Review of whole-farm economic modelling for irrigation farming

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Abstract

The main objective of this paper is to review the progress that has been made in South Africa with respect to whole-farm economic modelling over the past 2 decades. Farming systems are complex and careful consideration to the stochastic dynamic nature of irrigation farming processes and their linkages with the larger water system is necessary when conducting whole-farm modelling. Both simulation and optimisation approaches to whole-farm modelling have been developed. Simulation is able to realistically model key performance indicators for decision-making while taking cognisance of the stochastic dynamic nature of irrigation agriculture. Normally only a few predefined scenarios are considered and these do not include decisions regarding allocation of water between competing farm uses of water. Optimisation models take the opportunity cost of water into account while optimising water use between multiple crops. Simplifications of the soil-crop-water subsystem are necessary to optimise agricultural water use between activities which are differentiated by crop, irrigation technology and soil at whole-farm level. Appropriate use of crop simulation models to provide input for mathematical programming models holds promise but needs to be weighed against the extra time needed to validate models and generate the required information. Research is necessary to determine the value of considering water as a stock resource compared to a situation where water use is optimised without considering water as a stock resource. Optimisation results indicated that it is profitable to irrigate larger areas with water saved from deficit irrigation and increasing irrigation efficiency. Relatively little research was done to demonstrate the externalities caused by irrigation farming under the current water policy. Future research should focus on developing integrated hydro-economic modelling frameworks that will incorporate irrigation externalities. Modelling decision-making by means of a single-attribute utility function is unsatisfactory and more research is necessary to improve understanding of the decision-making process to enhance whole-farm modelling frameworks that will assist farmers in making tactical decisions.

Keywords: whole-farm, irrigation farming, profitability, modelling, optimisation, simulation, hydrology