Online Farm Trials: a national web-based information source for Australian grains research, development and extension

Judi Walters, Robert Milne & Helen Thompson

Centre for eResearch and Digital Innovation, Federation University Australia, PO Box 691, Ballarat, Victoria 3353, Australia
Email: r.milne@federation.edu.au

Abstract. An increased use of on-farm trials to conduct research in the Australian grains industry has led to problems in the dissemination of results from research trials: results from past research trials are difficult to obtain because they exist almost exclusively as hard copies, known only to the group(s) involved in conducting the trials. These factors have impeded the ability to learn from past research and have slowed expected productivity gains. To address these issues, the Online Farm Trials (OFT) project was developed to bring national grains research data and information directly to the grower, agronomist, researcher, the grains industry and the community through innovative online technology. OFT has been designed to provide growers with the information they need to improve the productivity and sustainability of their farming enterprises. Using specifically-developed research applications, users are able to search OFT to find relevant research information. OFT has been developed in close collaboration with grower groups, regional farming networks, research organisations and industry to bring a wide range of crop research datasets and literature into a fully accessible and open online digital repository.

Keywords: experimental, data, Grains Research and Development Corporation, GRDC, on-farm, research, trial, trials.

Introduction

On-farm research trials are increasingly being used to investigate the problems and priorities of Australian grain growers (Hunt et al. 2014). Trials are often managed by local grain grower groups with support from external funding, but there are concerns that the results of both new and past research trials are not readily accessible to the broader grain-growing community or industry stakeholders. Further, it has been suggested that the lack of information flow has contributed to the slow-down of productivity gains within the industry (Sheng, Mullen & Zhao 2011). Thus, to provide greater accountability of returns from research funding, and to realise future productivity gains through continued support and funding of on-farm trials within the Australian grains industry, grower groups will increasingly be required to publish high quality, reliable results to a wider audience (Mullen 2007).

Recognition of the need for better information dissemination and sharing of grains research trial results (past, present and future) led to the initiation of the Online Farm Trials (OFT) research project. The aims provide a web-based information source to:

- make trial data from past, present and future (planned) on-farm grains research trials available across Australia; and
- provide a standard for written reporting of on-farm grains research trials.

A brief history of agricultural research and development in Australia: how the on-farm trial seed was sown

Early agricultural research, development and extension (RD&E) in Australia began during the post-World War II period and was dominated by state involvement geared towards generation and transfer of production-based technologies and innovations to increase productivity (Anil, Tonts & Siddique 2015a). State Government departments [of agriculture] typically conducted research experiments and trials at designated research stations and within university research facilities. Research output played a key role in meeting the information needs of farmers and enjoyed considerable support from research and development organisations such as the Commonwealth Scientific and Industry Research Organisation (CSIRO). According to Petheram and Clark (1998), this mode of information delivery was based largely on a 'top-down' transfer of information from experts (i.e. research scientists) to stakeholders or subjects (i.e. farmers). The adoption of new innovations and technologies from information gained during this time led to significant increases in the productivity and profitability of Australian agriculture.

During the 1980s, the Australian Government began to use economic and structural reform policies to largely withdraw from the direct delivery of research and extension (Anil 2013), and to persuade rural industries to invest in their own RD&E (Hunt et al. 2014). New funding and strategic investment approaches were initiated – the most significant of these being the development of the 'Research and Development Corporation' (RDC) model, instituted during the 1990s. This model, which is unique to Australia (Anil et al. 2015a), is a partnership between

government and industry wherein the government provides dollar-for-dollar matching of industry expenditure on research and development [up to a limit of 0.5% of each industry's gross value of production]. RDC funds can be allocated to private organisations, government agencies and universities or other research organisations according to determined priorities and the capacity of applicants to deliver relevant outcomes.

The Grains Research and Development Corporation (GRDC) is one of 15 current rural RDCs that span the fields of agriculture, fisheries and forestry (Australian Government 2017a). The primary goal of the GRDC is to drive the discovery, development and delivery of world-class innovation to enhance the productivity, profitability and sustainability of Australian grain growers for the benefit of the industry and the wider community (Australian Government 2017b). To achieve this, the GRDC links innovative research with industry needs, and is primarily responsible for the allocation and management of investment in grains research and development (The Allen Consulting Group 2010).

Initially, the GRDC relied heavily on state departments to deliver programs, since this was where the residual expertise and infrastructure existed (Hunt et al. 2014). However, much of this research was conducted at research stations, and it was recognised that 'on-station' environments were often not representative of the actual farmer's environment (Pillay 1999) because results were not always fully tested for their adaptability to farmer's growing conditions (Xangsayasane et al. 2014). Views about methods of extension also changed (Hunt et al. 2012) and, in particular, there was a move from the 'top down' model to 'bottom up' approach, which focuses on those who are best placed to make changes – the land managers and farmers (Carruthers & Vanclay 2012). Together, these changes led to the formation of a number of self-organised groups supported by a mixture of public–private partnerships, including farmer-based organisations and local and regional grower or farming systems groups. By 2011 there were more than 60 such grower groups involved in grains-focussed research and extension in Australia (Long & Cooper 2011).

The role of grower groups in Australian RD&E

The central priority of grower groups is to improve farm productivity, sustainability and financial performance. Their core activities are to conduct research trials that aid in development of solutions to local issues, and to communicate results of research to members and the wider community (Anil 2013). The research focus of a grower group is usually defined by the objectives of the group: trials are generally designed by members of the group with assistance from a facilitator or agricultural research scientist (Grower Group Alliance 2015). The real benefit of on-farm trials, as seen by these groups, is to conduct trials under 'real world' (farming) conditions (Lauer 2006), using commercial-scale equipment (Neilson 2010). Farmers and scientists work together to conduct the research, in recognition that effective research uptake is best built on a foundation of active knowledge exchange and stakeholder engagement during the process of knowledge production (Phillipson et al. 2012). Indeed, grower groups are now recognised as key partners for the delivery of key research and extension activities (Taylor 2013).

Farmer decision-making processes around whether or not to adopt new innovations and technologies, which drive productivity gains, are inherently complex (Hill 2009; Carruthers & Vanclay 2012). Despite the complexity, various investigations into potential barriers to adoption have identified a recurrent theme: the lack of dissemination of relevant information to farmers (Rolfe & Gregg 2015). Critically, it has been recognised that there is poor information flow of both new and past research results from on-farm research conducted by grower groups back to other stakeholders (Watters & Clevenger 2014). Usually, results of on-farm research are communicated through group events such as field days and through publications such as newsletters and, most predominantly, annual trial results books. Field days are recognised as being of greatest benefit in capacity building (Anil, Tonts & Siddique 2015b) whereas trial results books are viewed as being a longer-term resource to refer back to in future years.

Very recently some of the larger grower groups have begun to make trial results available on their websites but much of the historic RD&E information is available only in hard copy format, much of which is accessible only by the grower group that conducted the research. Considerable value would be added if results from past trials were available to farmers across a wider geographical area.

Grains research, development and extension today: how the on-farm trial 'crop' has grown

Research conducted 'on-farm' rather than 'on-station' is neither a new phenomenon (Sadler-Richards et al. 1994) nor one applied only in Australia (Bowman 1994). However, farmer-driven research has become an increasingly large investment for RDCs in Australia since the early 1990s

(Fisher & Carberry 2004), meaning greater importance needs to be given to communication of results from these trials. Reviews into farming systems research in Australia show that there is little uniformity in approaches among groups undertaking and reporting on-farm RD&E (Petheram & Clark 1998). To improve this situation, Fisher and Carberry (2008) saw the development and implementation of a formal monitoring and evaluation strategy, coordinated through an overarching project as a critical requirement to ensure quality of processes and results for future success of grains RD&E in Australia. Similarly, in a study commissioned by the Co-operative Venture for Capacity Building (CVCB) into the development of an effective strategy for future interaction between RDCs and agribusiness, a key finding was that 'access to information is crucial and many advisors suggested that one centralised repository would be a practical place to access RD&E' (Stone 2010, p. 36).

Stone (2010) identified the importance of common access to research and development information in an appropriate and relevant format. He proposed the development of a central web-based information repository in the RD&E chain in which information from RDCs could be stored and accessed by agribusiness and end-users.

The Australian Communications and Media Authority (2008) found more famers are accessing the internet for various activities on their land (Australian Communications and Media Authority 2008). In 2007–08, 66% of farms were using the internet for business operations (Australian Bureau of Statistics 2016), and in 2011, 93% of farmers in NSW who responded to a telecommunications survey had a home internet connection [although members without internet connection were not as easily surveyed] (NSW Farmers 2011). In 2013, internet adoption was reported to be around 90% across Australian farms (The Conversation 2013), and this is likely to have increased since that time. Such statistics confirm that agricultural communication methods are changing through an increased focus towards online (web-based) approaches (Speirs et al. 2013). More importantly, internet usage is expected to increase further with the shift of land ownership with each generation with younger farmers making greater use of the internet than previous generation (Anil 2013).

Experimental or demonstration trial?

On-farm trials can be classified into 'experimental trials' ('scientific trials' or 'replicated trials') and 'demonstration trials' (non-replicated trials'). Experimental trials are conducted to test the performance of particular treatments and to statistically determine whether or not the treatment produced a significant effect: demonstrations are traditionally used when it has already been established – through an experimental trial – that a given treatment makes a difference and a demonstration trial is designed to show a proven effect (Orr 2015). Historically, it seems there has been some confusion between experimental and demonstration trials – with demonstration trials being used as the basis for testing new treatments or products but lacking the scientific rigour from which to draw results with an acceptable degree of confidence. From this, a 'rigour vs. relevance' debate has been associated with on-farm research because on-farm research has sometimes been seen as being less precise (Lawrence, Christodoulou & Whish 2004) than 'on-station' research because of a larger degree of heterogeneity within the experimental area (Piepho et al. 2011). However, with the relevant information and adequate support, there is no reason why on-farm trials cannot deliver results that are both reliable and relevant (Carberry 2001).

To avoid confusion, an on-farm trial should first be recognised as being an experiment or a demonstration. Within the suite of experimental trials, the intention will vary, so the design and the subsequent level of confidence that can be placed on the outcome of a trial will also vary. Blake, Patabendige & Pritchard (2000) suggest trials can be classified into five different 'test levels' of sophistication: from 1, being paddock comparisons through increasing levels of complexity to 5, being replicated small plot trials.

In general, there has been a push to increase the level of confidence that can be placed in the results of experimental trials. Some of the early information regarding the design of on-farm trials evolved from techniques used in 'on-station' experiments to investigate large agronomic or variety trials. These trials were inherently complex and difficult to conduct, analyse and interpret (Lawes 2010). However, since then a number of publications have provided information more relevant to on-farm (paddock level) experimentation and to overcome the practical problems faced by farmers conducting the trials. A list of readily available guides to conducting statistically robust relevant on-farm trials (within the agricultural research field) is provided in Table 1.

Table 1. A sample of on-farm trial guides

Title	Author(s)	Date	Publication
The numbers game – putting validity into farm trials	T Somes	2016	In 'Ground Cover'. GRDC
Advanced field-scale experimentation for grain growers. A guide to using precision agriculture to improve trial results	B Whelan	2015	GRDC and the University of Sydney
Review: Statistical aspects of on-farm experimentation	HP Piepho et al.	2011	Crop and Pasture Science 62: 721–735
Practical guide to on-farm research	RL Neilson	2010	Purdue University Department of Agronomy, West Lafayette, IN, USA
Trial design and analysis using precision agriculture and farmer's equipment	R Lawes	2010	Agribusiness Crop Updates 2010. pp. 169–172. Western Australian Agriculture Authority, Perth, WA, Australia
On-farm testing	J Lauer	2006	In 'Corn agronomy. Where science meets the field' University of Wisconsin, Madison, WI, USA

Generally, simple, classical designs such as completely randomised and randomised complete block designs (RCBD) dominate on-farm experimental trial designs. 'On-farm' experimental trials typically have fewer treatments and greater variance in experimental error than 'on-station' or pot/glasshouse trials (Fielding & Riley 1998). Further, 'on-farm' experimental units are often much larger than plots in 'on-station' trials, which can necessitate substantial reductions in randomisation and replication. However, it is possible for well-designed 'on-farm' trials with sufficient replication to reach levels of precision comparable with 'on-station' experiments (Piepho et al. 2011).

In a report on farmer-driven RD&E, Fisher & Carberry (2008) made a number of suggestions for addressing issues within grains RD&E, including a need to 'develop and implement formal monitoring and evaluation strategies to ensure that effective processes for the scientific, social and economic aspects of farmer-driven research are used' (Fisher & Carberry 2008, p. 34). It seems that such recommendations, although clearly desirable, have not been implemented to any great extent to date. Most notable is the lack of a single clear prescription or template that grower groups can access to ensure that they provide complete, detailed information in a format that allows for interpretation, comparison and implementation of results in a broader context. Even under the guidance of an agricultural consultant or research scientist, the information that is gathered and reported varies widely both across geographical areas, grower groups and across time (years) (J Walters, pers. obs). There is a need for a cost-effective, nation-wide solution to these issues to promote the future success of on-farm RD&E in the Australia through the development of increased access to relevant and reliable information.

The future of on-farm RD&E in Australia: harvesting the gains for grains through Online Farm Trials

The above review of the history and status of RD&E in the grains industry in Australia highlights an opportunity for increased uniformity and better access to information from past and present on-farm research trials. This would broaden the benefits from research findings and minimise unnecessary repetition of on-farm research trials.

The Online Farm Trials (OFT) project has been developed and delivered by the Centre for eResearch and Digital Innovation (CeRDI) at Federation University Australia with support from the GRDC. OFT aims to maximise access to current and past grains industry research data so that it is a resource for industry stakeholders – grain growers, agronomists, government representatives and researchers – to better respond to industry challenges such as climate change and natural resource management (Murphy et al. 2015). OFT federates data from on-farm trial reports that have historically been largely hidden– available only via hard copies or in basic electronic formats – and provides trial information in a web-based format that supports filtering and querying. This makes it easier for growers, researchers, agronomists and farming groups to access research that could contribute to improved industry practices (Murphy et al. 2015).

The OFT pilot project

The OFT pilot project for the web-based information system was launched in late 2013, and included participation from three grower groups – Liebe Group (WA), Northern Grower Alliance (Qld) and Southern Farming Systems (Vic) – as well as consultation with GRDC staff, GRDC panel chairs and organisations such as the Kondinin Group (WA). During the pilot project, the three participating grower groups provided historical trial data in various formats to allow the development of the central trial database and the OFT research applications. The International Plant Nutrition Institute and the Birchip Cropping Group also provided sample data for testing and development purposes. OFT was made live in October 2014, and the project is based on following key knowledge sharing principles:

- That the individual, group or research organisation supplying farm trial research remains the owner of the information supplied and retains all intellectual property rights.
- That data access rights and processes are entirely governed by the researcher and access rights can be adapted to maintain existing membership policies of the group or organisation.
- That the source and ownership of all data will be fully acknowledged and attributed.
- That the researcher maintains full control of trial data and information on the OFT database and may remove, edit and update information at any time.

Any grower group or research entity can be involved in submitting information to OFT. After submitting an expression of interest, a username and instructions to set a password are provided so data can be entered into the OFT Administration Centre. Data can be entered by administrative staff from within the relevant grower groups or by individual researchers or research organisations. In the main OFT research application, the 'Trial Explorer', there are over 3700 trial project entries: these have been contributed by 44 different groups (as at 19 June 2017).

One of the biggest challenges in developing an online information management system is to provide sufficient flexibility without compromising performance and data integrity (Ross et al. 2013). In OFT, to add a new trial project, a number of mandatory fields must be completed. At present, these are a Trial project code, Trial project title, Growing season year, Trial site and Crop type. Further information such as Lead research organisation, Host research organisation, Researchers, Funding sources, Aim, Treatment types and Key messages, as well as a number of trial specifics such as Sow date, Sow rate, Harvest date and Plot size can also be added. There is also the capacity to attach documents, such as the original Trial report or supplementary documents. Trial results data can also be entered: result outcomes are essentially entered as 'Measurement types', for which there exists a drop-down menu that was developed during the pilot phase. For each trial project entered, the year and the latitude and longitude of the trial site are used to link the report and subsequent results data to the Bureau of Meteorology (www.bom.gov.au/) for rainfall data and the latitude and longitude are used alone to link the site to outputs from the National Soil Grid (www.clw.csiro.au/aclep/soilandlandscapegrid/), for soil data.

Thus, in its current format and with the existing system of data sourcing, data entry and publication, OFT is a useful source of information through the collation of past and present trial reports. It provides access to reports from grower groups across all grain growing regions in Australia, and supports filtering by year, crop type, treatment type and contributing group. At present, all types of data (general information, experimental and demonstration trials) are included. The rationale behind this inclusion policy was developed after initial impact research showed the majority of users would rather be provided with all information available and use their own 'rules' or discretion to filter or exclude some results depending on the amount of information available and the intended use of the outcome (Murphy et al. 2015).

A consistent approach to data entry is needed for a successful compilation of a national database (Speirs et al. 2013), so a protocol was developed to articulate the minimum data requirements for inclusion in the OFT database. To implement the protocol, a number of fields within the replicated/scientific research trials category are mandatory and must be completed before a trial project is accepted into the OFT database. The information required has been drawn from a number of publications that provide advice on how to set up on-farm scientific trials (see Table 1) and will ensure that farmers and researchers planning a trial and entering data for OFT will be reminded of the relevant aspects of trial design that may otherwise have been omitted. In this way, OFT provides a much needed national standardised template for recording essential on-farm trial details that is free of charge, readily accessible and easy to use. As a web-based information source, OFT is well positioned to disseminate relevant, searchable data to a world-wide audience. Future developments will focus on improving reporting standards and scientific rigour of on-farm grains trials in Australia.

Conclusion

Investments into Australian agricultural RD&E have been recognised as critical drivers for achieving future productivity gains that are essential for the viability of the agricultural industry and for the ongoing, sustainable production of agricultural resources. Since the 1980s, on-farm research trials have made increasingly significant contributions to RD&E efforts in Australia, although adequate dissemination of results and outcomes has been lacking.

OFT aims to provide access to current and past grains industry research data, provide a resource for industry stakeholders to better respond to industry challenges and to provide of a national standardised reporting mechanism for grains research across Australia. By improving access to trials research OFT will help improve the productivity and sustainability of the Australian grain growing industry.

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