A Vision and a Challenge for Agricultural Science

Farrer Memorial Oration, 1993

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The first European visitors to record their views saw Australia as a "bright and savage land". A land with strange animals and plants, a land inhabited by a folk unmoved by the poor trinkets offered by Cook's sailors.

The visitors saw a landscape of unimagined antiquity, where the vegetation and soil organisms had evolved to deal with variable and uncertain climate, and with soils impoverished over millions of years.

Those visitors saw it as a land of hope, but they also saw it as land to be tamed and managed in the image of farming developed in a different, more predictable climate, in another hemisphere, on a landscape not much more than 10,000 years old.

Innovation, and great energy, initially served well that vision of a resource to be exploited.

By the end of the 19th century, however, the fragility of the farming system and of the landscape had become evident. William Farrer, whose achievements we honour this evening, argued that agriculture could only survive if it were supported by education and by science. The press of the day however reflected public suspicion that basic science was not related to practical outcomes, and was not sympathetic to his vision. Farrer nevertheless persevered and moulded opinion as he developed and applied technology pivotal to Australia's young grain industry.

Sixty years later, that public suspicion of science had quite changed.

In 1962, when Sir Otto Frankel delivered this Oration, science had just won a great war, and government, industry and the community strongly supported basic research. Frankel was more concerned about poor extension and poor application of existing knowledge, than by a need to justify science itself.

This oration re-examines the situation thirty years after Frankel, and ninety years after Farrer. I shall consider what has been achieved over that time, how public expectation has changed, and how our opportunities and obligations as agricultural scientists are altering as we enter the 21st century.

The first point is that agricultural science has served Australia well. Investment in research has been demonstrably beneficial: it has delivered new varieties of crops, new commodities, new fertilisers and chemicals, new machinery, and new farming systems.

Our achievements in agricultural production, however, have not always been matched by our ability to sustain and manage the land. Commonwealth and State Year Books reveal consistent improvement as well as increase in variety of our farming systems. But they

also reveal great variability in yield from year to year. Some of this variability is a result of the climatic uncertainty our farmers must contend with, but much is the result of inconsistent management.

In the case of cereal and pastures, unpredictable climate and uncertain management conspire to produce, on average, yields less than 40% of potential estimated from physiological and environmental considerations. Protein levels in wheat have been declining for many years, in part in response to decreasing soil nitrogen.

Many forms of degradation are well-recognised.

The export of soil nutrients in rural commodities is worrying. Their concentration and their ultimate discharge in sewage, often into the sea, is equally disturbing. Each year more than $700M worth of N, P and K is removed from the soil with Australia's wheat crop. Australia appears to be replacing these nutrients in an average sense, but their loss to the sea degrades that eco-system, and appears singularly profligate.

Concern over the waste of nutrients is not new. The great chemist, Liebig, expressed exactly the same concern when he criticised the British, 150 years ago, for robbing Europe of its bones and squandering the manurial equivalent of 3.5 million people down its sewers to the sea.

This criticism followed the invention of superphosphate in England, and the happy discovery that the bones of the dead in the battlefields of Europe offered a splendid source of phosphate to make it with.

Then, denuding the land of trees, and lavishly using cheap irrigation water, without providing suitable drainage systems, have caused problems with salinity which were anticipated more than a century ago, but which are still not resolved.

It is small comfort that we are not alone. Professor Hilgard at the University of California at Berkeley in 1880 warned that state, as it planned the irrigation of the great central valley, that the unwillingness to learn from the failures of the irrigation schemes of the past, was tantamount to asserting that the Almighty was disposed to set aside the laws of nature in favour of the state of California. As it turned out, the Almighty was not prepared to make that concession to California, and it appears he is not prepared to set those laws aside in Australia either.

Degradation of soil structure caused by excessive cultivation is well-documented, but is not well-managed.

Soil acidification associated with leguminous pastures and the use of nitrogen fertilisers is another major problem. The problem of acidification offers two interesting features.

Firstly, acidification associated with legumes is an "unexpected" outcome of what appears to be an environmentally friendly way to replace a nutrient essential to crop production. We should have taken account of the acidifying effects of nitrogen fixation, of N uptake by plants, and of nitrate leaching, on the soil. We chose not to do so and are now paying

the price.

But secondly acidification reveals differences among agricultural scientists in the ways it might be managed. One school asserts that we can breed and select acid tolerant varieties of plant, and thereby get ourselves out of trouble. Another school asserts that we need to ameliorate the soil.

These attitudinal (and territorial) differences prompted Professor Malcolm Sumner, the 1992 CSIRO McMaster Fellow, to observe that a "great deal of research is being conducted in Australia in an attempt to **circumvent** the consequences of the inevitable acidity which develops under legume-based pasture and cropping systems. While the rest of the world accepts the need for lime to maintain the soil pH, Australians appear to believe that they are exempt from the laws of chemistry in not having to apply lime to offset acidity".

My final example: In the arid and semi-arid woodlands of northern Australia, we failed to anticipate the consequences when we replaced the "British" breeds of cattle by the more drought tolerant Zebu.

In the old days, when the going got tough, the animals died and, in a sense, the system was self-regulating. The Zebu now survive in times of environmental stress, and they continue to exert considerable grazing pressure when the land can least sustain it.

As a result, native perennial grasses have disappeared, woody weeds have invaded the land, and soil erosion is now occurring at up to 50 times the "natural" rate of the past 5-10 million years. The system is unsustainable. It requires much more discriminating and sensitive management than is applied at present. It is encouraging that graziers in the semi-arid tropics recognise the issues and are seeking solutions. It is daunting because the solution almost certainly will require farmers to moderate short term profit in favour of a sustainable future.

Overall, however, farmers with good scientific advice are managing our agricultural lands better and more productively than ever before in our history. Farmers and scientists are also more analytical in their approach to management and are more aware of opportunities.

But often through ignorance, Australians are still degrading their land. Part of the difficulty arises because compromises we need to make in balancing production, and sustainability, are not well-accepted, understood nor managed. Part of this ignorance is caused by scientists who are too territorial and too blinkered in a disciplinary sense to approach land management problems in an holistic way.

Rural industries will continue to be a cornerstone of the Australian economy. Our way of life will continue to depend on cheap, clean and efficient agricultural production. Agricultural commodities will continue to represent an important component of Australia's export earnings. Foreign competition for markets will, however, increase.

So agricultural scientists will remain centrally important in maintaining Australia's

international competitiveness as well as our domestic well-being.

At the same time social and political emphases are changing. Society is more aware and more concerned than hitherto that many of our farming systems are unsustainable. In addition, the aspirations of urban dwellers are becoming politically more important. As a result, the natural environment is becoming more highly valued for its aesthetic and recreational attributes than simply for its ability to generate commodities. Public policy must reflect these changes.

Australians are also worried about non-agricultural land management and its consequences. They worry about the quality of water [which reflects soil quality], they worry about urban land degradation associated with motor cars, factories and power generation, and they are concerned about mine site management and restoration. They demand sustainable ways to dispose of, and to recycle, agricultural, urban and industrial effluents on the land.

In short, they are demanding general land management which ensures that the landscape is and remains aesthetically pleasing, productive and safe.

Australia's Ecologically Sustainable Development strategy, which seeks to ensure that our environmental heritage is sustained and maintained for the welfare of future generations, is a political reflection of these changed attitudes. The National Landcare Movement reflects the social concern.

These represent significant social changes from Dr Frankel's time and represent attitudes to the land very different to those of Farrer's experience.

But there are other changes as well. There is for example a reasonable expectation from farmers that scientists will provide more holistic and practical solutions to complicated land management problems.

Specifically, farmers want flexible management **options** rather than site-specific, and issue-specific and inflexible **recipes.**

They need guidance to decide under what circumstances herbicides are a better option than cultivation to manage weeds; to decide when a cruciferous break crop is a better option than a legume pasture; to decide when it is better to burn stubble than to attempt to incorporate it in the soil.

These demands require a more collaborative approach among research providers than has been the case hitherto. They also requires partnership with land managers. We now need a team approach, focussed on practical and holistic outcomes. We need to move away from the reductionist, competitive approach of the past, even though this approach at the time was entirely appropriate and very profitable. In this new context, basic research is seen as a means to an end, not an end in itself. These perceptions will profoundly affect the way that agricultural science is managed, and the way scientists are rewarded.

Furthermore, Ecologically Sustainable Development, as a philosophy, has a social

dimension. It implies a concern for communal welfare, and a generosity of spirit rarely revealed by economic rationalism. I believe that these social and ethical needs must also be recognised and met by our profession.

This technical and social complexity are not confined to agriculture. They carry over to non-agricultural land management. Management of mine tailings, or industrial waste can no longer be ignored or delegated to a bull-dozer driver.

Society is imposing stringent conditions for management, and implementation of these conditions demands the thorough understanding of the management of soil, water and vegetation. As agricultural scientists, we must provide for those needs.

Agricultural science must continue to support rural industries. It must also enlarge its traditional parish however to participate in more general land management. Agricultural scientists must also recognise the need for systems development and collaboration. They must learn to maintain and strengthen their knowledge base within a framework deliberately focused on practical outcomes.

In turn, society must recognise the tensions in science between the need to solve problems, and the need to maintain and improve the knowledge base necessary for future management. There can be no question that the operational achievements of this century were bedded in anticipatory basic research.

In meeting immediate operational needs, we must not err towards routine "fixes" at the expense of more flexible and innovative methods based in generalisable science.

The problems that face us are complicated. They may, in fact, be so complex that they are "trans-scientific", in that they defy formal solution using methods of science alone. The way forward, then, is by trial and error, intuition, experience, and a good deal of common sense. Even in the republic of trans-science, however, we cannot afford to forgo the rigour and the generality of good science, if only because it keeps us honest.

We must learn to operate in a way that maintains and strengthens basic knowledge and at the same time ensure that it is demonstrably focused on national need in the widest sense of that term.

Agricultural scientists also need to work more easily with land managers. We need them to enunciate their problems, as well as to implement and optimise choices in complicated systems. We also need their experience and their common sense, because the solutions they need will depend as much on their observations as they will on the scientific elements we offer.

So we need to improve training of environmental scientists and managers. University courses must focus more on problem solving, with science as the tool and not the end. Tertiary institutions traditionally committed to agriculture must accept a responsibility in the wider context of the natural and the urban environment.

Australia's scarce intellectual resources must be used to better effect, and concentrated in

fewer teaching and research schools. These larger "schools" will also have obligations to incorporate the social science approaches we need for more effective technology transfer.

In this regard, the Cooperative Research Centre model appears to offer opportunities for desirable integration in a disciplinary and in an organisational sense.

If we achieve these requirements and if we accept the social and moral challenge that Ecologically Sustainable Development entails, then I believe our children will inherit a continent which reflects views of management quite different from those prevailing in the past.

These views will encompass the vision that we humans, and the land, are part of an ecological whole; that the land is not a commodity belonging to an individual to be managed for personal profit, but a resource to be held usefully, but in trust for all generations.

Rules of conduct based in moral and ethical judgments and concern for the common good will govern its use. The cultural heritage our land represents will be acknowledged, and Australians will not be embarrassed to admit commitment to aesthetic issues such as beauty and delicacy, or wonder at the uniqueness and the antiquity of our heritage.

As agricultural scientists, our contribution is crucial. It will turn about an authority based in knowledge and understanding, and a feeling of wonder at the heritage we enjoy. Our opportunity, our responsibility, will be to accept the challenge and to pass that mystery to our children.

I commend my analysis and vision to you.

DE Smiles 8 February 1994