The role of economics in Australian cotton research

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Very few economists are employed in Australian cotton research. Biological researchers often seem to believe that the job of economists is just to "put in the prices" after a new technology has been developed. Certainly, there is confusion amongst scientists about just what an economist does do, or can do. In this paper, I want to outline some of the areas where an expanded economic input into the Australian cotton research programme might be justified. This can be done under three headings: project selection/portfolio management; economic optimisation; technology design and research management.

project selection/ portfolio management

An important problem for the Cotton Research Council (CRC) is the selection of a portfolio of projects from those proposed, given a budget constraint. Of course, project proposals are self-selecting to some extent: a proposal is more likely to be submitted if it is perceived by the proposers to be acceptable to CRC and may be framed in such a way that these coincidences of purpose are highlighted. But there are several potential problems with this arrangement:

(1) the kinds of project submitted may depend on different people's perceptions of what is acceptable to CRC and the coincidence may not be very exact,

(2) there may be gaps in the research programme because proposals are drawn up without everybody knowing what everyone else is proposing, and

(3) radical departures from existing research practices may not even be proposed because adequate funding can be acquired under existing arrangements for "safe research". Unfortunately, these may be just the areas where the economic payoff to research investment will be greatest. For example, fifteen years ago cotton plant breeding in Australia might have seemed a long shot.

Active management of the portfolio of research projects requires an economic input since it is a resource allocation problem. An analysis of this problem is itself a project which CRC might fund. An economic analysis will depend on project proposals being framed in economic terms. This might involve historical analyses of comparable projects as well as continuous monitoring of currently funded ones. CSIRO has already started to think along these lines. But the attempt is made difficult because of traditional project accounting methods: looking back, it is hard to say which projects used how much of which resources because their allocation to specific projects was not documented. The analyst is forced to use standard costs, but much of the detail is lost. Of course, in real life we can not draw exact boundaries: there is such a thing as a "portfolio effect". Nevertheless, the benefits of a project such as SIRATAC are different from those of plant breeding if only because the technology is different. We should try to take these differences into account when deciding on a research portfolio.

Active management of the research portfolio should also help to identify new areas of research, or new ways of doing research, the relevance of which only becomes apparent when the research portfolio is viewed as a whole. This might well involve non-traditional projects, especially ones with a predominantly management science or economics or sociological perspective. Work we have done on the economic consequences of a projected loss of endosulfan for Australian cotton production (Cox, Forrester and Brook, 1990) is in line with this. Other research projects of a similar kind might include: the economics of the resistance management strategy (was it a good investment? why?); and the implications of the possible introduction of cotton-free buffer zones around urban centres (what is the nature of the tradeoff between the requirements of town people for clean air and the need of cotton growers to pollute it?). Many of these important questions are located in a grey zone where technology and economics overlap.

economic optimisation

Previous research into the biology of the cotton plant and its associated pests and diseases has generated several technical production models *e.g.* the fruit model and *Heliothis* feeding model used in SIRATAC. These can provide tools for policy research *e.g.* on optimal crop management practices. We have used the SIRATAC models to look at different ways of defining the thresholds for *Heliothis* (Cox, Marsden, Brook, Talpaz and Hearn, 1990).

Policy research might not produce a commercial product other than an inscription in a journal. However, optimising procedures can be incorporated into farm level decision support tools. We have demonstrated how linear programming can be used to help decide the best area of cotton to plant when water is limiting (Cox and Hearn, 1990). In this form, the problem is almost trivial. But the approach can be readily expanded to include decisions to stop irrigating during the growing season (because water is even more short than expected), or the choice between cotton and other crops in a mixed farming situation.

In some cases, a formal optimising algorithm might not be necessary in order to get a grip on a problem. The cost of harvest delay is one such case: we have used a simple simulation model to structure this problem (Cox and Thomson, 1989; Cox, 1990). An important point which emerges is the variability of weather, which growers know all about anyway (Cox, Wells and Thomson, 1990). But, in spite of appearances, it is not the case that economics is just a branch of meteorology!

These different approaches to problem structure have different implications for commercialisation of decision-support software. Often, a simulation model will be self-contained. Optimisation models will commonly use off-the-shelf products. The design of appropriate marketing arrangements is another area where an economics input might be useful.

technology design and research management

Much modern agricultural research is multi-disciplinary and inter-disciplinary. Economics can contribute to this dialogue (some would say cacophony!). Its importance lies in the fact that it is not (yet?) a science. This may seem odd. Plant pathology, for example, does not concern itself with why it is not yet a social science. Economics provides a complementary research paradigm (different conceptual models, a different set of assumptions) to that provided by the experimental sciences. Neither one nor the other is correct in any absolute sense, although both can contribute in different ways towards the solution of the common problem of manufacturing knowledge. This can cause conflict, as I know to my cost, but the conflict can be creative.

In this context, economics shades into sociology, psychology and anthropology. Its input might be a social analysis of soil erosion (would a biologist think of looking at the problem like this?) or a cognitive analysis of reasoning bias (amongst growers or researchers?). The involvement of economics in agricultural research in this way has come to be known in recent years as Farming Systems Research (FSR). FSR is a procedure for technology generation. It is multi-disciplinary (which means that the inclusion of economists is compulsory!) and tries to take a holistic view of the farm and the constraints on its productivity. It has evolved an elaborate set of survey procedures which may not be entirely appropriate to Australian conditions ("Cotton growers have been surveyed out!"). On the other hand, the emphasis of FSR on continual contact between researchers and growers in the process of technology development, and its focus on problem-solving research, is salutary.

Some researchers argue that FSR is appropriate in developing countries, where there is a significant cultural gap between the expatriate researcher and his clients, but not in Australia. As an expatriate researcher myself, I feel that the more

significant cultural gap is between the mores of research and those of practical farming, and that this is largely independent of the nationality of the participants. A social science input in the research programme might help to bridge that gap. Economics might not be the best disciplinary background for this (rural sociology or social psychology could be better). But it seems likely that biological researchers have more in common with economists than with sociologists or psychologists, and that this might help to contain the inevitable disciplinary conflict.

Expert systems are a hotbed for generating this kind of debate. SIRATAC is a kind of expert system: it makes recommendations for pest management on the basis of information supplied by a grower and rules developed by researchers. But users commonly have only a limited ability to edit the rule base *e.g.* by adjusting the action thresholds to levels which *they* believe to be more appropriate. Expert system tools may be the latest in high technology, but the implementation often looks old-fashioned from the point of view of FSR. Although not a panacea, an economics input may help to correct this.

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