APSFARM: A whole farm systems analysis of economic and environmental indicators of contrasting farm business strategies in Central Queensland

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Abstract

So far existing tools and analyses of the viability of farm businesses have been solely based on the analysis of exposure to changes in climatic events, mostly rainfall, ignoring that what matters to farmers and rural communities is the impact of their decisions on household income and their long term sustainability. In this article we demonstrate some of the capabilities of APSFARM to support the farm business strategic decision making process.

Introduction

Many alternative technologies and management strategies are available to today's cropping farmers. These include choices such as crop mix, cropped land area, machinery, labour, etc. Changes in one component of the farm can cause changes in the performance, environmental impact, and profitability of the whole farm that are not obvious or easily understood when only single activities are analysed. To address this issue, we developed APSFARM: a whole farm business simulator capable of quantifying the trade-offs between profit, risk and environmental indicators for alternative tactical and strategic decisions across all farm enterprises. Here we describe and apply APSFARM to analyse profit risk trade offs of contrasting levels of "aggressiveness" in the decision making process of an opportunistic cropping farm business of Central Queensland.

Material and Methods

Case study: A farm manager from a farm business north of Emerald (Capella, Central Qld) was interviewed, and a complete description of the farm as well as of key farm-level and paddock-level management decisions were collected. Briefly, the farm business is a 2000ha no-till cropping system comprising three major soil types: a low plant available water capacity (PAWC) soil (120mm PAWC) in 20% of the land area; a medium (150mm PAWC) soil in 50% of the land area; and a high (180mm PAWC) soil in 30% of the land area. The farm was assumed to be divided into ten paddocks 200ha each. In this study, we only consider the farm's cropping enterprises, which constitutes 80-95% grain production including sorghum, wheat, chickpea and maize. In general 1/3 of the cropping area is dedicated to winter crops, though this usually decreases during wet years. Depending on soil water double cropping is considered though summer cropping is predominant.

The model: APSFARM is a multi-paddock dynamic simulation environment that uses the APSIM model (Keating et al., 2003) to simulate the opportunistic cropping system based on a number of farm level and paddock level criteria. Threshold values for these criteria were determined from the interview. Farm level criteria include: planting windows for each crop, definition of "break of the season" i.e. mm of rainfall, maximum area that could be planted to each crop (% of farm), and maximum work capacity (ha/d). Paddock level criteria include: minimum plant available water (PAW, mm) required to planting a crop, volumetric soil water content at 200mm depth required for a moisture-seeking planting, cropping history, soil type i.e. plant available water capacity (PAWC), and level of ground cover. Other inputs include commodity prices, production costs, available machinery, assets and farm debt level. Outputs from APSFARM include, production measures i.e. individual crop yields; economic measures i.e. crop and fallow costs, individual crop gross margin, farm annual operating return, and farm cash flow; efficiency measures i.e. whole farm water use efficiency; and environmental measures i.e. deep drainage, runoff, and erosion.

Sensitivity analysis: According to the farm manager, the level of “aggressiveness” of the decision making process (cropping intensity) can be best captured by varying the amount of stored soil water required before a particular crop can be planted. To evaluate changes in the “aggressiveness” of the decision maker on the trade-offs between profitability, risk and environmental impact, we performed a sensitivity analysis on PAW for a wet decade (1986-1995, annual median rainfall = 565mm), and for a dry decade (1996-2005, annual median rainfall = 442mm). The value of PAW provided by the farm manager for each crop was then increased and reduced by 10 or 20% to create the following simulation scenarios: very low cropping intensity (very low risk exposure VLR, +20%), low cropping intensity (low risk exposure LR, +10%), benchmark farmer risk level (current management), high cropping intensity (high risk exposure HR, -10%), and very high cropping intensity (very high risk exposure VHR, -20%).

Results

The simulated scenarios modified the farm cropping intensity from 82% (VLR) to 97% (VHR), and from 67% (VLR) to 83% (VHR) for the wet and dry decades, respectively. During the wetter decade farm profitability was higher and down side risk was similar than during the dryer decade (Fig. 1a). During the wetter decade the highly intensive cropping system strategy (VHR) had a higher cash flow - as we would expect during the better seasons. Conversely, during the drier decade the more intensive the system the lower its cash surplus (Fig 1a). The averaged results for the whole period under analysis are shown in Fig 1b. From comparing Fig 1a and 1b we concluded that modifying the cropping intensity would have little impact on farm performance unless a skilful, multi-season forecasts (e.g. decadal+) was available to guide the decision maker towards the best strategy to follow over the next few years.

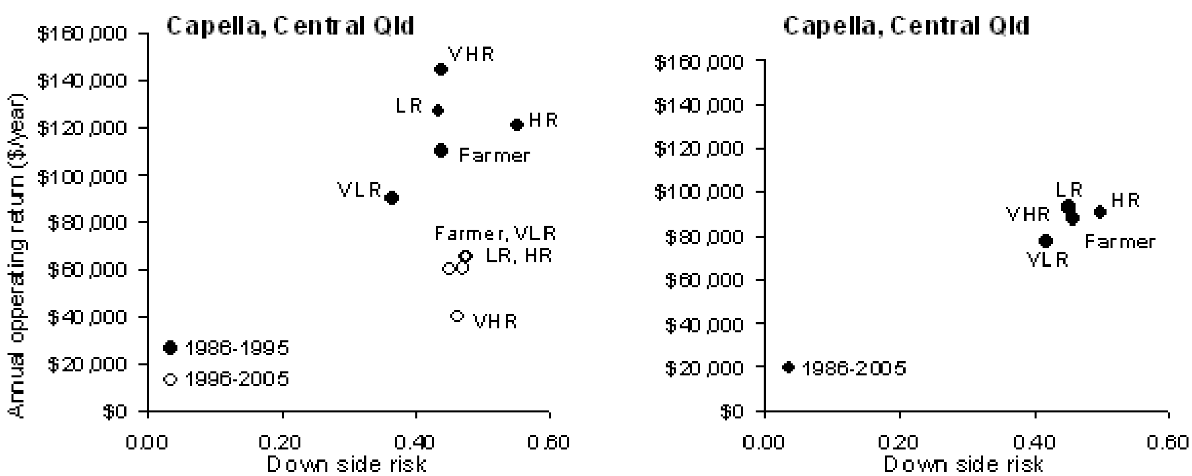

Fig. 1 Annual operating returns ($/year) versus down side risk, for (a) a wet (1986-1995), and dry (1996-2005) decade, and (b) the average results for the 1986-2005 period, under five levels of risk exposure or cropping intensity.

Conclusions

APSFARM can be used to better integrate farm business opportunities and design more profitable farm businesses, particularly when long-term climate variation is taken into account.

References

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