SUBMISSION TO THE PRODUCTIVITY COMMISSION'S PUBLIC INQUIRY INTO THE RURAL R&D CORPORATIONS

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This is a private submission that is concerned mainly with the changing nature of innovation in modern agriculture and the implications of this change for the role that the Rural R&D Corporations play. It is based on my experience in agricultural R&D and its fruitfulness (or not) over 40 years, including leading a program on Crop Adaptation in CSIRO Plant Industry for 15 years, being Deputy Chairman of the Southern Regional Panel of the GRDC for 6 years, and subsequently doing consulting work for GRDC, FAO, and International Agricultural Research Centers.

The following remarks apply to the grains industry, for that is the one with which I am most familiar, but I believe the principles apply to all agricultural R&D.

In summary:

1. The role of agricultural R&D is shifting from solving specific problems towards providing management options for farmers to choose among in dealing with their increasingly volatile and complex operating environments.
2. New options are being developed through close interactions between farmers (with their advisors) and agricultural scientists; on-farm realism is applied in parallel with the development, rather than in series.
3. New options increase the resilience of farming and thence of rural Australia. As the uncertain future unfolds, such options may be used now, or in 20 or more years time if circumstances change. Their beneficiaries cross generations. Their development therefore merits government support.
4. Radical new options depend on new mechanistic understanding that has implications for plants growing in the field.
5. Much laboratory research that is counted as agricultural R&D and is largely supported from government funds fails the test of utility or even the promise of utility, for it often deals with laboratory artefacts which preclude it from giving deeper insights into the behaviour of field-grown plants. The Rural RDCs have an important role in adding value to such laboratory research by exposing it to the scrutiny of crop and pasture physiologists.

The changing nature of agricultural innovation

There is a widespread view that the role of agricultural scientists is to respond to agricultural problems by producing solutions which are then delivered to farmers. It is essentially a one-way model, as is reflected by the predominantly linear language in current use (e.g. "technology transfer", "extension", "delivering outcomes"). It is a view that was certainly valid in the past. It was, for example, consistent with the discovery of trace element deficiencies and the "sub and super" revolution 50 years ago, the adoption of which was facilitated by some excellent state-funded extension services. It remains largely (but not entirely) true of breeding activities (for example, the requirement to keep on breeding for resistance to evolving diseases) but it applies much less now to innovation in overall farm management.

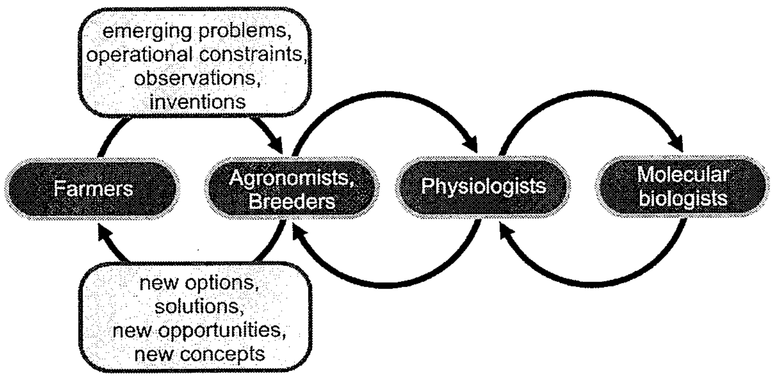
What are the main changes that have come about that enrich the one-way model?

(1) Farming requires much more skill now than it did a few decades ago. There is a much greater range of options to choose among: sequence of crops, cultivar, and a wide range of management practices relating to judicious timing of operations – including tillage, application of fertilizers, and control of weeds, pests and diseases. Add to this list: OHS and general environmental issues, marketing, sophisticated financial management (including hedging), on-farm storage, and so on.

(2) The demise of the state-funded extension services, coupled with the increased complexity, has resulted in the demand for private advisors/consultants, ranging from specialists in, say, financial planning, to generalists skilled in advising on whole-of-farm management.

(3) there has been an increasingly close connection, well fostered by the GRDC, between the advisors and the agricultural R&D community.

The GRDC has, for many years, run annual Advisor Updates which bring together advisors and agricultural (mostly field) scientists. These Updates are held at several venues around the country and attract many hundreds of advisors. The rationale for this is that the advisors represent perhaps dozens of clients each, and so new R&D information can be disseminated widely. However, the advisors are not passive consumers of information. They integrate the collective experience of their clients and thereby discern emerging problems and new opportunities that may merit new directions of research. The movement of information at these updates is by no means one way – rather there are mutually insightful conversations whose nature is summarised by the boxes above and below the main axis in the following figure (in which add "advisors" and "farmer groups" to the box labelled "farmers"). (Similar interactions are implied by the rest of the figure to the right of "agronomists, breeders", as discussed later.)



The development of groups of farmers (e.g. Birchip Cropping Group) who share their experiences and sometimes employ their own scientists, add to the richness of these conversations, which ensure that the scaling up of ideas being explored in experimental plots proceeds continuously and thereby minimises the impact of pitfalls in that process.

A portfolio of options

In contrast to a few decades ago, the main problems that farmers now face are predominantly multiple and interacting, and there is a much more tactical approach to farm management – that is, operations may be tuned to current conditions and opportunities as a new growing season develops. Indeed, operations in previous seasons are often geared to foster flexibility in the current season. The most effective farmers, with the help of their advisors, choose among a portfolio of available options in dealing with these problems.

These characteristics have been strongly evident in the recent run of droughts. While these droughts have caused much hardship, it is nevertheless clear that productivity of crops during this time has been much greater than it would have been 30 years ago. The most effective farmers have adapted rapidly. Their ability to do so has in large part been enabled by the widespread adoption of minimum or zero tillage which allows much more flexibility in the timing of sowing. Thus, to give one example, if they have ensured that any substantial summer rain (of which there has been some) is effectively stored in the subsoil for use by the following crop, they can sow immediately after any moderate fall of rain early in the season, if they deem that the prospects are good that the seed will germinate and the roots will reach the water in the subsoil. This option would not have been available 30 years ago. Indeed, many farmers have taken the risk of sowing into dry soil during these drought years, a technique that often gave them much better yields than those who waited for rain.

An example of a new option under development is the use wheat and canola varieties that can be sown early and grazed down to the ground during the winter (when feed is typically in short supply) without seriously reducing the eventual grain yield and sometimes, surprisingly, increasing that yield. This option has many implications, not least that it can contribute to integrated weed management if herbicide-resistant weeds are present.

Resilience

A major challenge before Australia heading into an uncertain future is to maintain a resilient agriculture, and, with the help of that, resilient rural communities. The examples in the previous section are intended to illustrate how farmers can choose among options to deal effectively and productively with their current circumstances. The implication is that future resilience will depend on agricultural R&D increasing the portfolio of useful options. Many of these options may be "sleepers" for many years. The use of dry sowing, mentioned above, is a case in point. The toughness of dry-sown seeds was known decades ago, and this old knowledge was mobilised to give the farmers the confidence to take the risk. But we do not know in advance which new options will be sleepers and which will be taken up rapidly.

Thus, I believe that an important role of the Rural RDCs is to foster the development of new options, not only of agronomic techniques but also novel cultivars (such as those that can withstand grazing as in the earlier example). The beneficiaries of such options will in only part be farmers who currently pay their levies. Given the uncertainties about new options in relation to an uncertain future, future farmers will also be beneficiaries. I believe that the development of such options is as much a public good as a private one, and that the government contribution is essential to maintain the focus of the RDCs on the longer term.

I also believe that much government funding is spent, in the name of agricultural R&D, on laboratory research directed at mechanistic understanding that is often impossible to scale up to elucidate the behaviour of plants growing in the field. The argument runs as follows:

Scaling up of laboratory research to fruitful application in the field

Developing radical new options will depend on new mechanistic understanding that has implications for plants that are growing in the field. Much of this new understanding will come out of controlled experiments in laboratories. Unfortunately, much laboratory research that is counted as agricultural R&D and is largely supported from government funds (e.g. via the Australian Research Council and Cooperative Research Centres) fails the test of utility or even the promise of utility, for it often deals with laboratory artefacts which preclude it from giving deeper insights into the behaviour of field-grown plants. This is not to argue that such research lacks intrinsic interest, but if it does seriously aim at eventually being agriculturally useful, its practitioners need to be aware of the difficulties involved in scaling up to real environments. If it does not so aim, then it should be excluded from the statistics of Australian expenditure on agricultural R&D. The Rural RDCs have an important role in adding value to such laboratory research by exposing it to the scrutiny of crop and pasture physiologists, as a halfway step to engaging the interests of breeders and agronomists, an essential requirement for eventually utilising that research on farms.

Here is a global example of what I mean: there has been much interest by lab scientists in searching for "drought resistance" in crops. Interrogating the Patent Lens data base: http://www.patentlens.net/patentlens/structured.html with ((drought NEAR/2 resistance OR drought NEAR/2 tolerance) AND plant NEAR/2 breeding AND transgenic in fulltext) generates 6000 hits. This number reduces to 650 if "fulltext" is replaced by "claims", but it is nevertheless evident that there has been huge investment in this general area – with the legal fees alone likely to be of the order of $300M. Yet, to my knowledge, no cultivar has yet been released based on any of these patents (though Monsanto claim to be close to doing so with experimental transgenic maize hybrids that yield modestly higher (about 10%) during droughts).

This type of research has come to be known as "pre-breeding", for its aim is to create novel germplasm that is of interest to plant breeders. On the topic of abiotic stress (drought, salinity, waterlogging etc.), Australia spends about as much on pre-breeding as on breeding of wheat and barley. There is concern that little of this substantial effort has resulted in new varieties, and in consequence a national Pre-Breeding Alliance has been established (http://www.grdc.com.au/director/events/grdcpublications/prebreedingalliance.cfm.)

A major difficulty is that there has not been a well-developed procedure for scaling-up from laboratory to field, an issue that was explored in a recent GRDC workshop, held under the banner of the Pre-Breeding Alliance, which brought together agronomists, breeders, and a range of pre-breeders from molecular biologists to crop physiologists. This workshop eventually led to the GRDC setting up dedicated field sites for exploring and expediting the introduction of novel traits into advanced breeding lines in realistic environments. This is a major initiative which will greatly help solve the generic problem of inadequate scaling up.

Concluding comments

I believe that the arguments I have put on the changing nature of agricultural innovation imply that the government contributions to the Rural RDCs have an even more important role in the next decade than they have had in the past. They will be essential for creating the wide range of novel cultivars and agronomic techniques that will be needed to ensure that farming remains as resilient as it has been.

Furthermore, I see a hugely important role for the RDCs in adding value to the existing large government expenditure on laboratory-based agricultural R&D. Dialogues between agricultural scientists working at different scales (molecular genetics, biochemistry, physiology, and so on) are as important as wellsprings of innovation as those between farmers and scientists. They are however much rarer. The challenge is to create R&D communities, of which farmers and their advisors are an essential part, in which the informal dialogues that stimulate sensible scaling up can be fostered across all scales from molecular genetics to farms.

The notion of the value-chain is well recognised beyond the farm gate. It is of equal importance in fostering innovation before the farm gate. No current institutions in Australia are better placed than the Rural RDCs for creating the appropriate communities. To do so they need to be supported by substantial contributions from the government – that is, if the government wishes to extract much more value than it currently is from its existing investments in laboratory-based agricultural research.