Providing high rainfall zone growers with confidence in new and alternative management practices

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Abstract

The long growing season in the high rainfall zone (HRZ) (>550mm annually) in south-eastern Australia provides greater flexibility and more management options to growers for wheat and barley production compared to the traditional drier wheat belt. To assist growers understand the impacts of these different management practices on grain yields and profitability, crop simulation models were employed to demonstrate the benefits of a range of scenarios developed by three grower groups. Seven case-study sites were established in South Australia, Tasmania and Victoria to validate a crop model and give growers confidence that the model could be used to test crop management practices. Integral to the success of this validation was the involvement of growers throughout the process. Growers selected case-study locations and field treatments. In-season management at the case-study sites was common practice used by the farm manager or local growers. Soils at each case-study site were characterised prior to sowing and at harvest. Measurements were taken during the season to validate the crop model. The crop model closely simulated grain yields in Victoria and South Australia but were more disparate in Tasmania. Simulated grain yields accounted for 71% and 69% of the variation in observed wheat and barley grain yields, respectively, across the case studies. Discrepancies in Tasmania were related to inaccurate model simulation of phenological development that were subsequently corrected. Based on these results, HRZ growers can have confidence that simulations showing alternative management practices accurately reflect crop performance in their region. Soil and climatic data from the case-study sites has been used to evaluate a range of management strategies nominated by local grain growers.

Key Words

Cereal, modelling, participatory action research, phenology, simulation

Introduction

The high rainfall zone (HRZ) (>550 mm annually) of south-eastern Australia has been identified as a region with potential for far higher grain production than is being realised (Sylvester-Bradley and Riffkin, 2008). Consistent yields, particularly in years declared drought in the traditional winter cropping areas, means the HRZ has the potential to significantly contribute to Australia's winter crop production (ABS 2004a; 2004b). Grain growers in the HRZ have many crop management options that can lead to high grain yields. Growers can choose from a broad range of cereal maturity types, sowing times and post-sowing crop management strategies depending upon their time, budget and objectives (Clough et al. 2008). Hence choosing which crop management option is the most likely to produce the highest yielding or most profitable crop can be difficult. Crop simulation models have been validated and used in the lower rainfall environments of south-eastern Australia to assist growers make better agronomic management decisions (Hunt et al. 2006). These same models may be able to be applied to the HRZ. However, crop models have not been validated for the soils and climate of this region and may not match the performance of the cultivars when they are grown in different environments. Validating crop models is only part of the process required to improve crop management. Adoption of new information or techniques by growers is essential. Collaborative practice-change research involving growers, agronomists and researchers has been shown to result in high adoption and trialling of new practices (Carberry et al. 2002; Price and Hacker, 2009). This paper will discuss the participatory approach taken in our HRZ region to validate a crop model and how the model has been used to generate new information for a series of crop management strategies nominated by local growers.

Methods

Grower engagement

The research team acknowledged from the outset that grower involvement in any research aimed at improving agronomic decision making was essential. The grower groups, Southern Farming Systems (SFS) and Mackillop Farm Management Group (MFMG), were engaged as conduits between researchers and local growers. The project commenced with the grower groups organising and facilitating three workshops with local growers, agronomists and crop modellers. Eight to fifteen growers and at least four agronomists attended each of the three workshops. These workshops were located in Longford (Tasmania), Inverleigh (Victoria) and Naracoorte (South Australia) and ran for about four hours. The workshops were an organic forum for brain storming local agronomic issues and practices that might be able to be addressed by employing crop models. The model to be used had not been decided at this stage since the most appropriate model would depend upon the issues raised in the workshops. All agronomic issues proposed by the workshop participants were documented along with the strategies that they thought may address those issues. Growers selected the cultivars and cropping practices of interest; defined standard practices (e.g. sowing windows, fertiliser rates) and defined the boundaries of their locality.

Case-study site selection

During the workshops, growers were asked to nominate two localities, and preferably farms, in their local region that they felt confident had representative soil types, topography, climate and agronomic practices of interest to them and the broader population of growers in the area that they represented. In some workshop groups, a participant nominated their own farm and the remainder of the group agreed. In other workshops, the locality was decided on the day and the farm was sourced later through the grower group. Grower-group members hosted the case-study sites at Meredith and Mininera in Victoria, Campbell Town and Perth in Tasmania, and Millicent and Frances in South Australia. The SFS research site was used as a case-study site at Dunkeld, Victoria.

Case-study design and management

The case studies were paired treatments with one practice differing for each pair. The differing treatment was selected from the issues generated at each workshop and was a practice that as could be modelled in a single-year study. Most case-study sites were completely managed by the farm manager; hence, the final decision as to which treatment was selected determined at the farm level. The aim was to allow paddock management to be completely controlled by the farm manager except for the one treatment which they agreed to and did not place an onerous burden on farm staff. Records of all management were kept by the farm manager. Case studies at Dunkeld, Frances and Campbell Town were conducted on research plots as part of existing projects. At these case-study sites, the treatment imposed was determined by the grower group who were conducting the existing project and keeping records of all site management.

Using the case studies

Crop growth and grain yield were simulated using the APSIM wheat and barley model (Keating et al. 2003) for each case-study treatment using the site-specific soil and climate data for the year the case study was conducted. The APSIM model was chosen because it had local exposure among some growers through its commercial derivatives and had established some degree of credibility. Results of the simulation were compared to the observed crop growth and grain yield. For each case-study site, another local workshop was convened by SFS or MFMG to discuss the results of the comparison and its implications for using the model to build decision-making tools for issues of local importance. These secondary workshops had a smaller number of participants than the initial workshops and ran for about two hours. Participants were local growers and agronomists drawn from the membership of the organising grower group.

Strategy development

After the validations for the crop and site had been presented at the secondary workshops, agronomic issues nominated at the initial workshops were run using long-term climate data (120 years) and site-specific soil data. Not all issues could be addressed using the available models and this was discussed at the workshops. Participants in the secondary workshops set all the agronomic parameters such as plant densities, fertiliser rates, fertiliser timing and sowing windows used in each strategy. Simulations were presented to growers and agronomists as two to four page fact sheets depending upon the complexity of the strategy. Drafts of all fact sheets were presented at further workshops with four to eight participants and the fact sheets were refined for content and presentation style. Some first drafts required major re-working after group discussion and were referred back to growers, the grower groups or agronomists up to three times before release. It was important that the growers and agronomists were working as a team. All fact sheets were made accessible to growers and agronomists by publishing on the grower-group websites.

Results

Grower engagement

Growers and commercial agronomists willingly contributed in this research with some participants providing input at several workshops. Grower contributions provided both overall direction by identifying strategies and provided advice on some very pragmatic issues such as ensuring fact sheets could be read by all growers; some of whom were colour blind. On average, growers were actively involved in strategy development about every two months. This is far more intense than earlier Participatory Action Research with APSIM where growers were invited to workshops every six months (Carberry et al. 2002). The intensity of grower involvement has blurred the line between research team members and end users which is exactly what was intended.

Case studies

Simulated grain yields generated against the site-specific soil data accounted for 71% and 69% of the variation in observed wheat and barley grain yields, respectively, across the seven case studies conducted for each crop (Figure 1). This level of performance is similar to that achieved by the commercial variant of APSIM, Yield Prophet, across all sites in the five mainland States that were deemed to have appropriate soil characterisation in 2005 (r^2 = 0.68) (Hunt et al. 2006).

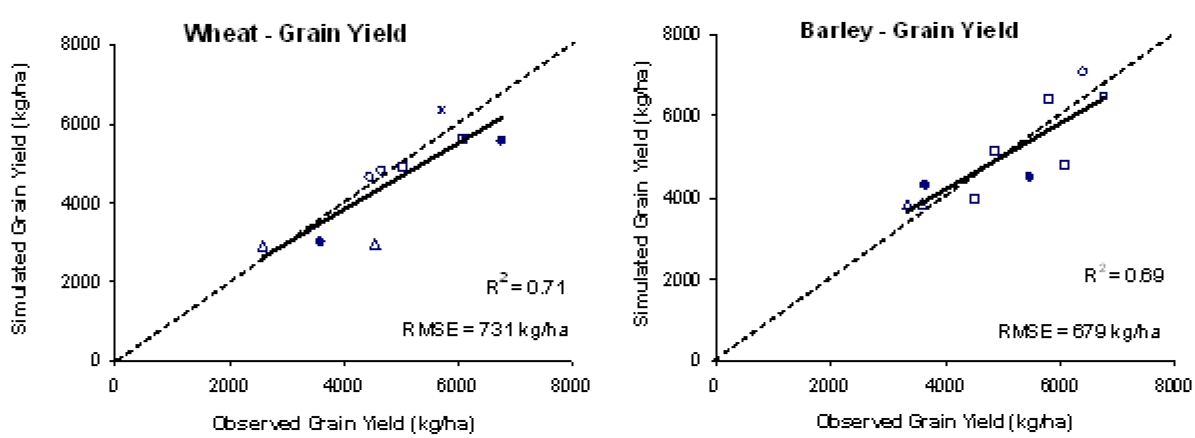

Figure 1. Observed data from the case-study sites verses simulated data for wheat and barley grain yield. Open triangles are for South Australian sites, closed circles are for Meredith, open

circles Mininera, stars are for Dunkeld and open squares are for Tasmanian sites. The dotted line represents the one to one line. RMSE is root mean squared error.

Localised decision-making tools

Several crop management strategies that could be simulated were nominated during the initial brainstorming. Some of the strategies were common to all three grower groups including a desire to better identify the best time of sowing. Although the general issue was the same across groups, related management decision differed between groups (Table 1). These local nuances sometimes made a considerable difference to which crop management strategies were feasible or profitable. The degree of customisation as a consequence of grower and industry involvement is what makes these strategies unique to the region. Even with intense input from local growers, the project does not make any specific recommendations as to which strategy is best. Rather, growers are given information that allows them to understand the risks involved in undertaking each option and manage their risks according to their own situation. The tangible outputs from this Participatory Action Research has been the production and circulation of a series of decision-making support tools in the form of locality based fact sheets developed from the case-study sites. Confidence in the fact sheets by industry is demonstrated through voluntarily distribution by agribusiness, grower groups posting the fact sheets on their websites and requests for fact sheets from growers outside the study region.

Table 1. Different underlying strategies agreed by each local growers' group for the same strategy, time of sowing wheat.

Grower group	Cultivar type	N fertiliser rate
Tasmania	long season only	non-limiting
Victoria	short, mid, long season	non-limiting
South Australia	short, mid, long season	maximum of 75 kg N/ha

Conclusion

Intensive grower involvement in the research process from project initiation can lead to the production of highly localised information suited to local grower interests, requirements and practices. Adoption of outputs from crop models by growers is improved by involving growers in the whole validation process including making judgement for themselves as to how well simulated matches observed data. At the majority of case-study sites, there was sufficient correlation between observed and simulated data to permit long-term simulations of crop management strategies to be explored. Customising each strategy to the soil, climate and related management strategies of the locality was essential to the outcome of each crop management strategy. There were distinct differences in optimal management for most case-study sites even though some were less than 100km apart. This Participatory Action Research has demonstrated that within the limitations of the modelling analyses, cropping systems models can be used in the high rainfall zone of south-eastern Australia to provide wheat and barley growers with information that will increases their ability to manage risk and increase their likelihood of producing highly productive and profitable crops.

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