# Improving Granular Fertiliser Aerial Application for Hill Country Farming

A thesis presented in partial fulfilment of the requirements for the degree of

**Doctor of Philosophy**

**In**

**Agricultural Engineering**

At Massey University, Palmerston North, New Zealand

MASSEY UNIVERSITY
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UNIVERSITY OF NEW ZEALAND

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**2017**

## Abstract

Soil fertility and pasture productivity varies significantly over hill country farms. Therefore conventional aerial fertiliser application of a single application rate is inefficient. Automation of the aircraft hopper door increases control of fertiliser application. This includes the ability to achieve variable rate application, where multiple application rates can be applied over the farm. Ravensdown Limited has installed variable rate application technology (VRAT) on their Pacific Aerospace Cresco (PAC) 600 aircraft to improve the aerial application of granular fertiliser to hill country farms. The objective of this study was to measure and improve the performance of the VRAT system. Various aspects of the system's performance were examined; including hopper flow dynamics, control of the hopper door, estimation of a fertiliser particle's landing position from a known release point, collection of field data, and prediction of wind effects on the ground fertiliser distribution.

Performance trials, bench testing and static hopper flow tests were used to improve the VRAT system. Three performance trials were carried out. Each had a different sampling configuration: grid, nested grid and line. Sampling configuration varied because the objective of each trial differed, and there were advantages and disadvantages to each configuration. Accuracy, precision, level of off-target application, and capability of the VRAT system to vary application rate was measured. The trials observed accurate application rates, and improved precision when compared to pilot operated hopper doors. Off-target application occurred because the buffer was insufficiently sized, and did not consider the forward motion of particles, wind effects, and the mechanical/hydraulic limitations of the VRAT system. Bench testing, modelling and field trials can be used to improve the sizing of buffers under varying field conditions. Statistical tests showed the VRAT system was capable of applying different application rates to application zones.

While some parts of aerial topdressing can be controlled, there are other factors that cannot be controlled and are a source of variation. Several factors are discussed. Particle bounce out of the collectors was observed after the second performance trial. This issue under-estimated the field application rate in the first two performance trials. Additional trials were completed to improve the capture efficiency by 38% for superphosphate, and provided correction factors for DAP and urea.

Wind contributes to variability in aerial applications, and automation of the hopper door is unlikely to significantly mitigate its effects. Ravensdown Limited wished to develop a wind

displacement calculator tool. The calculator uses a single particle granular fertiliser ballistics model to predict the displacement of the transverse spread pattern and swath width by wind. To achieve this, the ballistics model was validated for superphosphate, urea, di-ammonium phosphate (DAP), and a 70% superphosphate/30% Flexi-N blend.

The model was validated from two data sets for each fertiliser type. From the first data set, the propeller wash component was excluded because fertiliser particles leave the hopper door in a mass flow. Therefore in the initial time steps, the particles are not singular and the propeller wash does not significantly influence their motion. There was good agreement between the field and modelled transverse spread patterns. Additionally, the Kolmogorov-Smirnov test statistically showed that the two distributions were similar. The development of the wind displacement calculator tool and production of wind displacement look up tables is described. From a limited number of inputs, the calculator predicts the displacement of the peak mass in a transverse spread pattern. To decrease modelling time, wind displacement look up tables were created from the tool for superphosphate, urea and DAP.

In conclusion, the VRAT system will improve fertiliser application to hill country. However, aerial topdressing is highly variable and some factors cannot be controlled. Ballistics modelling can be used to minimise these factors and improve understanding of the variability. The model and wind displacement calculator should be used with care, as they are based on assumptions, which may not be completely representative of field conditions.

## Acknowledgements

Many people contributed to the success of this project. Firstly, I would like to thank my supervisors Professor Ian Yule and Dr. Miles Grafton for their advice and guidance throughout this project. I am grateful to them for giving me the opportunity to complete this PhD.

Next, I would like to thank the incredible team at the New Zealand Centre of Precision Agriculture, who helped me with my trials and provided sound advice in troubled times. In particular, I would like to acknowledge Kate Saxton for her work in organising staff and the logistics of the trials. I have also enjoyed my time with my fellow PhD students. They have not only provided entertainment and encouragement, but also voluntarily participated in my trials. Additionally, I would like to thank John Edwards for his years of advice and kindness in the lab, and Ray Watson (Comtel Limited) for being an amazing problem solver.

I am thankful for the funding provided by Callaghan Innovation and Ravensdown Limited. This project could not have been completed without the support of Ravensdown and their staff. I want to thank Michael White and Michael Manning for mentoring me and giving me the opportunity to learn more about Ravensdown. I would like to acknowledge Grant Lennox and Mark Tocher, who operated their aircraft for my trials and co-operated with my ideas.

Lastly, I would have not made it without the love and support of my family and friends. My parents have continued to support all my endeavours, and I am eternally grateful for their encouragement and advice.

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