

Putting science into practice - an overview presented at the final conference session

J.V. Lovett

Department of Agricultural Science, University of Tasmania, Hobart, Tasmania

Introduction

Some 230 reports were contributed to this Conference in working paper form, complementing the 15 major contributions, including the C.M. Donald Oration, by authorities who have encompassed the whole spread of agricultural activities "from the drawing board to the field", as Peter Finlayson put it in his address to the first Plenary Session. These contributions demonstrate the agronomist's established skills in research planning, obtaining funds and putting the research plans into practice. They deal with concepts from the philosophic to the pragmatic and in so doing emphasise the continuing dilemma of agronomy and the agronomist, namely, the conflict between the need for short-term performance - to be this to find a solution to an immediate practical problem or simply to gather sufficient data to justify next year's grant application or to gain next year's promotion - and the need for long-term approaches to conserve agricultural resources - of which the most basic is the soil. Agronomists also bear much of the responsibility for feeding the growing world population about which we have heard so much for so long that it takes an Ethiopia to remind us that an estimated five hundred million people (Swamanithan, personal communication), or 10% of world population, will go to bed hungry tonight.

The papers

When grouped about elements of common interest the contributed papers indicate the directions being taken within a large proportion of the total agronomic research effort of Australia. Many groupings are possible but I have chosen five, indicating also the percentage of total contributed papers which they represent. The five are soil management (17%), removal of constraints to production (30%), crop protection (10%), crop management (23%) and pasture management (20%).

The first group is strongly related to the long-term needs of agriculture, being concerned with the decline of soil fertility, soil erosion and the development of more thoughtful systems to deal with these problems. Conservation farming and tillage papers reflect a world-wide interest in these strategies and techniques. Grouped together with the contributions of Jim Pratley and David Coventry in Plenary Sessions, the substantial work in progress on soil management is indicative of the growing concern of agriculturalists at the degradation of soils, which has taken place in Australia over a mere two hundred years of European settlement.

In my second group a wide diversity of crop and pasture species (from onions to subterranean clover) is represented. It is refreshing to find emphasis being placed upon efficiency of use of scarce resources, exemplified by studies of the efficiency of plants in using nutrient elements and water, especially as we shall increasingly be concerned with optimising rather than maximising plant production. Crop protection may be perceived as an adjunct to this segment since more effective crop protection reduces stress on plants and, as Karel Schubert indicated in his address, permits them to make better use of available resources.

In the crop management segment there is, again, interest in a range of plant species from sweet potato to rapeseed. Topics encompass novel growth regulators together with current work in established areas such as the effect of spacing on plant performance and aspects of crop adaptation to environment. The importance and consequences of good adaptation were developed in the addresses to Plenary Sessions by Alec Lazenby, Bruce Cockcroft and Jim Davidson. These contributions give food for thought when we recall that the adaptation of, for example, sunflower to Australian conditions was improved within a decade (from the late 1960s to the late 1970s) but that our most important cereal crop, wheat, grown and researched for more than a century, remains poorly adapted to environmental conditions in most of Australia. Let me add, however, that wheat is singularly well adapted to the type of production which

epitomises the strength of Australian agriculture. Certainly, average wheat yields per hectare are low by contemporary standards in Western Europe and elsewhere, but the average yield per person involved in production is high (an important consideration in terms of labour cost and efficiency) and production is energetically efficient. Indeed, Australia is notable among food producing and exporting countries in that agriculture shows a net energy gain, that is, more food energy is produced than ancillary energy is expended. This contrasts with agricultural production in countries such as Israel and the Netherlands, where energy inputs exceed energy outputs. Whilst the average grain yield per hectare in such countries may present a target to aim for, I contend that the methods and costs of production in those countries do not provide models for emulation. Frank Crofts' eloquent commentary, during the Donald Oration, on the cost/price squeeze would support my contention.

Eight different crops are discussed in the ten papers on crop legumes, an indication of the contemporary interest in this ancient group of plants.

Of particular interest in the crop management segment is the measurement and recording of agronomic data discussed in Plenary Session by Graeme Wright and in which the role of satellites and electronic data capture in the monitoring of factors limiting to plant production are included. In this context, I admire the innovative approach exemplified by the demonstrations of Peter Cull and others present but, like Bill Casimaty and Bob Loomis (a combination which spans the expertise represented at this Conference), I believe that human powers of observation remain a powerful data-gathering tool which is readily at the disposal of researchers and farmers alike. If the Australian Society of Agronomy were looking for a creed or motto, it could do worse than adopt "walk, talk, look, listen".

The pasture management segment was greatly enhanced by Frank Crofts' presentation in which thirty years of progress were reviewed. Among the contributed papers two novel species are dealt with, indicating a continuation of the established trend to introduce from overseas plant material of possible advantage to Australian agriculture. The high level of interest in subterranean clover and other pasture legumes, together with studies of their emergence and establishment, reflect also the continuing interest in species of proven worth.

Taken overall, the Australian Society of Agronomy and those organisations which fund the research of its members can view the output displayed at this Conference with satisfaction. This brings me, however, to the first of three elements which underlie many of the concerns discussed in sessions formal and informal and which must be addressed if the theme of this Conference - "Putting Science into Practice" - is to be translated into reality. The first of these elements is a concern as to the future funding and direction of agronomic, and other, research.

Some matters of concern

(a) Funding

Recent data of the Australian Bureau of Statistics (1984) show that, of funds devoted to research and development in Australia, agriculture is second only to defence in attracting Commonwealth support (Table 1). Agriculture attracts the largest share of monies allocated from all sources and receives some 48% of total research funding in the economic development sector. The nearest rival, manufacturing, receives some 14%. These data indicate that, whilst Australia no longer "rides on the sheep's back" (as some pundits delight in reminding us), rural research continues to attract a gratifyingly high level of financial support.

Table I. Research and experimental development carried out in Australia (1981-82). Source: Australian Bureau of Statistics, 1984.

Socio-economic objective	Expenditure (\$'000)				Total
	Commonwealth Government	State Government	Higher Education	Private Non-profit	
National Security (Defence)	113,215	-	743	-	113,958
Economic development					
Agriculture	104,005	131,864	35,476	36	271,381
Manufacturing	63,657	1,830	12,984	-	78,471
Total Economic Development	280,467	166,405	110,942	747	567,561

During the First Plenary Session, Gary Goucher reminded us that fundamental changes in, for example, Commonwealth funding of Rural Industry Research Funds (RIRFs) are taking place. The Federal Minister for Primary Industry, Mr. Kerin, has instituted a review of RIRF funding and has foreshadowed changes in the administration of these funds and in the composition of the committees which administer them (Gerin, 1984). Administrative support is to "be progressively divested to the relevant industry bodies" rather than being supplied by the Department of Primary Industry whose co-ordinating potential will, accordingly, be impaired. RIRFs will, in future, meet the full costs of administrative support. Given that the Australian Wool Corporation, for example, charges more than \$1M to administer funds of \$23M (\$13M of which goes to one organisation), and that the much smaller Australian Oilseeds Research Committee, which in 1983/84 disbursed \$631,641, will face administrative charges in 1985 in excess of \$50,000, it follows that significantly less funds will be available for allocation to research.

The members of RIRF committees are to be selected through a Commonwealth Selection Authority rather than representing common interest groups such as primary producers, CSIRO or the universities as is presently the case. Time will tell whether this is, or is not, a helpful development.

"Accountability", that is, acceptability of research objectives and priorities by rural industries, will become of paramount importance. It is not clear whether this emphasis means that the "wrong type" of research has been done in the past (as hinted at by some speakers), whether "adoption constraints" as discussed by Vock and Cull are operating, or whether the message of what research is being done simply does not reach the people who ultimately pay for it (a point to which I shall return later). In any event, these developments seem likely to determine the types of research which will be funded and may give rise to concern, particularly among those of us who perceive today's field application of research to stem from the applied research of yesterday and, in turn, from the basic research of the day before yesterday. In this regard Gary Goucher made the telling comment that experience of "User Boards" advising on research priorities was that they "didn't generate many new ideas".

Such ideas will still be needed. Traditionally, the universities have been a refuge where coats could be trailed and kites could be flown with relative impunity, but the recent declaration of another Government Minister makes quite clear that this may no longer be acceptable: "...it will be wise for universities and other higher education institutions to inch - if that is still a proper English verb - towards a larger contribution to their funds from the private sector" (Association of Commonwealth Universities, 1984). The implication is that the potential for fundamental research, already jeopardised by the loss of an estimated 950 research personnel in 1985 consequent on lack of funding of the Australian Research Grants Scheme (FAUSA, 1985), will be still further eroded. The words, incidentally, are those of Sir Keith Joseph, Secretary of State for Education and Science in Mrs. Margaret Thatcher's Government, but might equally well have been uttered by Senator Susan Ryan, Education Minister in an Australian government of a different political persuasion.

A welcome initiative from Mr. Kerin is that RIRFs will be encouraged to develop five year strategic plans within which annual research programmes and budgets can be framed. Also, the Commonwealth Special Research Grant is to receive additional finance and will be upgraded to become the Australian Special Rural Research Fund with an objective of funding multidisciplinary research, an area of considerable relevance to meeting the short-term and longer term demands which I have mentioned. It is also an area

which Onko Kingma, in his address to the closing session of the. Second Australian Agronomy Conference identified as being deficient in contemporary Australian agronomic research (Kingma, 1982).

The definition by the Minister for Primary Industry of increased accountability as an objective to be attained leads me to the two other elements which emerge from the Conference as areas of priority. These are communication and education, which are inextricably linked.

(b) Communication

A second statement by Kingma (1982) was that "unless results from your research are used by the agricultural community, then the research can be regarded as having been of doubtful significance".

An enormous amount of information has been contributed to this Conference. How much of it will reach a wider audience? We have a greater, more technically sophisticated array of communications equipment available to us in 1985 than has previously been the case. Yet, the provision of adequate extension services to bridge the gap between researcher and farmer remains problematic. Agronomists and other agricultural researchers have proved less able in "getting their message across" than in the attraction of funds and execution of research to which I have already referred.

Building the necessary bridges is, of course, fundamental to putting science into practice in an effective manner. I perceive two problems in particular.

One is the difficulty of transferring the sheer volume of research material from generator to user. The second is the length of time occupied by the transfer. Peter Finlayson and Bill Casimaty both focussed directly on the latter, while Alec Lazenby, perhaps unwittingly, gave a splendid example of the time lag in his reference to the work of H.L. Penman which is being put into practice by farmers some thirty years after it was published (see Penman, 1952). To return, briefly, to the subject of research priorities and funding, what success might Penman, a theoretical physicist; have of attracting rural industry funds in a climate of "accountability"?

It is a matter for reflection that in this age of "computer awareness" many, perhaps the majority, of primary producers still find telephone calls or face-to-face contact with extension workers the most effective means of communication with State Departments of Agriculture and, increasingly, with the private sector. Perhaps this is simply the contemporary expression of the old syndrome whereby looking over the neighbour's fence was the accepted way of disseminating novel agricultural ideas.

The enduring efficacy of the spoken word may have caught the attention of readers of the Journal of the Australian Institute of Agricultural Science, in the latest edition of which a cassette tape approach to communication is discussed. Ernst (1984) reports that for 7 years the Queensland Department of Primary Industry's Beef Cattle Husbandry Branch has run a current awareness programme based on cassette tape recordings. "It aims at improving communication by removing some of the obstacles presented by written communications and ultimately increasing awareness by field staff of developments in the beef industry" (Ernst, 1984). This is, presumably, an alternative to the traditional means of communication in the Government Departments of Queensland, in which an elderly character of moral rectitude and stern demeanour carries down engraved tablets of stone (or should it be engraved blocks of New Zealand chocolate?) from Mt. Kingaroy at regular intervals. The cassette tape approach could well be developed to complement contemporary initiatives in, for example, the advent of the communications satellite "AUSSAT" which is expected to return \$80 million per annum from its services ("The Australian", 28 January, 1985), many of which will benefit primary producers, especially in remote areas.

Bennett and Richardson (1984) give the following perspective of information technology and farmers. "The farmer as an expert is less likely to be replaced by software than will experts in other, more revered fields. Personnel officers, experts in tropical medicine and petroleum geologists are already in danger of being out-performed by computer programs. But the farmer, being an expert generalist, combining his manual skills with some knowledge of finance, automobile repair, weather probabilities, veterinary

medicine, plant pathology, plant and animal nutrition, real estate, both human and animal psychology, environmental science, water engineering, building, fires, drought, storms and pests is invulnerable to replacement. However the farmer needs all the help he or she can get from information technology" (Bennett and Richardson, 1984).

Although not strictly, or exclusively, agronomic, two further problems of communication are related to the level of education and awareness of the agricultural community at large. The best efforts of research and extension workers will count for nothing unless there is adequate feedback from primary producers. This is the first problem and it may be ameliorated by the developments in rural industry research funding to which I have alluded.

In addition, there are many opportunities for individual farmers and their group representatives to tap research organisations for information, and if scientists are still perceived as dwelling in ivory towers, it may just be that no one has invited them to come down to ground level.

(c) Education

The second communication problem - and the third element to be discussed - is that of the level of education in the agricultural community per se.

In an address to the Conference of Principals/Directors of Agricultural Colleges in the South-West Pacific held at Queensland Agricultural College in September 1984, Woodford (1984) reported that the majority of farmers in the South-West Pacific region have received no formal post-secondary education. New Zealand had the greatest participation of farmers in tertiary education, a 1981 survey showing that 14.9% had Lincoln College or Massey University qualifications and 32.5% had some form of post-secondary education, excluding short courses. Amongst farmers aged 35 or less the figures were 19 and 45% respectively. There are no comprehensive national data for Australia, but a 1980 survey of South Australian cereal growers found that only 5.7% of farm husbands and 11.9% of farm wives had some form of post-secondary education. An earlier survey in Queensland showed that only 2 of 89 graziers had attended agricultural or pastoral college and none had been to University (Woodford, 1984). These data are cited not to belittle the educational attainments of past or current generations of Australian farmers, but to indicate the need for information to be presented by scientists in such a way that it is related to skills and experience developed essentially in the work place and not in the lecture theatre.

The provision of adequate educational experiences for the man, or woman, currently on the land is challenging. Farmers range from the neophyte hobbyist with 10 hectares, a lot of enthusiasm, hope and weeds, to the third or fourth generation farmer with a lot of experience, no illusions and fewer weeds - perhaps. All require information in an assailable form.

At the same Principals' Conference an encouraging development was reported by Clarke (1984), namely, the growing enrolments of farmers in external study programmes instituted at the Victorian College of Agriculture and Horticulture in 1980. Early difficulties in presentation have been overcome and enrolments in a variety of courses (See Table 2 on the following page) reached a total of 326 in 1984.

What of the forthcoming generation of farmers? Data are, again, incomplete but, Australia-wide, farmers' children have a lower than average participation in tertiary education (Hughes, personal communication). In some areas participation even in secondary education is at very low levels (Stoessiger, 1980). Several factors contribute to this situation, not least the expense and other difficulties of students living away from home at a comparatively early stage. Tannock (1981) cites data which indicate that in excess of \$4,000,000,000 of Commonwealth funds are devoted to primary and secondary education of Australian children. In 1980 some \$5,000,000 (or 0.125%) was specially allocated to disadvantaged country areas.

Table 2. Courses offered to farmers externally at the Victorian College of Agriculture and Horticulture. Source: Clarke, 1984.

Title	Duration	Approx. course hours	1984 Enrolments
Further Certificate in Farming (Dairy Farm Management)	Mar-Nov	200	46
Further Certificate in Farming (Beef Management)	Mar-Nov	200	36
Further Certificate in Farming (Sheep Management)	Mar-Nov	200	25
Further Certificate in Farming (Farm Financial Management)	July-June	200	27
Further Certificate in Farming (Pig Management)	July-June	200	29
Trees on Farms Course	July-June	200	22
Horse Husbandry Course	July-Dec	160	141

A study, in which outback areas of Western Australia and Queensland were compared with areas of Tasmania, showed the latter to have the worst record for student participation in secondary education after Year 10 (Stoessiger, 1980). Financial and social considerations weigh heavily in this State **where**, however, educational institutions are responding to the need for **diversity** of educational opportunities at secondary and tertiary level. Thus, Rural Science has recently been accepted as a matriculation level subject in secondary schools; at Burnie Technical College the Department of Technical and Further Education offers a Farm Apprenticeship course through which post-secondary students participate in residential courses at Durnie whilst in training, on farms; the Tasmanian College of Advanced Education and the University of Tasmania offer tertiary level courses. Similar developments are, of course, in train at institutions on the mainland.

Conclusion

The communication gap, to which several speakers alluded during the Plenary Sessions of this Conference, must be increasingly bridged if agronomists are to retain both their credibility and their research funding.

I have already referred to the messages which Onko Kingma delivered to the final session of the Second Australian Agronomy Conference. He also defined 13 broad areas of research interest, here summarised, for our further attention (Table 3). These will not be discussed in detail but might make interesting reading as delegates "wind down" from this Conference. In brief, nine areas are receiving significant attention on the evidence of papers delivered this week. Topics 5, 8, 10 and 12, which are related to the three elements of concern to which I have referred and which are echoed in recent Ministerial pronouncements, merit greater attention. There remain opportunities for better integration of research effort, particularly in studying the economic implications of agronomic work, a point emphasised by Peter Finlayson. A related area for study is that "beyond the farm gate", recognised by the Donald Medallist, other speakers at this Conference and elsewhere (Miller, 1984) as a much less efficient sector of agriculture than is the production phase. Finally, although Australian farmers are recognised as being among the most efficient in the world, there is room for consideration of alternative forms of agriculture into which much current research discussed at this meeting might make an input. I shall wait with interest the Concluding Review of the Fourth Australian Agronomy Conference to learn whether, collectively, we have directed increasingly hard won resources into these more complex, but rewarding, areas or whether we have taken what is, possibly, the greater risk and played it safe.

Table 3. Areas of serious under-representation in agronomic research. Source: Kingma (1982).

- Genetic engineering to resist stress.
- Development of new plant systems to improve fixation and uptake.
- Reduced tillage techniques.
- Developments in farm machinery to improve cultivation operations.
- Development of integrated approaches to control pests and diseases.
- Contribution of stubble to soil conservation.

- Conservation and management of natural resources.
- Exploration of organic farming techniques.
- Impact of new machinery systems on soil quality.
- Technical improvements beyond the farm gate.
- Greater attention to a broad range of crops.
- Economic analyses of crop production.
- Formulating relevant research programs and setting of priorities.

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