From the drawing board to the field

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1. Introduction

In the context of the theme for this conference, "science" includes the physical, social and economic disciplines.

The contribution made by science to the improvement of agricultural productivity in Australia has been most impressive. However, it should be recognised that science alone cannot claim all the credit for the tremendous increases in production and efficiency during the past century.

A stringent economic environment characterised by reliance on fluctuating world prices for our major agricultural products, token support from Government by way of cost/price subsidies, a highly protected secondary industry and high wages, has resulted in a generally long-term negative terms of trade trend in agriculture, particularly for the crop industries. This trend has accelerated in recent years and is likely to worsen, at least in the short to medium term future, as costs continue to escalate and grain prices stagnate. In response to lower marginal returns per unit of capital resource, farmers have been forced to restructure to take advantage of the economies of size and many families have left agriculture, especially during the last 50 years. Rapid industrialisation and a small population in relation to our substantial natural resources have enabled this readjustment to occur fairly painlessly. At the same time the remaining farmers have taken up the prolific technological advances made by science allowing most of them to remain viable.

The scientific developments in Australian agriculture and the capacity of the industry as a whole to adapt to its economic master are held in high regard internationally by aid agencies, and we are admired for our ability to utilise our semi-arid environment for viable extensive crop and livestock production.

2. The challenge

Impressive though the scientific record is in Australian agriculture, the maximum potential exploitation of our physical and economic environment has still to be achieved. The scientists continue to refine technology and attain occasional 'break-throughs', while the gap between knowledge and practice is still very wide, with notable exceptions, despite the economic pressure on farmers to improve productivity.

The reasons for this lag time between scientific development and farmer practice are several:

- The well-known distribution curve of farmer technology adoption
- rate applies as much to an advanced agricultural sector as to a subsistence-based peasant agriculture; there are a few innovative entrepreneurs and a mass of conservative followers who adopt more slowly.
- Research and extension programmes have tended to rely on seat-of-the pants assessment of priorities, and were sometimes unduly influenced by farmers' perception of their wants rather than objective analyses in terms
- of costs:benefits, and so some production oriented packages were not entirely relevant at the time.
- While simple, low-cost obviously beneficial technologies may require little promotion and be taken up generally fairly quickly, the more complex advances need further screening and interpretation coupled with intensive extension support to meet individual farmer requirements before their impact is significant.
- Financing and organisation of research has tended to be industry

- oriented when a farming systems approach using multi-disciplinary resources would be more appropriate,.
- Extension service personnel have tended to be specialists and therefore unable to provide fully integrated, production systems advice. The effectiveness of the generalists might also be questioned!
- A low officer-to-farm ratio and the confidentiality of farm financial data generally restrict the extension service ability to provide personal advice and to fully accommodate the socio-economic context of their advice.
- Many applied research programmes were and still are conceived in physical terms alone without evaluation in an economic framework.
- Advice by commercial sector agencies is not always as objective as it should be leading to anti-economic decisions by farmers.

The challenge then is, in essence, I believe, how to improve the adoption rate of the more complex, significant advances. Not only is this necessary for the economic well being of the country which is already suffering balance of payments problems, but more importantly it is necessary to help offset declining viability of agriculture and hence the livelihood of many farm families. Unless Dr. Cockcroft contradicts me, I believe we have recognised and adopted most of the easy practices; the 'too-hard' basket must be opened wider, divulged and made palatable. Recrimination over past weaknesses will achieve little and indeed they are generally acknowledged and are being corrected.

The basic constraint to rapid adoption of technology is the size of the disinterested, resistant mass of followers. There are so many who are slow to motivate, slow to comprehend and slow to activate, that only a massive allocation of skilled resources in facilities and personnel will speed up the application of difficult advances. The poor and conservative of this world are a very costly sector to motivate to help themselves in Australia as in Asia or Africa. Is there a solution?

3. Meeting the challenge

If the answer were simple it would have been implemented long ago. Clearly it depends on how the community as a whole values improved agricultural output for the sake of the economy or for the welfare of individual farm families (these objectives can be conflicting) in relation to resource availability and other competing needs. The short answer is that we probably have to accept the present public resource allocation as representative of community values, despite its inadequacies, and recognise that the more sophisticated technology will be adopted only slowly. But, perhaps it can be helped along.

As generally agreed it is the innovative, managerially more competent entrepreneurial farmer who takes up scientific advances quickest. Since farmers in this group tend to operate larger farm businesses they have an impact on agricultural production far out of proportion to their relatively small number. Given that economic rather than social objectives have priority for resource allocation, it follows that research and extension effort directed to the innovative farm sector has a more favourable benefit:cost return than if aimed at the smaller farmer.

Although the simple, obviously beneficial technologies are understood and adopted by farmers without much intervention from a middle person, many new developments require interpretation and sieving before they are palatable enough for acceptance and practical application. Advances in basic scientific knowledge first need applied investigation and then these results usually require further refinement and modification for specific application at the farm level. Here environmental factors: soil, climate, topography, vegetation; economic aspects such as prices and costs; financial components including cash availability; and, above all, the social environment: farmer aspiration, attitude to risk, managerial capability and innovativeness, must be identified, quantified to the extent possible and given due weight when practical recommendations are being formulated and extended.

The amount of evaluation and sieving of research results, especially physical data, for field application depends on their complexity and the target group; regional advice requires rather less interpolation than that needed for individual farm consumption. The two main pre-digestive assessments of potentially useful technology involve economic analyses to determine the possible benefit to the farmer user, and the social framework of the farm to evaluate the "degree of difficulty" of applying the technology. To help the adviser to make these evaluations, the technology should be presented in a form which allows it to be considered through a range of options so that sub-optimal as well as optimum solutions can be provided for the farmers' decisions; not all farmers can afford or want optimum productivity. Thus the data should be made available as production functions, where appropriate, rather than as single (maximum) outputs. Likewise the input structure of the technology is necessary so that productivity relationships can be determined.

Figure 1 illustrates how the production function, when expressed in economic terms, can be used to offer a variety of solutions to the farmer. 0 is the point on the production function at which the marginal cost equals the marginal return. It is also the maximum gross margin. Since optimum investment opportunities available to the farmer with (usually) financial constraints do not allow such complete utilisation of farm resources, the effects of sub-optimal levels of input need to be assessed. Similarly broad-based regional recommendations need to take account of such alternative solutions and be couched accordingly.

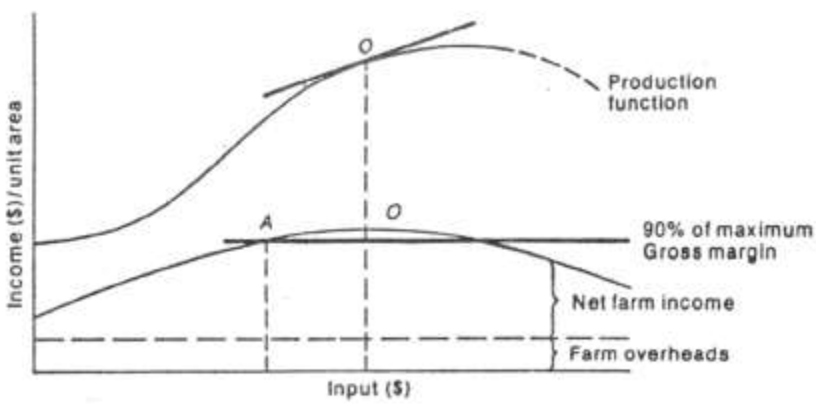

Figure 1. (Finlayson, 1980)

Determining appropriate crop rotations, fallowing practices and farming systems, where individual technologies (fertilizer responses, varieties, land preparation methods) are combined into integrated systems of production, are examples of practical applications requiring a range of data and considerable pre-digestion before their selective extension.

The need for a multi-disciplinary approach to research is implied by this discussion. The farm management economist is usually the key person in the research team because he is best able to monitor the economic environment, at both the macro and micro levels, to ensure the project is correctly formulated and balanced. The team as a whole also needs to maintain contact with on-farm practice and liaise with middle persons periodically to ensure the research programme is geared to satisfying the real problems and priority needs.

4. The role of the middle man

The interpretation and tailoring of appropriate farming systems for each farm by middle persons involves a diverse range of skilled people: accountant, agronomist, extension specialist, farm management economist, banker, lawyer and engineer. While each of these people has a unique contribution to make to farmers' decisions, I submit that the agricultural consultant is one of the more important links in the communication chain between science and its on-farm practice. The consultant is a hybrid animal who combines some of the skills of the agronomist, sociologist and economist at least, and, with his more intimate appreciation of the socio-economic context of the individual farm, is best able to package science to particular farmer needs and wants.

The farm adviser (agricultural consultant or agro-economic technical specialist/extensionist) relies on his research colleagues for new technology although he may carry out some minor adaptive research work. This means (ideally) attending research station field days and meetings, keeping abreast of the literature and maintaining contact with research personnel.

Depending on the local experience of the consultant/adviser, excessive statistical accuracy is not necessary before research results are made available; guideline data which can be interpreted as interim information are often better than no data. In addition, the lag time between a research finding and farmer adoption is often too long to afford the luxury of waiting for refined data. This implies selective feeding of research data to consultants and their ilk before the farming community.

This can be done by ensuring that consultants and those advisers capable of interpreting "semi-processed" data are provided with statistical analysis of the data annually and are given the opportunity of attending research-oriented seminars and workshops. Special publications pitched at a level between farmer consumption and the scientific journal may also be warranted at a regional level.

The consultant and his colleagues in the public sector advisory service also have an important role in linking science with practice. Their involvement by researchers at planning meetings and on advisory councils and panels, as well as through informal discussion, provides the forums for feed-back from farmer to researcher; none of us can be, although some dare to try, all things to all men.

5. Conclusion

My plea therefore is for more collaboration between disciplines and between public and private sector research and advisory services, in both the formulation of scientific research programmes and in the disbursement of advanced technology to agriculture.

Science must continue to extend the production frontier by exploiting the economic production potential in each discrete environment. More disciplined advisory service programmes will also be needed in the future if the chasm between present levels of production and the attainable potential from even existing knowledge is to be bridged.

Reference

77. Finlayson, P.M. (1980). J. Aust. Inst. Agric, Sci. 46: 156-160.