Serious games to explore uncertainty of future farms

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Abstract
We produced an interactive farm game for use in workshops conducted with farmers, grower group staff, advisers and researchers. The workshops aimed to explore possible consequences of combinations of future management, land-use options and climatic factors in a no-risk, virtual manner. The game workshop was conducted with 52 participants at five locations across the wheatbelt of Western Australia. Seventy-four per cent of participants considered that the workshop helped them to consider options that would be useful on their farms. While acknowledging the simplifications inherent in a game, participants considered that much of the 'game-play' reflected their real decision-making. The opportunity to hear the decision-making of others, and to observe the effects, was of particular value. These findings illustrate the potential for the game-workshop approach to explore complexity in dimension, time and space and, particularly, to identify information needs for farmers in a specific region. They also highlight the decisions that would be made on farm in the absence of constraints of time, capital and logistics.

Key Words
serious games, farm management, climate change, Western Australia, adaptive strategy

Introduction
Estimating the impact of changes in a single factor, such as the level of an input, on the performance of an agricultural system can generally be achieved with reasonable confidence by applying some combination of empirical evidence, experience and modelling. However, estimating the likely impacts of several uncertain factors simultaneously (e.g. climate, season, technology and land-use options) is more problematic and less certain, particularly when attempting to estimate that impact into the future. Such estimates are usually attempted through the use of models, but these are usually limited to specialists. Games provide an excellent medium for the active communication of ideas and concepts in a participatory manner (Schelling 1961) and have been used in numerous contexts and sectors (e.g. Barab and Dede 2007, Dray *et al* 2007, Gee 2007, Mayer *et al* 2004). We produced an interactive farm game, utilising concepts from a scenario planning game (Fisher *et al* 2009) and participatory modelling (Barreteau *et al* 2003), for use in workshops with farmers, grower group staff, advisers and researchers. The workshops aimed to explore, in a no-risk, virtual manner, possible consequences of combinations of future management and land-use options, in the face of climate challenges and variable prices, on the profitability, sustainability and enterprise-mix of farm businesses. This paper reports the development of the game-workshop and results from workshops held at five locations across the WA wheatbelt. The degree to which the workshops fulfilled the aims, how the decision-making of 'players' in the game related to current practice and implications for decision-making are discussed.

Methods
The workshop
The workshop was designed for farmers and advisers to 'trial' combinations of future management and land-use options and to examine possible consequences of these in a no-risk, virtual manner. During the workshop the participants, working in teams of 2–3 players, made decisions to manage a virtual farm in the face of future seasons, using a suite of land-use and management options. 'Players' were provided with information about the cost of each option and expected returns or benefits. During the game information was provided about forecasts and weather to date as well as the changing prices of commodities. Over the course of the game several new technologies and management options were available to implement on-farm. At the end of each decision-making period and again at the end of each game year, players reviewed and discussed the consequences of their decisions on farm profitability and sustainability.
Farm game
The workshop featured an interactive farm game that was conceived and developed specifically for the purpose. The game comprised 12 virtual, 2 000 ha farms that were distributed around a fictitious district in a

4 x 4 grid that also included a town area and three areas of bush reserve of the same dimensions as each of the farms (Figure 1). Each farm had 10 equally sized paddocks that, for simplicity, each contained a single soil-type. There were four soils per farm distributed in a 4:4:1:1 ratio. The same maps were used for each workshop, but the names of the soils, and their attributes, were changed to broadly match local soil types.

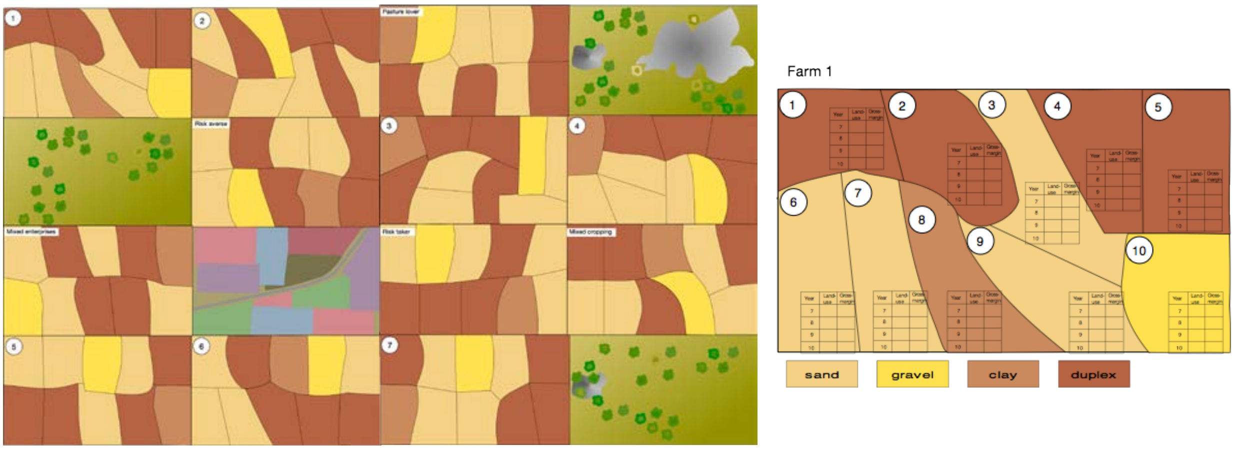

Figure 1. District map (left) showing bush reserve and town areas and farm map (right). Each team received a farm map that looked different, but had the same number of paddocks with the same distribution of soil types.

A simple spreadsheet model of key aspects of a mixed-farm in the wheatbelt of WA was developed specifically for the farm game-workshop. The model used baseline cereal (wheat) yields for each year as the basis of production. The remaining parameters used in the model (relative yields of crops, performance of livestock, impact of management options) represented best-bet, average values derived from publicly available research and extension information from Crop Updates papers, Fact Sheets, local or related trials and papers from the Australian Society of Agronomy. The costs were estimated from current costs or expected costs of future options, while the prices used were actual prices for years of the early 2000s, obtained from ABARES reports. The spreadsheet model was transferred into an agent-based simulation platform, using a publicly available software (Cormas, 2011), and this simulation model was used to calculate the gross margins for each paddock of each farm during the workshop.

Each game year was divided into six phases. The first five phases were player decision points, corresponding to the end of April, early May, late May, early June and late June to July. At each of these decision points, the teams decided what, if any, changes or additions they wished to make in the land use, input level and management of the enterprises on the paddocks of their farm. In each of these phases they were provided with information about the rainfall to date, seasonal forecast and current commodity prices. At the end of phase five, the players briefly reviewed and discussed each team's decisions for the year and the rationale behind them. The game year concluded with the final phase in which players were shown the weather for the remainder of the year and the final prices for commodities and then given a report that summarised the performance of each paddock within each of the farms in the game and the relative position of each team.

The five game years were identified by numbers only. Year 1, which was considered to be a year in the recent past, was used as a test year to familiarise the players with the game. The next four years, Years 7–10, were years in the future and were the actual game years. The five game years were selected from the historical record for each location. The years were chosen, within the limitations of having only five in total and four in the future, to match expected aspects of future weather (using the down-scaled runs from CSIRO climate models as a guide) and to present various climate challenges such as presence/absence of significant summer rain, variable break to season, wet harvest, frost and heat shock. The years 1972, 1982, 1985, 1914 and 1980 were selected. All of the years had annual and seasonal rainfall at or below the long-term average.

Assessment and feedback
Feedback from the participants was obtained in a number of ways. Following the end of decision-making in each game year (phase five), the groups were gathered around the district map to discuss the land-use and inputs on each of their paddocks. At the end of each turn, after each group received their report, key aspects of the results obtained were discussed.

Pre- and post-game questionnaires were collected from each participant. The pre-game questionnaire asked the participants about their expectations regarding the challenges posed by aspects of future climate and to rate how important they considered various farm adaptations (diversity of enterprises, diversity of crops, making the most of available moisture, manipulating inputs, range of sowing times and new technology/options) in managing future changes in climate. The post-game questionnaire asked participants about the workshop and the game, their experience of the game relative to reality and their impressions of likely changes to climate-related factors.

Results

Workshops were conducted at five locations in the WA wheatbelt (Wubin, Salmon Gums, Wickepin, Northam and Kojonup), representing a range of environments and annual rainfall. The workshops were attended by a total of 52 participants, 38 of whom were farmers. Seventy four per cent of participants answered that the game considered options that would be useful on their farms. The workshop and materials were generally well received with average responses (on a 1 (not at all) to 5 (highly) scale) of 3.7 for “objectives of the workshop were clear to me”, 4.2 for “the workshop materials were clear and well-produced”, 4.4 for “the farm game was enjoyable”, 3.9 for “the farm game was challenging” and 3.6 for “the workshop was useful for me”. Comments from participants (not presented) highlighted that the workshop was a useful means of discussing options, observing and discussing others’ decision making and exploring options, but also highlighted the limitations of a hypothetical, game approach.

Table 1. Participants average rating of the importance of various farm adaptive strategies in assisting them to manage future climate (pre-game), in maintaining profitability in the game (post-game) and in managing risk during the game (post-game). Ratings were from 1 (not important) to 5 (extremely important).

Adaptive strategy	Importance for:		
	manage future climate	maintain profitability	managing risk
Diversity of enterprises	4.1	3.7	4.0
Diversity of crops	3.9	3.9	4.1
Making the most of available moisture	4.6	4.4	4.2
Manipulating inputs	4.2	4.3	4.2
Range of sowing times	3.8	4.0	4.0
New technology/options	4.3	3.8	3.8

The participants’ rating of the importance of six farm adaptive strategies in assisting them to manage future climate (assessed pre-game) were the same as their rating of the importance of the six adaptations in maintaining profitability and in managing risk during the game (both assessed post-game) (Table 1). Before the game, participants were asked to assess, on a scale of 1 (greatly challenging) to 5 (not challenging), the expected challenge posed by (i) variability between seasons, (ii) amount of summer rain, (iii) timing of break of season and (iv) growing season rainfall in 2024 compared with the current situation. The average scores, for (i)–(iv) respectively were 2.1, 2.5, 2.3, and 1.9 (Figure 2). This assessment did not change after the workshop (average 2.2, 2.6, 2.3 and 2.1 respectively). Participants indicated a moderate confidence in their ability to manage these challenges, with no difference before and after the game (3.5±0.95 and 3.6±0.86).

These combined results indicate that the game was reflective of the current reality of the players, albeit at a greatly simplified level. The participants adopted new crops and management options more rapidly in the game than they do in reality as they were not limited by constraints of time, capital and logistics. Interestingly, the proportion of cropping by the players in the higher rainfall location tended to be greater than in reality and the proportion of livestock in the low and medium rainfall locations tended to be greater than in reality. While these findings are merely a reflection of the simple, artificial nature of a game compared with reality, they do point to the need to take account of these factors when considering how farming systems may adapt in future to challenges and opportunities presented by climate and other factors.

Conclusion

The results illustrate the potential for a game-workshop approach to explore complexity in dimension, time and space and, particularly, to identify information needs for farmers in a specific region. They also highlight the decisions that would be made on farm in the absence of constraints of time, capital and logistics.

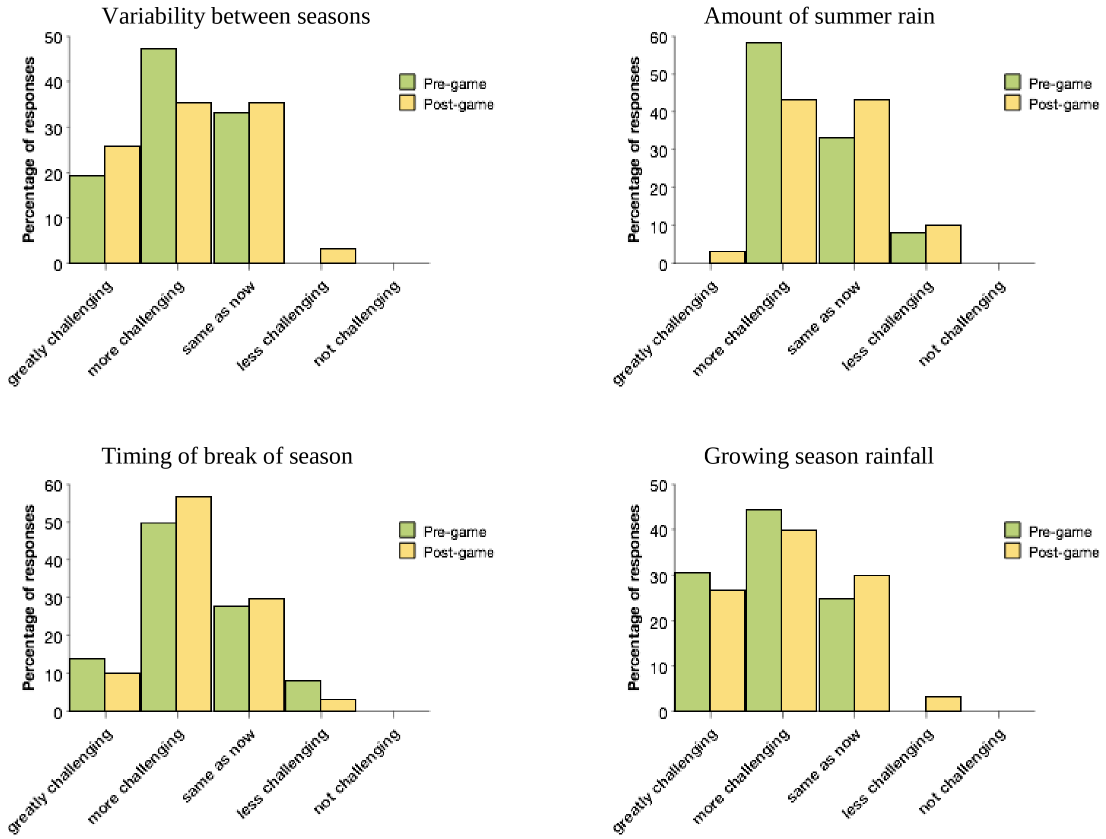

Figure 2. Participants' assessment of the degree of challenge expected to be posed by various aspects of the climate in 2024 compared with the current situation.

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