Final Project Summary

Project title	Developing enhanced breeding methodologies for oats for human health and nutrition (InnovOat)		
Project number	21120004	**Final Project Report**	PR627
Start date	1 September 2014	**End date**	31 January 2020
AHDB Cereals & Oilseeds funding	£157,841	**Total cost**	£2,914,000

What was the challenge/demand for the work?

To improve the economic competitiveness of oats, it is essential to invest in varietal improvement and management. In particular, it is important to understand and enhance nitrogen (N) use efficiency. Reducing the total crop N requirement and/or better targeting the nutrient will improve the profitability of the oat crop. In addition, it will lead to environmental benefits, through reduced greenhouse gas (GHG) emissions and nitrogen leaching/run-off.

Currently, N-management guidelines for oats do not adequately consider milling quality and grain composition, despite its importance to the end-user and milling industry. Recent stakeholder discussions identified the need to understand grain quality traits (specific weight, hullability, grain protein and β-glucan) better to accelerate targeted breeding, and to improve the selection and management of oat varieties.

How did the project address this?

Nitrogen-response field trials

Building on recently completed AHDB-funded work, two N-response experiments investigated the interaction of N with trait expression in winter oat varieties and determined economic optimum N rates. Assessments included detailed grain quality and yield component analyses. This revealed the contribution of panicles per unit area and the number of grains per panicle. Conducted under various environmental conditions, the trials provided valuable information on trait stability. Importantly, the work delivered information on the optimum N rates required to grow high-quality winter oats for milling.

Genetic markers for yield and quality

Unique genetic material was used to improve understanding of the genetic and environmental factors that contribute to yield and grain quality variation. This work used oat lines in which specific genomic regions involved in the control of key grain quality and yield-related traits had been introgressed into a common genetic background. This aspect helped to develop markers and knowledge for innovative oat breeding.

Final Project Summary

What outputs has the project delivered?

Nitrogen-responses

- Low inputs of nitrogen resulted in low grain yield and quality.
- Higher nitrogen inputs increased grain number per m^2 and yield.
- Higher nitrogen inputs resulted in variety-dependent positive responses on all grain quality parameters measured, except specific weight and screenings.
- Grain yield was not associated with thousand grain weight, although many of the grain quality traits measured were.
- Grain protein and β-glucan content increased in response to nitrogen, whereas oil content decreased.
- At high nitrogen rates, some varieties may have specific weights and screenings below milling specifications, despite having high kernel contents and hullabilities.
- A lower β-glucan variety could reach acceptable levels with higher nitrogen applications.
- The variety Mascani displayed stable grain quality across all nitrogen treatments.
- As varieties differed in the extent of response to nitrogen fertiliser, ideally, variety-specific nitrogen management plans would be developed.
- Dissection of grain quality traits revealed the importance of grain roundness and grain filling on grain quality traits.
- Due to the decrease in grain size at high nitrogen application rates, screenings (grains that pass through a 2mm sieve) may also increase in some varieties.
- The decrease in mean grain size was accompanied by an increase in the range of grain sizes found and variety-dependent changes in the bimodality of this distribution.
- Varietal differences were found in nitrogen uptake and utilisation efficiencies.

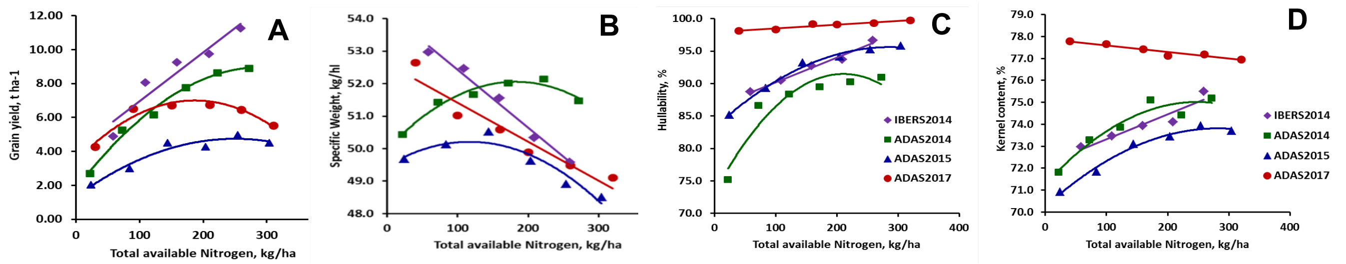

Figure 1. Effect of nitrogen (N supplied plus soil nitrogen measured using SMN tests) on grain yield (A), specific weight (B), hullability (C) and kernel content (D). IBERS 2014 (Lydbury North), ADAS 2014 (Rosemaund), ADAS 2015 (Rosemaund) – mean of Mascani, Gerald, Tardis and Balado. ADAS 2017 (Rosemaund) – mean of Mascani, Maestro and Griffin.

Final Project Summary

Genetic markers
The project developed and characterised a series of reciprocal genetic crosses (QTL-NILs) differing in their chromosomal regions with traits related to adaptation, yield and grain quality. The work validated QTL for height, flowering time and grain size. It also revealed the interaction of QTL underlying yield-determining traits, in particular flowering time and stem elongation, along with their impact on grain quality. The plant population developed provides an excellent resource for understanding mechanisms and genes underlying these traits.

Who will benefit from this project and why?

This work will benefit the whole oat industry*:

- Growers will benefit from an improved understanding of the yield and quality response of oat crops to various nitrogen rates, helping to make oats more profitable crop in the rotation.
- Agronomists will benefit by having more up-to-date and reliable information.
- Millers and processors will benefit from the knowledge of the response of both variety and nitrogen management in the production of oats that mill more efficiently and cost-effectively.
- Breeding companies will benefit from the knowledge and genetic markers developed that provide the ability to track regions of the genome associated with grain yield and quality in breeding programmes.
- The research community will benefit through the provision of novel tools and resources to help identify the genes (and their natural variants) that underlie the chromosomal regions identified here as controlling yield, yield components and determinants of grain quality.

*Note: Project findings informed a recent revision on nitrogen recommendations for winter oats within the AHDB nutrient management guide (RB209).

If the challenge has not been specifically met, state why and how this could be overcome

Further testing of modern oat varieties is required to optimise nitrogen recommendations for yield and grain. Nitrogen management of spring oats was not part of this project. Despite many varieties with enhanced yield potential coming to the market, guidance has not been updated for many years. The 2018–22 AHDB and industry-funded project 'Nitrogen and sulphur fertiliser management for yield and quality in winter and spring oats' (21140039) aims to address these gaps.

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