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Some Recent Developments in the Role of Simulation Models in Farming Systems Research

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Farmers' views of modelling and decision support systems

Although agricultural scientists have been building simulation models for over 30 years, acceptance into the main stream of research has been slow in coming. However, in Australia, there appears to be a new willingness to fund research which depends on models. But it is clear that this new receptivity is fragile, and unless the high expectations for this research are met, this could change quickly. As indication of this, one need look no further than the recent results of a survey of farmers conducted by the Kondinin Group (Cook, P.1994).

When farmers were asked what areas of research were the most important, they ranked the activity that included modelling and decision support systems 20th in a list of 23. Since this study was conducted to help the GRDC set its funding priorities, this result is cause for concern on the part of researchers in this field. What explains this market perception, and how should researchers respond? The survey found that, nationally, only 4% had used a Decision Support System (DSS), while in Queensland, this was higher, at 14%. Farmers are renown for being quick to recognise value when they see it, and word spreads when something of value is discovered. That this has been happening only slowly in this R&D area is disappointing and perplexing, considering the considerable attention given to model-based DSS in the past 15 years and the number of products generated.

Exploration of a new role for modelling in farm management

The QDPI/CSIRO Agricultural Production Systems Research Unit was set up three years in advance of this survey, largely to develop DSSs. We started out with a conceptual framework which featured benefits to client managers in an R&D learning cycle (Figure 1) (McCown et al. 1992). We tended to view benefits as decision support products or special once-off analyses (Fig. 1, right). One major project set out to research the market, ie to interview decision makers and study their operations to gain a better understanding of how they manage and to identify niches for professional input (left). What would a successful information product look like? Our key technological resource in generating useful things was a cropping systems simulation capability (bottom of cycle). We also had a research philosophy that recognises the importance of working *with* clients, and especially on farms (centre of cycle).

For the past two years we have been working on the Darling Downs and in Central Queensland with farmers and advisers on farms (Cox et al (1993). Our *general aim* was to discover effective ways for professional researchers, farmers, and advisers to work together in learning how croplands can be better managed. One of the specific aims has been to elucidate the potential role of models in this.

Major features of this research include:

- Joint experiments on cropland management, especially with respect to soil water and N,
- Focus on soil monitoring,

- Use of models to flesh out the (necessarily) incomplete picture provided by field results (eg in what proportion of seasons will a fertiliser response documented in the experiment be experienced?),
- Farmers selected as belonging to an existing farmer groups, providing infrastructure for "extension",
- Close involvement from outset of the farmer's consultant/adviser (and convenor of associated farmer group), and
- What-if analyses and discussions (*WIfADs*) which build on collaborative research involving both monitoring and modelling.

The following table illustrates the kinds of management issues addressed. This work is with dryland cotton growers at Brookstead (between Millmerran and Pittsworth).

Farmer	**Issue being researched**
A	• N fertilisation strategy for dryland cotton • Performance of cotton versus sorghum • Fate of N fertiliser applied early
B	• Cotton performance on conventional vs zero-till fallows • Loss of soil moisture over a long dry fallow
C	• Required starting soil moisture to plant dryland cotton • Soil moisture storage under conventional vs zero-till

What have we learned about the potential role of modelling in such research on soil and crop management?

- Most relevant research on crop and soil management requires farmer involvement, and it has not been difficult find farmers keen to be participate in such research.
- Initially, farmer interest is in the monitoring side of the experimentation. (Even good farmers know surprisingly little about their soil and what is going on in it, and they realise this deficiency.)
- At the outset, after hearing the explanation of our vision of how the models would help in this joint venture, none of the 20 farmers (or their advisers) with which experiments were negotiated and planned expressed any interest in this aspect.
- The entry point for modelling has been curiosity in whether the model can actually simulate what we measured together in the field.
- Demonstration of predictive ability has proved to be necessary (and sufficient) to gain involvement of farmers and advisers in operational research with models (eg Table 1).
- The experiments serve mainly to (a) provide demonstration of the value of investing in better monitoring soil water and N and (b) provide data for running and testing models.
- Farmers and advisers value the WIfADs as a means of exploring rules of thumb (ie tactical planning tool).
- A wide range of cropland management issues can be presently addressed with models. Most of these issues are tactical, but rapidly-developing capabilities for simulating long-term soil degradational change will soon make it possible to look at strategies(eg for maintaining soil OM with pasture rotations).

- It is the capability for exploring "what -ifs" that is important, not our views about what farmers "should" do.
- An important aspect of the research is the learning experienced by the researcher, not just about the effects of management actions on soil and crop outputs a highly variable climate, but about the choices real farmers make under given conditions. Knowledge of the latter is valuable elsewhere, eg in realistically simulating system performance to assist policy analysis.

Is this decision support or something else, and does it have a future?

Ten years ago the term "decision support" to most in agricultural R&D implied software used by decision makers. But today there seems to be a more general usage that encompasses *anything* that is of value to a manager in making decisions, including software. In general, farmers involved in WIfADs are not making decisions, but are rather planning tactics and operations. In this climate, especially, most planning can be only conditional. In WIfADs farmers try out both their present rules of thumb and new ones. The experience is one that enables them to better face choices in the future in response to a wide range of possible conditions.

Although the professional researcher running the computer is not attempting to "push" messages, he is acting in the role of a consultant to the degree that he specifies the model to simulate the particular paddock and conditions of the farmer. His ability to do this is one of the features most appreciated in this approach. (Farmers readily recognise that with the model and the field data, the researcher knows more about the crop and paddock (is certain important respects) than he, the farmer, does without this information technology.)

There is a world-wide recognition that the ways in which professional research interfaces with farmers and advisers needs re-examining. The need for this is reinforced by the drastic reduction in public-funded extension. Although examination of the interface between researchers and policy analyists is also needed, contribution to policy will be enhanced by effective engagement of researchers with managers of farms. Our work indicates that networks of *relationships* and communication among researchers and producers/advisers may be more important in the near future than information products generated by researchers. New relationships and modes of communication are beginning to emerge.

Having established that initially-sceptical farmers can come to value models, one of the important outcomes of the on-farm research has been the interest shown by commercial consultants in our approach which uses modelling and monitoring together in addressing difficult issues. They want to explore the transfer of this RD&E capability to their organisations to enhance their consulting capabilities. Since consultants will be the major players in the extension of the future, a new project will soon feature training of consultants and adaptation of modelling software to meet consulting needs. This project will also explore other means of communication and means of involving more farmers in activities which involve models in this mode.

Conclusions

We asserted at the beginning that agricultural research which uses simulation models is experiencing a window of golden opportunity. What is needed in the way of performance to capitalise on this? Firstly, we must show that the objectives of certain important research (not all) are achieved more effectively and more efficiently with an approach which uses simulation modelling. This is clearly the case in crop and soil management research which is aimed to be relevant to real farming in climatically-variable locations. It is also the case where long-term soil changes are an important consequence of cropping.

Secondly, we must ensure that the outputs of different modelling efforts are convergent. This is very important to funding bodies. Meetings like this one can lead to alliances that minimise unnecessary diversity in modelling, eg joint ventures that capitalise on relative comparative advantages, co-design to ensure cross-compatibility of modules, etc.

Thirdly, modelling must be seen by our natural clients as a *bridge* between agricultural science and practical agricultural production rather than something that distracts scientists from real farm problems and issues. Although, extensive surveys of farmers indicate that the vast majority of farmers place research that involves models low in the priority list, we now know of a number of farmers and advisers who have discovered the value of models as tools for research and consulting, and it is changing the way they think and act.

There are of course other well-established applications for models in research. Just because farmers have been largely indifferent towards these doesn't necessarily detract from the their value. But, it is likely that continued support for these will be enhanced by getting in place modelling applications which farmers value. Enthusiasm of farmers for modelling is contagious.

Acknowledgements

Much of the success of this work has been due to the efforts of Mike Foale, Neal Dalgliesh, Peter Cox, Peter Ridge, Alan Garside and the farmers and advisers whose unflagging interest and energy continues to inspire us all.

The cotton model used in simulating the cotton yields presented in this paper is OZCOT, a product of the CSIRO Cotton Research Unit, Narrabri.

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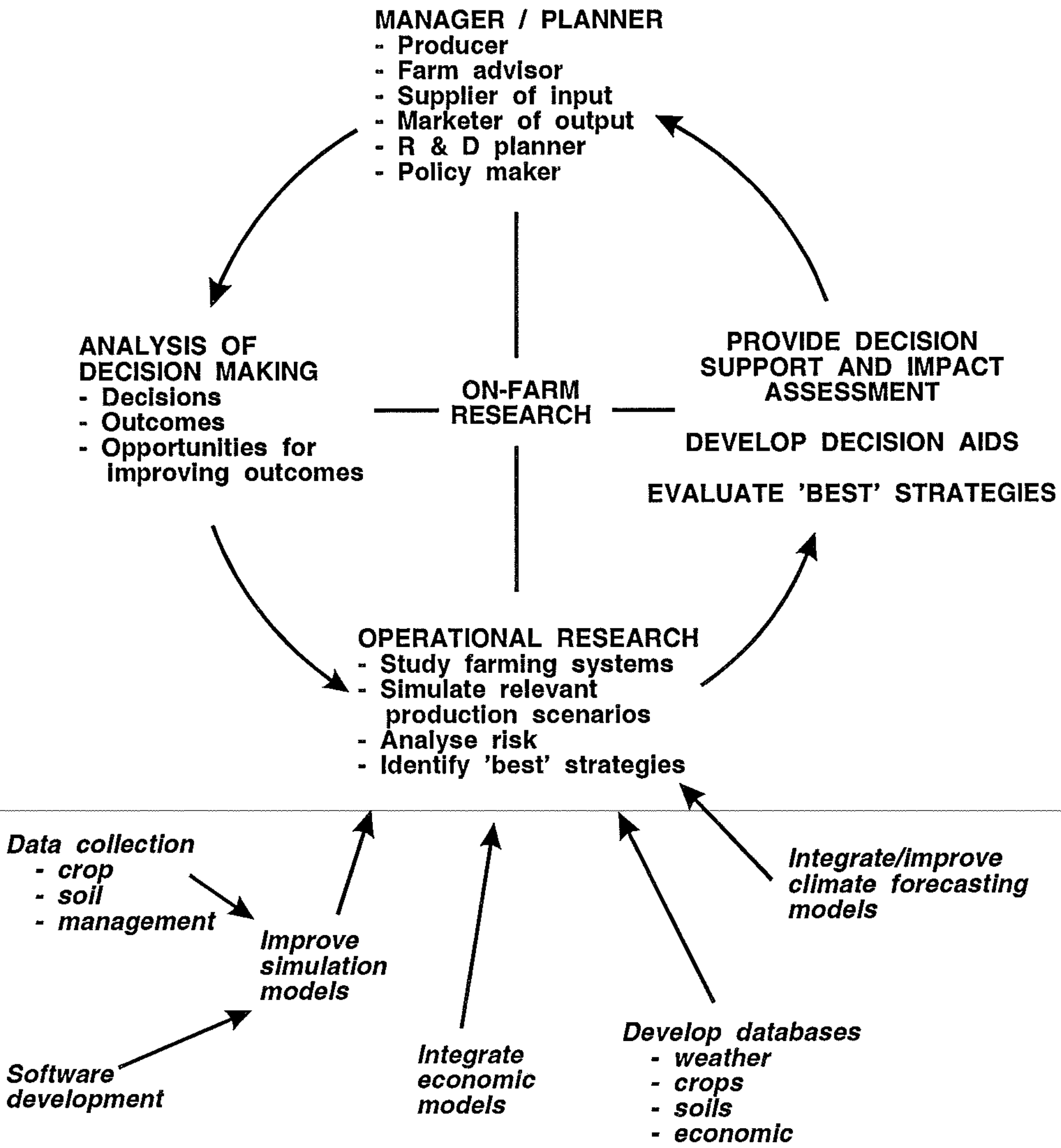
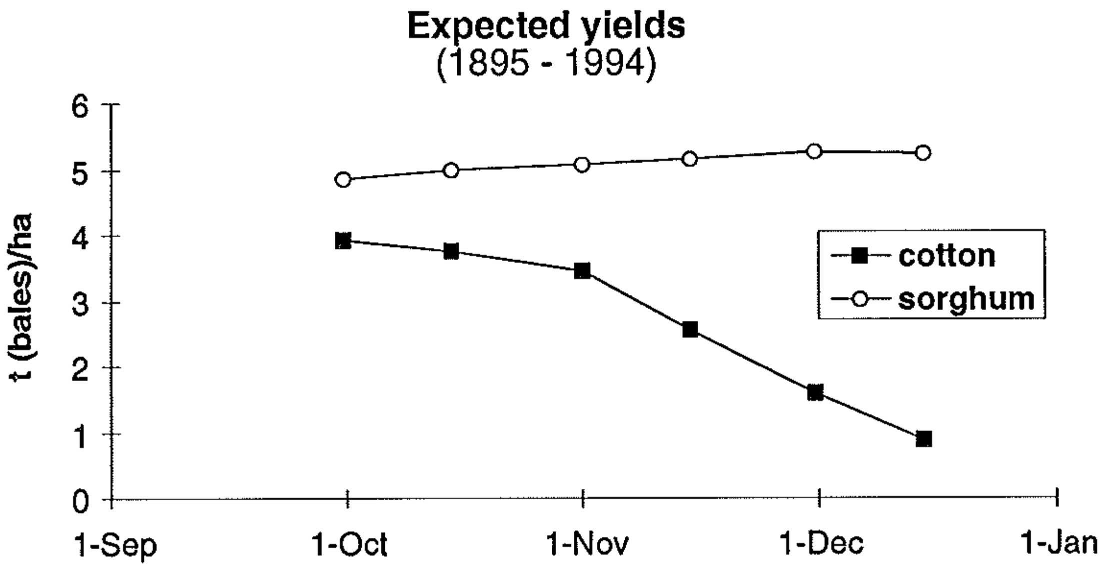
Table 1 - Performance of simulation models in relation to measured yields of commercial crops when initial soil conditions were well documented.

SORGHUM	Sow Date	Starting SW % Profile AWSC	Grain yield (14% moisture) t/ha observed	predicted
Crocker	15.9.93	5%	0.0	0.1
Fairweather	14.1.93	13%	0.4	0.4
Haeusler	24.9.92	46%	2.6	2.3
	30.11.92	48%	2.5	2.6
	14.12.93	48%	4.6	4.6
Town	30.11.92	62%	0.6	0.7
	14.10.93	47%	4.2	4.6
	20.12.93	97%	7.9	7.7
	11.02.94	100%	2.2	1.9
Walters	14.10.92	22%	0.0	0.8
COTTON			Cotton yield bales/ha	
Town	1.12.92	58%	2.0	2.0
	11.10.93	45%	4.0	3.7
Walters	14.10.92	48%	1.3	0.9
Skerman	1.12.92	52%	1.9	2.2
	28.9.93	45%	2.0	2.6
	10.11.93	80%	3.0	2.8

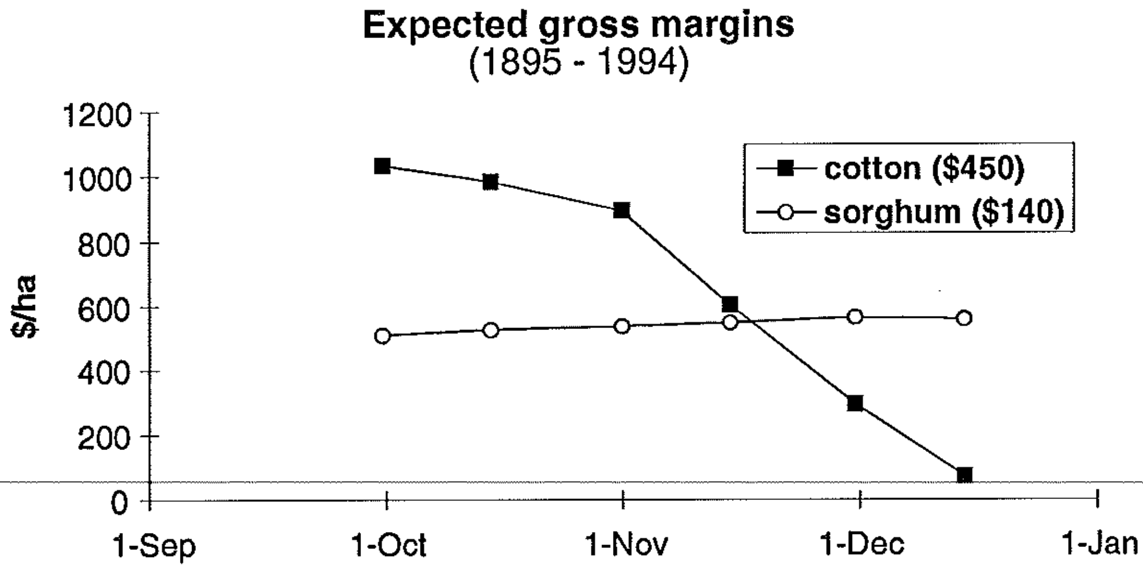


Framework for client-oriented R & D aimed at improving management of production and associated processes in an agricultural system.

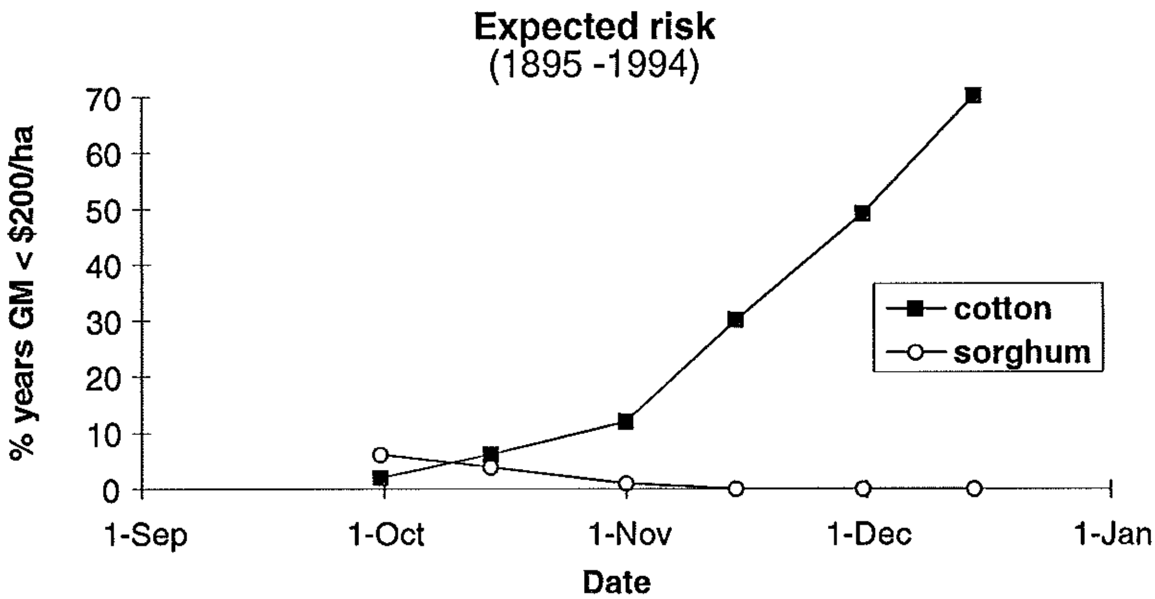
Fig 3



Expected yields
(1895 - 1994)
t (bales)/ha
0
1
2
3
4
5
6
1-Sep
1-Oct
1-Nov
1-Dec
1-Jan
cotton
sorghum



Expected gross margins
(1895 - 1994)
$/ha
0
200
400
600
800
1000
1200
1-Sep
1-Oct
1-Nov
1-Dec
1-Jan
cotton ($450)
sorghum ($140)



Expected risk
(1895 -1994)
% years GM < $200/ha
0
10
20
30
40
50
60
70
1-Sep
1-Oct
1-Nov
1-Dec
1-Jan
Date
cotton
sorghum

Fig 2

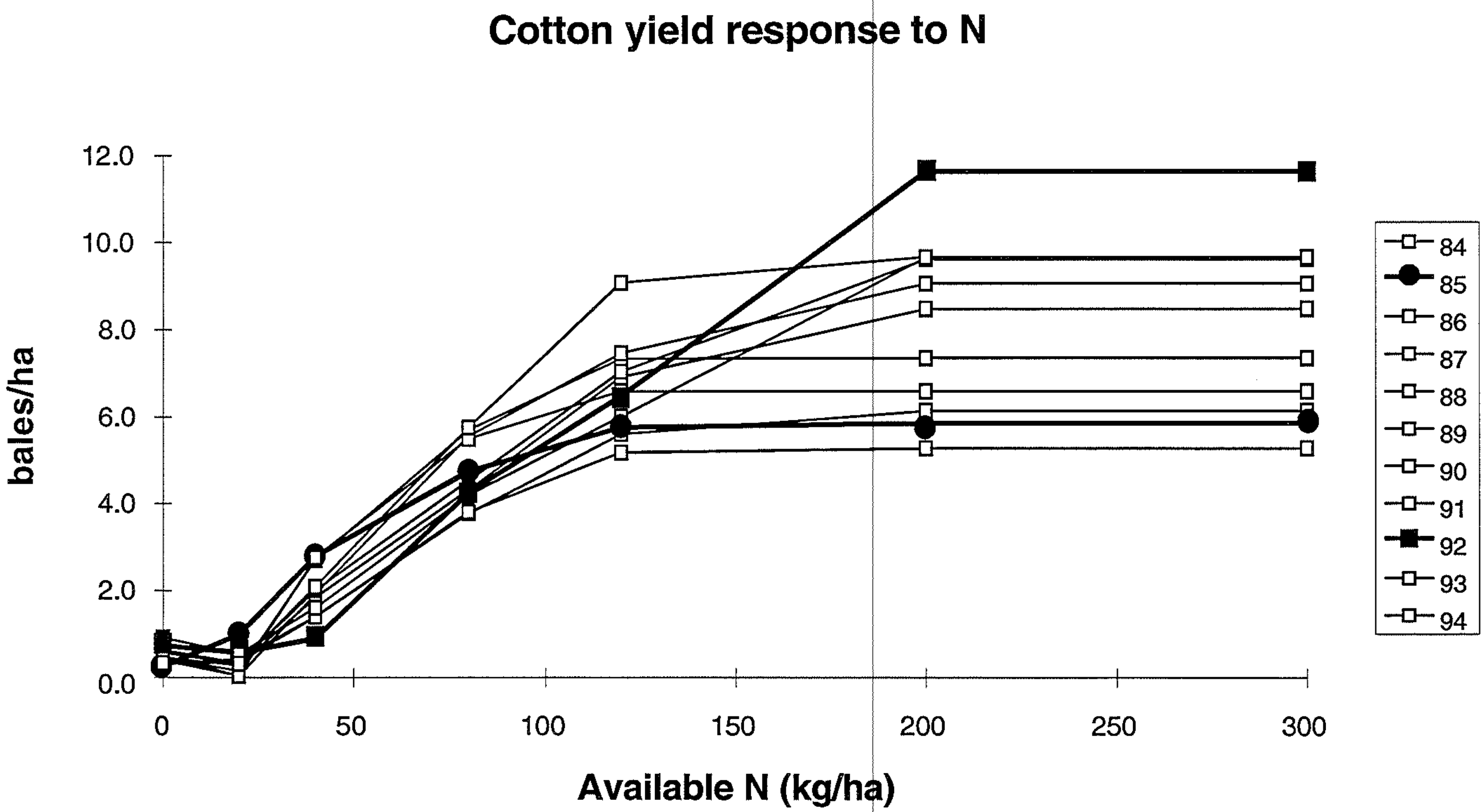
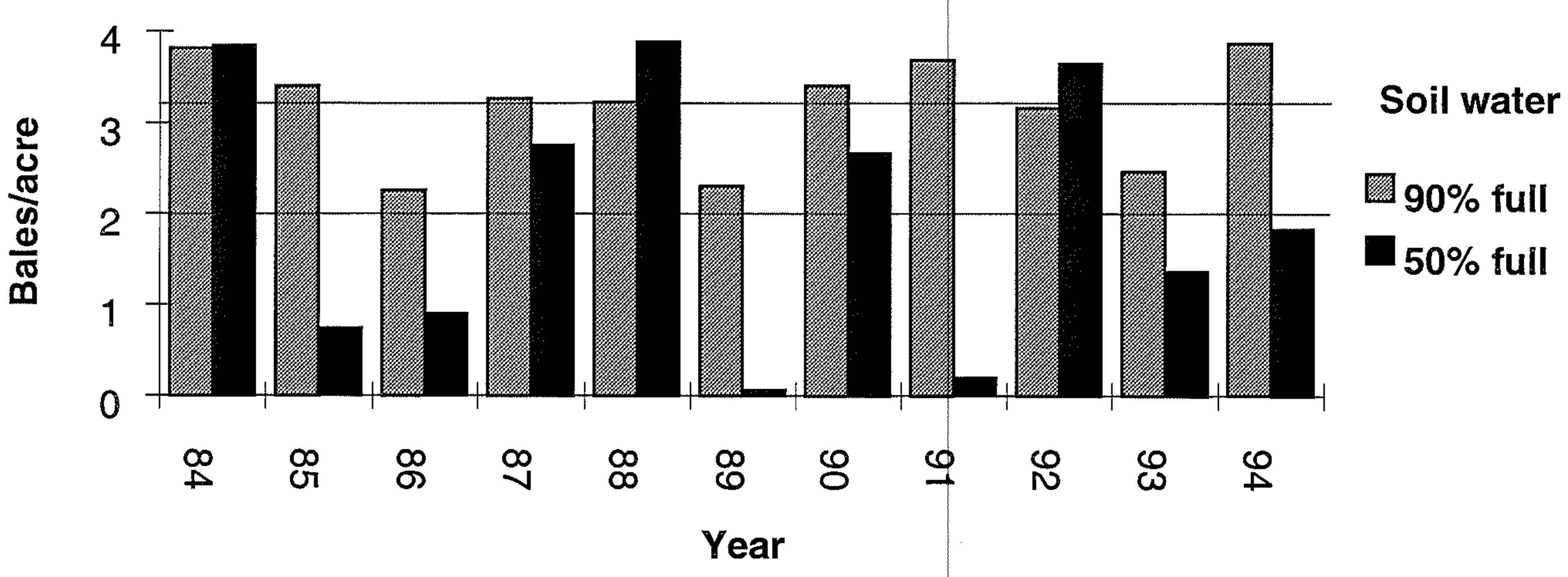

Cotton yield response to N
bales/ha
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0
50
100
150
200
250
300
Available N (kg/ha)
84
85
86
87
88
89
90
91
92
93
94

Fig 4

Cotton yields



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