flystrike extension program



Simplifly™ (ON-0075) is a one-day face to face workshop delivered by AWI-accredited advisors in partnership with AWI's state grower extension networks, which assists wool producers to develop a strategic property-specific plan to reduce the impact of strike in their flocks. A key element addressed as part of an overall flystrike control program, is selecting for flystrike resistance.

Classifly™ (ON-00815) is also a one-day workshop and addresses designing and implementing a breeding program for flystrike in more detail. It is designed to increase understanding of what is involved in breeding for flystrike resistance and covers selection strategies and classing skills for use with both mulesed and unmulesed flocks.

Stratefly™ (0N-00818) aims to build awareness of what is required if moving to a non-mulesed flock and aids in the development of a property-specific strategy for moving to a non-mulesed enterprise.

This includes the determination of optimal approaches for incorporating breech strike resistance in breeding programs, tailored to the individual enterprise. Attendees include woolgrowers with a range of experience from those who have already moved to phase out mulesing to those contemplating a change and wanting to clarify what is involved.

Amplifly™ (0N-00818) focusses on provision of 'train the trainer' programs to facilitate one-on one coaching in the development and conduct of optimal control programs for individual enterprises. Individual consultation is provided by AWI-trained and -accredited advisors on a fee for service basis.

In addition, the AWI website continues to provide a comprehensive body of well-coordinated and timely publications, focussed towards practical on-farm issues and cross linked to and harmonised with other information sources such as the Sheep Genetics website, Merino Lifetime Productivity project and Sheep Sustainability Project. Notable amongst breeding-relevant extension articles published on the AWI website are: Visual Sheep Scores- Producer version, Planning for a Non-mulesed Merino enterprise, Breeding Naturally Breech resistant Merinos, Merino Genomic Reference Flock, and Merino and Dohne Genetic Trends. Beyond the Bale also continues to be important in providing timely articles, reporting on recent research outcomes, alerting wool growers and other stakeholders to the occurrence of high-risk periods and the availability of upcoming flystrike-related workshops and training courses.

ON-00790 ParaBoss Phase III – Animal Health Australia (AHA) and The University of New England (UNE), with funding from MLA

The ParaBoss Phase III contract, which is currently managed by Animal Health Australia was originally set to conclude in August 2024 but has now been extended to 30 June 2025. Ongoing discussions among AWI, MLA, and AHA are currently addressing future funding and structural arrangements. ParaBoss is now widely recognised as a key, web-based extension module for producers and other industry personnel addressing ruminant parasite control for sheep, as well as for cattle and goats. It is seen as a critical tool into the future as State departments reduce their animal health extension resources.

We note that while FlyBoss contains a comprehensive and still useful section on breeding for flystrike resistance. With the rapid recent advances that have been made in this area in recent years, some of the information provided is now somewhat dated and the breeding section would benefit from a review to update it and harmonise it with advice available from the Sheep genetics and AWI websites. Ongoing funding for operation of ParaBoss and particularly for the FlyBoss module which addresses sheep flystrike control is strongly supported.