The objective of this research is to evaluate and demonstrate the impact of new field based crop sensing technology for measuring biomass and key quality traits relevant to the sustained growth of the export oaten hay industry. This project will develop proof-of-concept calibrations from analysis of FieldExplorer measurements (new field based crop sensing technology) and manually collected data.

The long-term goal is to support breeding, pre-breeding, and agronomy research, improving the accuracy and throughput of current quality trait assessment, increasing genetic gain. Newly developed sensing capability can now be evaluated in the field to assess crop growth and quality traits. FieldExplorer sensors are contained in a cabinet with supplemental lighting that facilitates consistent imaging throughout the day regardless of cloud cover. The advanced image-data acquisition, fusion, and processing software platform aboard the FieldExplorer provides the capacity to fuse the results from different sensors, resulting in integrated datasets, as well as the ability to compare different sensing technologies for their ability to assess oaten hay traits. Calibration trials will be sown each year with approximately 100 genetically diverse breeding lines selected from stage two, three and four breeding trials.

**Project Overview**

**Implementing new technologies for assessing oaten hay yield and quality**

September 2020 – August 2023

**Background**

There are current limitations for assessing biomass and quality traits in oaten hay breeding and agronomy research. Manual hay cuts need to be carried out at consistent growth stages requiring several visits to field sites. Samples are transported to the laboratory, oven dried and processed through two different mills. Ground samples are assessed using near infrared (NIR) technology for quality measurements.

There is a significant opportunity to utilise phenotyping technology to measure quality traits, such as neutral detergent fibre, acid detergent fibre, colour, water soluble carbohydrates (WSC) and crude protein (CP), using new sensing technology in the field. This will reduce labour inputs and cost while improving the throughput and accuracy of measurements. Significant investment in field phenotyping technology was recently made by the University of Adelaide, the Plant Accelerator and the company Crop Traits.

The FieldExplorer is a novel field phenotyping platform, combining LiDAR, hyperspectral imaging, and colour imaging technology. The hyperspectral imaging has the potential to measure hay quality in the field similar to lab based NIR techniques, while LiDAR sensors have the potential to provide rapid and accurate measures of biomass. Once ‘new’ quality calibrations are established for the FieldExplorer, manual sample cuts and subsequent laboratory analysis will not be required.

Benefits include accurate hay yield and quality assessment at more sites for breeding and agronomy research resulting in increased hay yield and quality for growers and processors. In addition, calibration models developed with the FieldExplorer can inform the design of low-cost multispectral sensors which could be used by growers and processors in the future to improve management decisions impacting both yield and quality.

**Objectives**

The objective of this research is to evaluate and demonstrate the impact of new field based crop sensing technology for measuring biomass and key quality traits relevant to the sustained growth of the export oaten hay industry. This project will develop proof-of-concept calibrations from analysis of FieldExplorer measurements (new field based crop sensing technology) and manually collected data.

The long-term goal is to support breeding, pre-breeding, and agronomy research, improving the accuracy and throughput of current quality trait assessment, increasing genetic gain.

**Research**

Newly developed sensing capability can now be evaluated in the field to assess crop growth and quality traits. FieldExplorer sensors are contained in a cabinet with supplemental lighting that facilitates consistent imaging throughout the day regardless of cloud cover. The advanced image-data acquisition, fusion, and processing software platform aboard the FieldExplorer provides the capacity to fuse the results from different sensors, resulting in integrated datasets, as well as the ability to compare different sensing technologies for their ability to assess oaten hay traits. Calibration trials will be sown each year with approximately 100 genetically diverse breeding lines selected from stage two, three and four breeding trials.

They represent a broad range of phenotypic variation related to biomass and quality traits, primarily focusing on digestibility, water soluble carbohydrates, and neutral detergent fibre DOM. The FieldExplorer scans the entire plot and three biomass cuts across the five row plots are done. Samples are dried, weighed, and milled. Wet chemistry methods will quantify quality traits for the samples.

LiDAR Canopy Height and LiDAR Projected Volume is extracted from the 3D point cloud data using proprietary software developed for the FieldExplorer. The hyperspectral data will be analysed by spectral pre-processing followed by multivariate regression analyses or machine learning approaches to correlate the sensor data with manually collected data, determining the predictive performance. The models will be developed using data from the first two years and the robustness determined by using the models to predict data from the third year.

**Expected outcomes and implications**

- The hypothesis is that new sensing technologies will be more cost effective and efficient replacing older technologies to quantify biomass and hay quality traits.
- Outcomes of the project will be quantification of the benefit and future role of new sensing technology in the oaten hay industry.
- Demonstrate return on investment resulting from implementation of new technology to improve genetic gain for traits relevant in export markets.
- Industry understands the role of imaging technology and commences adoption for predicting biomass and quality traits in oaten hay.
- Determine the potential for commercial, low cost sensor development within reach of breeders, agronomists, growers, and processors to determine on farm the most desirable time for cutting to maximise hay yield and quality.
- Economic, environmental and social impacts include greater selection efficiency (lower cost, higher accuracy) relating to hay quality traits in breeding programs, more accurate hay yield measurements and quality assessments at more sites for agronomy research resulting in increased yield and quality for growers and processors. Maintaining oat hay as a competitive crop in the farm rotation compared to other crops provides diversification on farm and increases farm income while spreading economic risk. Hay production also provides employment and business opportunities in regional areas for contractors, processors, equipment retailers, and growers.
- Calibration models developed from FieldExplorer data to predict hay yield and quality can also guide the development of low cost sensors sensitive to key wavelengths. Multispectral cameras or sensors are significantly cheaper than hyperspectral cameras and simplify data analysis. This technology could be used as a management tool to improve the yield and quality balance for growers and agronomists.
Publications


Alphitobius diaperinus, in chicken broiler houses. BioControl 64:489-500


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