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ADOPTION OF PRECISION AGRICULTURE  
TECHNOLOGIES FOR FERTILISER PLACEMENT IN  
NEW ZEALAND

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

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in

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## ABSTRACT

Major agronomic and economic losses are caused by inaccurate application of nutrients from ground based spreading vehicles. These losses come from both over and under application of fertiliser resulting from such practices as driving at inappropriate bout widths. This work reviewed current spreader testing procedures; compared the performance of international test methodologies and evaluated the use of a digital image processing program to perform spreader testing. Methods to evaluate field performance were developed; this analysis of field application was used to calculate the economic effect of using precision agricultural technologies in New Zealand dairy farming systems.

A matrix of fourteen hundred 0.5 x 0.5 m fertiliser collection trays was used to evaluate individual test methodologies. Results indicated that there were major variations in calculated certifiable bout width between different methods and direct comparison should be avoided. Tray layout within  $\pm 5$  m of the centre spread line had the largest effect on calculated bout width whilst methods that incorporated rows of trays in the longitudinal direction were less variable compared to those using a single transverse test. The probability too accurately assign bout widths using different international test methods was analysed, the ACCU Spread (Australia) test method had the highest level of confidence in its bout width calculation followed by the ES (Europe) test method. The ISO(i) (World), ISO(ii) (World) and Spreadmark (NZ) tests were all found to be comparable to one another whilst the ASAE (USA) method had the lowest level of confidence in its bout width calculation because of wide collector tray spacing.

A method to extract a wider range of data from spreader tests using a hybrid image processing system was developed. Results indicated that there was a strong relationship between two dimensional particle area and particle mass under laboratory ( $R^2 = 0.991$ ) and field ( $R^2 = 0.988$ ) conditions.

Although transverse spreader tests provided a good indication of machine performance, they did not account for the interaction of the spreader and its operational environment. A method was developed that used the vehicle location during field application and the transverse spread pattern represented as polygons to create field application maps. Initial results showed large variations compared to the measured transverse spread pattern. A wider study over 102 paddocks on four dairy farms showed that average variation was 37.9%. An improvement to the field application method discussed is given; this tool used the geographical

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position, heading angle and a series of static spread pattern tests from the spreading vehicle to achieve greater accuracy in field measurements.

The described field application methods were used to assess the ability to execute a nutrient plan using both actual and optimised spreading data collected during field application. A loss of \$66.18 ha<sup>-1</sup> was calculated when comparing the efficiency of using current spreading methods to those assumed in nutrient budgeting practice. If a guidance and control system were used correctly to provide optimised field application the loss could be reduced to \$46.41 ha<sup>-1</sup>.

This work highlighted the difficulties in achieving accurate field nutrient application; however, by developing the ability to quantify field performance, economic opportunities could be evaluated. Overall, this work found that there was a strong agronomic and economic case for the implementation of precision agricultural technologies in the New Zealand fertiliser industry. However, the current range of equipment used by the spreading industry would have difficulty in delivering these benefits.

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