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FARMERS, ADVISERS AND RESEARCHERS LEARNING TOGETHER BETTER MANAGEMENT OF CROPS AND CROPLANDS

M.A. Foale[1], P.S. Carberry[2], R.L. McCown[3], M.E. Probert[4], J.P. Dimes[5], N.P. Dalgliesh[6], and D. Lack[7]

[1,2,3,6]Agricultural Production Systems Research Unit, Box 102, Toowoomba, Qld 4350.
[4]Agricultural Production Systems Research Unit, 306 Carmody Road, St Lucia, Qld 4067.
[5] Department of Primary Industries, POBox 102, Toowoomba, Qld 4350
[7]Department of Primary Industries, PO Box 251, Biloela, Qld 4715

Summary. Farmers in the northeastern sub-tropics of Australia must cope with very high climatic variability in order to succeed in crop production. Their capacity for innovation was tapped by means of an on-farm research project that brought farmers, advisers and researchers together on the Darling Downs and in central Queensland. The researchers added value to the farmers' own experiments on fertility and water use efficiency by soil and weather monitoring at specific sites and then using a simulation model of cropping systems to extend findings to a wider context of climate and soil. The advisers extended knowledge aquired from this experience via local farmer networks and have undertaken training in the use of simulation to support farmers' management decisions. The experience described opens up possibilities for developing new, cost-effective ways for devising and testing improved farm management.

INTRODUCTION

The Australian farmer has a well-developed capacity to learn from experience. This form of learning, so important to good farming generally, is especially challenging in the sub-tropical northeast region of the continent, where patterns in rainfall are extremely weak. Farmers who operate in such an environment have a natural inclination to test different options, in other words to do experiments on-farm. An opportunity was seen by a group of researchers to undertake research which combined the relevant focus of the farmer with the regional knowledge of the adviser and the capacity of the researcher to add value to observations that were made. The approach can be summarised by the use of three key words: *observation; explanation* (interpretation); and *calculation (*simulation). Observations and measurements are made on the soil, crop and weather relevant to the issue under investigation by the farmer. The data are then discussed by the participants in order to impart their respective insights into the performance of the system. The final step is to use appropriate data from the observations as inputs to test models of the production system in order to construct new understanding and to test alternative management by means of simulation.

This paper describes the experience of a research team from the Agricultural Production Systems Research Unit in collaborating with grain and cotton farmers and advisers in a three-year pilot project in Queensland.

MATERIALS AND METHODS

The project involved three groups of five to seven farmers, from Capella in the central Highlands, Banana in the Dawson Callide, and Dalby on the Darling Downs who were coopted into the project in 1992 with the assistance of local advisers. Most of the farmers were well-established in the district and had a reputation for energetic and innovative management. The process for establishing individual collaborations was described by Cox *et al*. (1).

Researchers agreed to support experiments on soil water and N that farmers wanted to conduct in their commercial paddocks. During the experiments the researchers monitored the soil, measured growth and yield of the crops, and recorded the weather. Meetings were held with the farmers and advisers to interpret the data generated on the soil, crop and weather and explore their implications beyond the present site and season using simulation modelling (2).

The groups were originally concerned with devising an optimal strategy for N fertilisation, to deal with the great variation of yield and grain protein level among seasons, and the possible role of legumes in the rotation. The early experiments were conducted on sorghum, cotton and wheat, but as the worst drought on record took hold of the region the emphasis shifted to managing limited opportunities to plant a crop. Mung bean, chickpea, maize and sunflower were included as a result of opportunities to plant these optional crops. A list of the districts and crops is shown in Table 1 which also indicates the number of plantings of each crop.

Table 1. Crops that were studied in the project, 1992 - 1995.

District	Crops
Capella (central Highlands)	sorghum (3), sunflower (3), wheat (2), and chickpea (1)
Banana (Dawson Callide)	mungbean(1), sunflower (1), sorghum (1), and maize (1)
Dalby (Darling Downs)	sorghum (7), cotton (5)

Observation

Soil cores were taken from four locations on each experimental strip (usually 6 m wide by 400 m long) which provided samples for the measurement of water and nitrate nitrogen. Concurrently with the experiment an area of land 4 m square was soaked with water for a period of weeks in order to fully saturate the soil profile enabling a measurement of the upper limit of water retention by the soil. The difference between that value and the water content of the soil when the crop had extracted water to the limit of its ability defined the capacity of the soil to hold plant-available water. This number became a very useful indicator for the participating farmers for comparison of paddocks and *country*, i.e. landscapes and soil types.

The performance of the crop, in terms of phenology and biomass accumulation was monitored at flowering and at maturity when grain (or lint) yield was also measured.. The weather was monitored at each site using an automatic weather station to log the output of instruments measuring rainfall, solar radiation and temperature.

Explanation

Both in the course of field sampling, and during the planned meetings for progress reporting, there were opportunities to discuss observations, causal relations, between soil water and crop growth for example, and implications for future management. The farmers indicated that they valued greatly information about the amount and distribution of water and nitrate nitrogen in the soil profile, an area in which their prior knowledge had been deficient. The only monitoring of soil that most farmers had done in the past involved probing with a rod to assess the depth of wet soil, and also the collection of surface samples for chemical tests. Such sampling usually had not included the deeper layers where our studies showed that nitrate often accumulates.

Observation of rooting depth also contributed to the explanation of the performance of crops, especially during seasons of low rainfall. Generally, to the surprise of the farmer, the root system was often found to be active in extracting water at a depth of 2.0 m in some soils.

Calculation

Upon completion of an experiment the scientists compared the yield calculated by the simulation model (3) with the measured result. It was generally found that the simulator made sense in relation to the field experience, leading the farmers and advisers to express confidence that the simulator was dealing satisfactorily with the critical inputs to the production system. This resulted in farmers and advisers wanting to interrogate the simulator about alternative management choices and natural resource inputs, giving rise to *what if* analysis and discussion (WIFAD) sessions. Some of the issues explored are listed in Table 2.

Table 2. Inputs and variables that were explored during the WIFAD sessions.

Management inputs	Natural resources
Alternative crops and cultivars	Soil texture and depth
Sowing date and planting rules	Amount and depth of stored soil water
Plant density	Rainfall
Tillage practice	Temperature and frost
Nitrogen fertiliser	Depth of nitrogen in the soil

Interest on the part of farmers in the simulation step of the collaboration was greatly enhanced by the model being specified for the farmer’s own paddock and choice of variety, combined with the rainfall data of the farm. The utility of the model was confirmed with the farmers and advisers as they saw simulation outputs that align with their own observations and experience.

RESULTS AND DISCUSSION

In this section we present an assessment of the reported influence that the on-farm experience had on the farmers, the advisers and the scientists.

In the WIFAD sessions, farmers were keen to explore the consequences of planting different crops, choosing different dates, and having different starting conditions with respect to soil water. In this sub-tropical climatic zone uncertainty about in-crop rainfall is high for summer crops and very high for winter crops. In the absence of timely soil sampling there is further uncertainty about how much water is stored in the soil. Farmers were particularly interested in exploring the likelihood of yield outcomes given different known amounts of stored water and nitrogen in different strips and paddocks on the farm. Some expressed the view that the WIFADs provided a useful type of *experience* with a range of management decisions without the risks and costs that accompanied their past experience. The simulations also enabled the farmers to appreciate better the nature and action of critical limitations to crop performance. Many farmers have now adopted soil monitoring at their own expense.

The advisers expressed great interest in the application of the simulator to describe the risk environment in a wider context than the individual farm. This embraced different crops, a range of different soil types and geographic locations, and different management, especially in relation to methods of tillage. Simulations were run for particular crop/soil scenarios using long-term weather data. The advisers also saw the model as a valuable means of educating others, such as a new adviser unfamiliar with a region, about the performance of crops in different local environments under different management options. Many advisers have asked to be trained in the application of this approach to system management, and many farmers have endorsed the idea that their advisers should have access to the tools used here by the researchers (P. Ridge, pers. commun.).

The advisers also proposed that simulation could be used in a bench-marking role to calculate the potential yield in a given cropping scenario to assist in recognising a limitation such as disease or nutrient deficiency, to assess the effectiveness of a pest management regime, and also to support an insurance claim for crop loss or damage.

The researchers learned a great deal, from this collaboration, about the practical aspects of decision making by the farmer, affected by so many other influences besides the bio-physical ones that experiments and simulations deal with. They noted that farmers would give credence to any information, whether generated by direct measurement of variables in the field or by simulation, provided only that the information made sense of their own experience.

In evaluating the impact of this collaborative activity on farmers J.Coutts (pers. commun.) found that they attached great value to the relationship with researchers generated by the collaboration, and to the measurement and explanation of soil variables. The participating advisers were especially interested in the capability of the simulator. Many other farmers also endorsed the idea that their advisers should be able to use the tools and procedures that the researchers introduced into the on-farm project, namely monitoring of soil and weather and simulation of crop performance.

This study has highlighted the value of good quality measurement of system inputs, which included especially the general properties and current state of the soil relating to water and nitrogen. When simulation results were presented to farmers who had not been involved in the on-farm project, they were generally quite prepared to consider them to be relevant if there was an opportunity to test simulations against their own knowledge and experience. A new project has been undertaken with GRDC support to develop a cost-effective methodology for the application of this approach to developing improved farm management.

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