Government Intervention in Rural Research: Some Economic Aspects of the Commonwealth’s Role
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Australian Government Publishing Service
Canberra 1983
FOREWORD

Most rural industries have benefited from the development of new varieties of crops and pasture, better breeds of animals, effective disease control or new production techniques. Many of these advances have resulted from research programs where scientists and economists have applied their professional skills to problems confronting rural industries. Much of the funding for this research has been from government sources, either from consolidated revenue or from producer levies collected under legislation enacted for the purpose. In 1981, the Senate Standing Committee on National Resources commenced hearings on the Commonwealth Government’s role in funding or undertaking rural research and the subsequent dissemination of the results of research to producers.

In this paper, the rationale for government involvement in rural research is examined, as are a number of methods by which this involvement can be achieved. The material is based on the BAE evidence presented at the Senate Standing Committee’s hearings.

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March 1983
GOVERNMENT INTERVENTION IN RURAL RESEARCH: SOME ECONOMIC ASPECTS OF THE COMMONWEALTH'S ROLE

SUMMARY

There is general agreement that substantial benefits flow from rural research and that these contribute to greater economic efficiency in agriculture. Rural research expenditure is around $250m, with Commonwealth and State funding accounting for over 90 per cent.

While the costs of research can generally be assembled, the benefits are difficult to quantify and are often indeterminate because they are diffuse over time and throughout the community. Judgments are therefore required in evaluating research, in forming research priorities and in deciding on levels and forms of any government involvement.

The IAC, after examining the financing of rural research in Australia, concluded in 1976 that total expenditure on rural research was at an acceptable level and should be maintained in real terms. No further evidence has become available to challenge this conclusion.

There is a prima facie case on efficiency grounds for government intervention to achieve higher levels of research expenditure to make up for deficiencies in private expenditure. Such deficiencies occur when private firms or individuals bear the costs of research but must then share the benefits with other groups in the community.

The Commonwealth Government has four avenues of intervention open to it, should private investment in research be perceived as deficient. The Government could:

- publicly fund research;
- use its legislative powers to redefine property rights (e.g. by granting plant variety rights);
- collect payment from producers (e.g. from industry levies); or
- encourage collective action (e.g. through co-operatives).

The latter three forms of intervention may not prove to be adequate either because resulting research expenditures may be judged to be still below socially desirable levels or because they may be judged to have unacceptable distributional effects.

Public funding either supplements the funds available from private sources, as in the case of the matching of industry levies, or meets all or most of the cost, as happens when research is undertaken by public agencies. Public funding is particularly justified for research on government policy and for 'basic' or exploratory research for which the resulting benefits may flow broadly to members of the community.

Funds made available from consolidated revenue do not necessarily constitute an economically unjustified payment from taxpayers to firms or individual researchers. Economically unjustified payments arise when public funding is disproportionately large relative to the benefits to the broader community.
Supplementing industry levies from public funds cannot be justified on the grounds that it benefits consumers. Consumers benefit from industry-funded research to the extent that the research results in increased production at lower prices. But by the same token, consumers also share in the costs of any research through the operation of market forces. Theoretically, the costs of research will be distributed between producers and consumers in the same proportion as the benefits of research.

Most of the benefits of rural research are likely to accrue to producers and consumers of rural products. However, less than one-tenth of rural research expenditure is derived from industry sources. There would thus appear to be a prima facie case for expanding the relative contribution made by rural industries to research expenditure. A recommendation from the 1981 Grains Industry Conference that grower contributions to wheat research be increased implicitly recognised that this was the case in the wheat industry.

In a market economy, the Commonwealth funding role should be residual because low-cost forms of intervention involving legislative changes in property rights (patents or levies) may stimulate private research without further government interference. However, low-cost forms of intervention may be inappropriate due to unacceptable distributions of the attendant benefits of research. Property rights legislation in many cases may be unworkable in rural research.

Several considerations need to be kept in mind when deciding on research priorities among rural industries. The results from rural research which reduce production costs will, very generally, yield greater benefits:

- the larger the size of the cost savings;
- the sooner the cost savings can be realised;
- the larger the industry;
- the faster the growth of the industry;
- the more specific are the cost savings to Australia in the case of traded goods;
- the larger Australia's share of world production;
- the smaller Australia's ability to influence world prices.

Because of the difficulty of measuring the benefits of research, the need to make value judgments on social priorities and the distributional effects implied in these priorities, as well as the need to tailor forms of government intervention to suit particular deficiencies in private research, there are, in the Bureau's judgment, potential net benefits from having centralised co-ordinating machinery specialising in deciding research priorities and monitoring and evaluating research programs in the light of changing national priorities. Functions of this machinery would include examining the appropriate form of government intervention, determining the level of government funding needed (both in absolute terms and in relation to industry and State contributions) and determining research priorities for government funding. The development of timely national inventories of research would be an integral part of this function. Presently, the Standing Committee on Agriculture (SCA) only partly fulfils the role envisaged for this centralised machinery, mainly because it lacks specialised resources.
1. Introduction

This paper is based on evidence presented by the BAE to the Senate Standing Committee on National Resources which examined 'the Commonwealth's role in rural research and extension services in relation to the development of the rural sector and the Australian economy'.

The overall objective of this paper is to summarise the key public policy issues relevant to rural research and extension. The specific objectives can be itemised as follows:

- to provide summary background information on rural research;
- to delineate broadly the case for government intervention in rural research;
- to examine the alternative forms of government intervention in rural research; and
- to examine some of the issues and organisation relevant to government intervention in rural research.

2. Background on Rural Research

The Australian rural sector and its component industries operate in a dynamic environment which necessitates continuing changes in response to opportunities and pressures from within the domestic economy and developments in export markets. The results of research provide a significant input to the process of adjustment which characterises such an environment. Rural research is, nevertheless, undertaken primarily because it is profitable. Through this profit motive, rural research contributes to an improvement in productive efficiency in circumstances of changing resource endowments, growth opportunities, changes in domestic and export markets and intersectoral pressures for adjustment. In addition, rural research contributes to an improvement in policies and decision making at the government level. Improving productive efficiency involves (a) the implementation of new technologies together with the adaptation of existing technologies to increase the quality of resources and outputs and (b) better organisational capacity and resource use at the farm level.

In the Industries Assistance Commission report entitled 'Financing Rural Research' (IAC 1976), and the associated study by Marsden et al. (1980), there were documented a number of instances where the benefits from research have been assessed. Among successful rural research projects which have yielded very high returns to research investment and have had significant effects in stimulating productivity, the following examples were cited by the IAC to show the capability of high returns in rural research:

- Sugar cane research, 1945-58 - internal rate of return (IRR) of 50 per cent;
- Hybrid corn, USA, 1940-55 - IRR of 35-40 per cent;
- Pasture research - IRR of 25-80 per cent.
Similarly high rates of return are reported in more recent studies (e.g. Edwards and Freebairn 1981b). After examining the profitability of both successful and unsuccessful research projects, the IAC concluded that considerable evidence points to the profitability of rural research and its contribution to efficient resource use and higher standards of living. The IAC recommended 'that the real level of aggregate [rural] research expenditure should be at least maintained, and not eroded automatically as a result of inflation' (IAC 1976, p.67).

Since the IAC inquiry in 1976, a number of studies have addressed the question of research priorities for Australian rural research.

A study of Australian science and technology (ASTEC 1978) assessed human and financial resources available to rural research and development in Australia in 1976-77, and included consideration of Australian rural sector research, particularly as it related to broader considerations of science policy. Past trends and future priority areas were discussed.

A major study of rural research priorities was commenced some years ago by the Standing Committee on Agriculture (SCA) and the Commonwealth Council on Rural Research and Extension. A number of progress reports have been prepared but not made public. These studies have not yet been finalised.

The BAE and CSIRO co-operated to review socio-economic developments in the Australian economy and, from these, to deduce the research needs for major Australian rural industries (BAE and CSIRO 1981). The conclusions of this study are presented in Appendix A.

The most recent information on Australian research and development expenditure is summarised below.

The best available estimate of total research and development expenditure for Australia in 1980-81 is around the benchmark of $1200m, which amounts to about 1 per cent of GDP. This contrasts with research and development expenditures amounting to 2.5 per cent of GDP in the USA, and between 1.8 per cent and 2.2 per cent of GDP in the UK, France, the Federal Republic of Germany, the Netherlands and Sweden. The difference is largely due to lower private sector investment in research in Australia.

The latest available breakdown of total research and development expenditure for Australia is for the year 1976-77 (Department of Science and the Environment 1980). Of a total research and development expenditure of $802m for that year, $515m (64 per cent) was from public funds allocated by Commonwealth, State and educational institutions. A breakdown of these public funds is as follows:

- agriculture: 20 per cent
- biological sciences: 14 per cent (some spin-off to agriculture)
- engineering and applied sciences: 27 per cent
- other: 39 per cent.

It is reported in a recent paper (Williams 1981) that an overall increase seems to have occurred over time in total funds available to
rural research and development in real terms - rising from some $158m in 1968-69 to $202m in 1976-77. During this period, Commonwealth allocations remained relatively stable in real terms, varying between $90m in 1973-74 and $98m in 1976-77. In contrast, State Government funds nearly doubled in real terms over the period, from $59m in 1968-69 to $101m in 1976-77. Since then, there has been a marked decline in Commonwealth funds, which totalled $73m in 1980.

Information on the exact amount of current expenditure on rural research and development is not readily available. A rough calculation suggests that it is in the region of $250m for agricultural and pastoral research, and in the region of $350m when activities in areas such as extension, soil conservation, and research in forestry and fisheries are included.

Industry funds for rural research and development, which are mainly from rural industry levies, seem to account for less than 10 per cent of total rural expenditure on research and development. Rural industry contributions to research and development and matching Commonwealth Government funds comprise the total rural industry funds which have fallen in real terms since the beginning of the 1970s (see Table 1). The real decline has been from an average of about $42m a year in the three years to 1972-73 to an average of about $31m a year in the three years to 1979-80 - a drop of some 25 per cent. Rural research funds currently available are estimated to amount to about $30m, about half of which comprise dollar-for-dollar matchings from consolidated revenue. Therefore, given a total rural expenditure on research and development of between $250m and $350m, industry contributions seem to be less than 10 per cent of the total.

Table 1: ESTIMATED FUNDS AVAILABLE TO RURAL INDUSTRY RESEARCH FUNDS(a): In 1980 dollar values

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<th>Year</th>
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<td>1970-71</td>
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(a) Approximately 50 per cent from producers and 50 per cent from Government.

The moneys for rural research available to ten major industry funds over the period 1970 to 1980 are presented in Figure 1, while a breakdown showing the funds' beneficiaries over the same period is presented in Figure 2. It can be seen from these figures that:

- the wool industry is by far the single most important contributor to rural research funds, accounting for a little less than half the sum available;

- the wool industry's relative contribution has declined in recent years, while those of the meat and wheat industries have increased; and

- the CSIRO is a major beneficiary of these funds. In 1979-80, the CSIRO received about 37 per cent, while about 50 per cent went to the States and universities.

The major Commonwealth Government involvement in rural issues is undertaken through the Department of Primary Industry, whose involvement in rural research is summarised in Appendix B.

3. The Case for Government Involvement

The main considerations in the economic case for (Commonwealth) government intervention in (rural) research are examined in this section, without an attempt to analyse their more technical underpinnings.

The general economic case for public intervention in research rests on the argument that there will be underinvestment in research if research expenditures are determined solely by decisions of firms and individuals responding to market forces. In this situation, investment in certain types of research is not profitable for private firms because they are not able to capture through the market enough of the benefits to make their investment worthwhile. The product of research is new knowledge embodied in information which often cannot be adequately appropriated by producing firms or, conversely, kept from benefiting others who have not borne a commensurate share of the costs. In some cases such as environmental research, the benefits of research may accrue so far in the future that they could be outside the planning horizons of private firms. In such situations, governments as agents of the community, may find investment in the research worthwhile even though private firms do not.

While governments may intervene to subsidise research, the rationale for subsidisation, which changes the distribution of income among groups, is different from the rationale for ensuring that markets operate efficiently. As stated by the authors of a recent study, changing the distribution of income through subsidies can be more efficiently achieved by means other than research policy (Edwards and Freebairn 1981a). The case for government intervention in research based on improving the functioning of markets is essentially a case for greater efficiency in the economy. Such intervention is designed to correct deficiencies in research investment by private firms, not to subsidise their operations. Thus governments need to intervene to make up for a lack of private
Figure 1: Funds Available to the Ten Major Rural Industry Research Funds: In 1980 dollars

Figure 2: Allocation of Funds by the Ten Major Rural Industry Research Funds to Various Research Sectors: In 1980 dollars

investment in research in the interests of the productivity of the community as a whole. Governments can use their power to ensure that benefits from research flow to the relevant groups in society, and to compel payments from beneficiaries of the research who may not otherwise have had the incentive to pay their share. Governments can therefore correct the operation of markets and thereby 'produce' information of an appropriate type, level and quality.

Theoretically, the break-even point for optimal investment in research is the point at which the marginal returns from additional investment in research equal the marginal cost of undertaking the research. While it is sometimes possible to measure the primary benefits of research, such as when the benefits are associated with technologies like hybrid plant varieties which act directly to reduce production costs, in many cases it is difficult to measure all primary and secondary benefits. The benefits are difficult to quantify and are often indeterminate because they are diffuse, cumulative, subjective, intergenerational or, for other reasons, intangible. Because they have a major bearing on the conclusions reached about the degree and forms of government intervention, an appreciation of these difficulties is crucial.

The product of investment in research comes in the form of information, irrespective of whether the research is in the social sciences such as economics or the physical sciences. The difference is that in the physical sciences, but not the social sciences, the information can sometimes be embodied in a technology. In these circumstances, the benefits of the research can be internalised to, or captured by, producers of research by means of patents or, in the case of product differentiation, through the use of brand names. However, such internalisation to individual firms is not always possible, even in the physical sciences. When, for instance, the information which is the output of research relates to a technique or process, such as an improved combination of technical inputs, the benefits of research could be difficult to internalise to individual producers of the information. Nevertheless, when the research output takes the form of information about a process or method, its relevance is often confined to a particular industry. In these circumstances, although the benefits of the research cannot be internalised to particular firms in the industry, they could generally be internalised collectively to all firms within the industry.

Research in the social and physical sciences is interdependent and mutually reinforcing. Economic research, for example, may provide the market information relevant to identifying needed technologies and techniques and may also provide the market context for evaluating their payoffs to individuals, industries and society. Conversely, economic analysis requires an appreciation of technical feasibility in order to prescribe strategies and policies to farmers and governments.

The problem of private underinvestment in research due to a divergence between private and community interests is likely to be particularly acute in the rural sector, which is characterised by a large number of small firms or individual operators. For instance, the 'Green Paper' (Harris et al. 1974) states that no individual would have found it profitable to finance research into myxomatosis since its benefits could
not be appropriated by the investor. However, the problem is likely to be less acute in intensive farming, such as poultry and pig farming, where integrated corporate production processes may make some types of research investment worthwhile for larger firms. Nevertheless, as a general proposition, rural research, more than research in other sectors of the economy, is likely to produce benefits that are less capable of being captured by individual firms because of the structural character of the sector.

Also, the specialised information needs of governments have created a distinct area in which the market cannot be expected to perform well, if at all. For example, governments' information needs may be poorly served if the only information available is produced by special interest groups with a vested interest in the outcome. Since numerous individuals rely on market signals in order to make management decisions in their own best interest, governments can help to ensure that the multiplicity of decision makers receive accurate and reliable signals through the provision of impartial market and policy information.

The need for a continual and systematic process of information generation is all the greater when governments intervene in the market for such purposes as market stabilisation, adjustment and welfare, and the subsidisation of inputs. Such types of market intervention obviously need ongoing review, monitoring and evaluation, as well as periodical examination of possible alternatives for improved performance in governmental activities. It will be shown below that the very nature of the type of information needed for this purpose requires research which is in-house and timely, and which provides information in a form readily available to the public.

Once the government has intervened to produce research results, further intervention may be needed to ensure the availability of the results at a price which reflects the marginal cost of making the information available. The output of research can often be made available to others at little or no extra cost, such as through the mass media. The IAC (1976) cites the example of research findings on the control of pests in wheat storage which can be readily applied to the control of insect pests at little or no extra cost to the research projects, and which does not deprive anyone, say, rice growers, of the benefit of the results. Yet, if the wheat industry charged rice growers for the right to use the results, this could result in less than optimal use of the research findings from the point of view of the rural community as a whole, with economically inefficient results.

In some cases the marginal cost of communicating research results may be large, particularly when the research finding can be communicated effectively to farmers only on an individual basis by extension officers. A public role in extension can be justified on the basis that such intervention is needed to ensure that publicly produced research findings are disseminated efficiently, i.e. made available at a price reflecting the marginal cost of dissemination. Utilising private firms to disseminate publicly produced research findings may give rise to the problem of ensuring a sale price for the research findings consistent with efficient dissemination. In addition, firms selling the information would experience difficulties in ensuring that their product (i.e.
information) is confined only to those who pay, when the information relates to a process, technique or method. However, private enterprise would find it profitable to disseminate research findings when, for example, an advertising campaign is designed to sell a privately produced technology or equipment to farmers and the information is specific enough to the product, or when individuals are willing to pay for packages of information selected by private firms from among large volumes of public information.

4. **Forms of Government Intervention**

The foregoing considerations have established a distinct role for government involvement in rural research to compensate for private underinvestment in research. In a primarily market economy, the government's role is necessary but supplementary. However, it does not automatically follow that government intervention should necessarily take the form of government funding or that, when government funding is necessary, research should be undertaken by the government's own unit or agency. The different ways in which governments could intervene to engender higher levels of research are identified below, with the last three representing possibly lower cost alternatives to government than the public funding of research.

- Government subvention to produce the information for itself using an in-house research unit or agency, or to financially contribute toward the costs of research undertaken by non-governmental bodies such as private consultants and universities.

- Government legislation to compel payment for research from potential beneficiaries of the results to avoid underinvestment due to a free-rider problem, thereby circumscribing individual rights to determine a minimum level of research expenditure.

- Government legislation to redefine property rights so as to confine the benefits of research to persons who have undertaken it.

- Government legislation to facilitate collective action by groups, which would make it worthwhile for the group to undertake or sponsor research which would not have been worthwhile for any member of the group acting individually.

Before examining each of the above alternatives in turn, two general points can be made. First, the different mechanisms available to government for stimulating higher levels of investment in research are not mutually exclusive. Depending on the nature of the research and the incidence of its benefits and costs, a 'package' of two or more measures may be considered to be 'best'. For instance, if statutorily imposed industry levies are used to generate research results that also have broader community benefits, supplementation of industry levies from consolidated revenue would have prima facie economic justification. Second, while the above measures are designed to correct research deficiencies for efficiency reasons, these same mechanisms could, if desired, be used to channel subsidies to selected groups. For instance, the use of public funds for research expenditure when all the benefits of the research can be internalised to an industry involves a transfer from
taxpayers to the industry. In practice, the size and direction of such transfers are difficult to determine, given the difficulties experienced in measuring both the level and incidence of benefits.

4.1 Commonwealth Funding

When research - especially research in the social sciences and particularly economics - is undertaken within government, there are several benefits to the Commonwealth. It is easier to influence the direction of the research effort and to tailor particular studies to suit the government's policy requirements when this type of research is government-funded. The government can also prescribe broad research goals or commission special studies to meet industry and community needs, thus serving interests which extend beyond a particular industry and cut across State boundaries. Ongoing and systematic research provides the Commonwealth Government with a bank of independent and timely information which can be drawn upon for the formulation and implementation of policies. It can also make this information available to the States and industry bodies, and so contribute to more meaningful dialogue between the States and the Commonwealth and between industry and governments.

In addition, the Commonwealth can fund research while not itself undertaking the work. It can provide funds for specified types of research to be undertaken in universities or by private sector consultants. The Commonwealth also provides funds through direct appropriation to match industry levies, as mentioned earlier.

4.2 Government-Sponsored Levies

An alternative to government funding of research is for governments to use coercive power embodied in legislation to collect payments from firms which cannot be excluded from receiving the benefits of research. The intervention, in effect, circumscribes the property rights of individual firms to decide a minimum level of research expenditure. Numerous examples are available in Australia of levies imposed on rural producers for research and development. In these situations, the government intervenes to provide the legislative basis for the collection of funds on behalf of the industry, and the funds are thereafter spent under the supervision of the industry for research, the results of which are freely available at least within that industry.

However, a system of levies to fund research does not necessarily result in a socially desirable level or combination of research (Martin 1977). There is no assurance that firms compulsorily contributing to research expenditure will benefit proportionally from the benefits of the research because, for instance, the technology or information produced may be more suited to firms in a particular region or to a particular enterprise size. Therefore, the suitability of this option for correcting deficiencies in research investment for reasons of efficiency may also depend on the appropriateness of its distributional effects. Also, while this form of intervention may confine most benefits to firms within the industry, there could still be a leakage of benefits to other industries and/or to the broader community.

As a general proposition, it is appropriate for public funds to be used to supplement industry levies in proportion to the benefits accruing
to the broader community. Thus a dollar-for-dollar matching of industry collections from consolidated revenue implies that half the research benefits accrue to the community outside the industry being levied. The information from rural research flows between rural industries and between the rural sector and other sectors. While the results from research projects in economics may be directly relevant to a particular industry, they could also be relevant to the overall public policy making process and be important for broader allocative efficiency. The IAC (1976) stated that many of the external benefits from rural research relate to discoveries which assist in the development of techniques which improve human health. The examples cited were from the physical sciences, specifically entomological research in CSIRO and research into animal health and nutrition. Generally, basic research and research in the social sciences has more diffuse benefits compared to applied research in the physical sciences.

It follows that, to the extent that benefits to the broader community are disproportionately less relative to the amount that is publicly contributed, there would be a transfer or subsidy from taxpayers to the benefiting industry. While it is often impractical to identify and measure either the level or incidence of research benefits, particularly in relation to research in economics, two considerations suggest that the proportion of research funding from industry levies may be too low. The first is that supplementing industry levies from public funds cannot be justified on the grounds that this research benefits consumers. Consumers will benefit from industry-funded research to the extent that increased production is available at lower prices. Equally, consumers will share the costs of any producer levy on research to the extent that this levy results in increased costs of production and hence prices. Market forces will, in fact, generally ensure that any research levy will ultimately be distributed between producers and consumers in the same proportion as the benefits of research (Edwards and Freebairn 1981b). The second is that industry levies contribute less than a tenth of the expenditure on rural research. This therefore raises the question of whether most of the benefits of rural research do in fact accrue to the broader community. A recommendation by the 1981 Grains Industry Conference that grower contributions to wheat research be increased is consistent with this position.

4.3 Redefining Property Rights

Government intervention in research need not take the form of public funding or public collection of levies if the reason for underinvestment in research can be overcome or reduced by legislative action to confer property rights. The granting of property rights may enable research investment by private firms which previously found such investment unprofitable because of their inability to adequately appropriate the benefits. Measures conferring property rights already exist in the granting of copyrights and patents. A topical example is plant variety rights.

The relationships between government-sponsored levies, property rights and public funding can be readily demonstrated in relation to the plant variety rights example. In the absence of plant variety rights or government intervention to collect levies for plant-breeding research, public funding would be necessary to ensure an adequate level of
investment for the purpose, i.e. to stimulate higher levels of investment in plant breeding for efficiency reasons. The granting of proprietary rights to plant breeders would enable them to use royalties to appropriate to themselves more of the benefits of their investment in research and development. This is likely to stimulate higher levels of private research and development investment in the development of innovative biological technologies. However, whether the increase in private investment following the granting of plant variety rights would then reduce the need for public funding would depend on whether total investment levels, and their mix, were already optimal. Otherwise, given a level of industry collections, private investment resulting from plant variety rights would simply substitute for public investment, and the granting of plant variety rights would only have distributional effects (see below), with no efficiency gains. Some evidence cited in a recent BAE paper (Ockwell 1982) shows that the granting of plant variety rights in the Federal Republic of Germany, Denmark and the Netherlands resulted in public funds becoming oriented toward basic research. The same paper reports that in the USA a number of small firms expanded their plant breeding activities following the granting of plant variety rights.

Although the foregoing evidence is weak, it supports a strong a priori belief that the granting of property rights stimulates private funding in research. Therefore, the granting of plant variety rights could reduce the need for public funding in areas where market deficiencies are corrected as a result of plant variety rights. To this extent, the granting of property rights is a low-cost alternative (for governments) to public funding as a means of increasing research expenditure.

However, it is a solution not without drawbacks. It may stimulate the development of varieties that yield quick profits in the short term, rather those that are in the longer term interests of the community. It could also lead to spurious differentiation of plant varieties, depending on the basis on which plant variety rights are recognised. Moreover, if the private producers of the new variety price it at a higher level than it would have been if the variety had been publicly produced, the dissemination of the variety would be relatively less widespread. The issue of the appropriate use of new products applies equally to patents, copyrights and all product differentiation.

In summary, whether the granting of property rights alone is adequate to correct deficiencies in investment in research will depend on whether enough firms and individuals could recoup enough of their research and development costs to make up the deficiency. In the face of the empirical evidence cited above, it is likely that a supplementary role for government funding will continue to exist because of the difficulty of internalising sufficient benefits through the medium of property rights alone, particularly for more basic research, i.e. research with no specific application in view but which is necessary for the advancement of knowledge.

4.4 Collective Action

A further alternative to government-produced research is for the government to encourage collective organisation. This also involves
conferring property rights through legislation to facilitate such group action. The formation of producer co-operatives is a general example. The 'Green Paper' (Harris et al. 1974) cites the specific example of the almost wholly self-financed and self-organised sugar industry in Australia. However, the 'Green Paper' also makes the point that few rural industries are likely to be able to develop the close-knit organisation of the sugar industry.

5. Government Intervention and Research Priorities

In attempting to identify the Commonwealth's role in rural research, three interrelated aspects can be addressed:

1. What is an appropriate procedure for deciding on government intervention in rural research?

2. What form should such intervention assume and what level of intervention is appropriate?

3. What are the organisational requirements for efficient intervention in research?

While no definitive answers will be provided to these questions, certain broad guidelines are suggested which may clarify some of the issues.

Because of the difficulty of assessing all the benefits against the costs of research, there is no completely objective basis for determining an appropriate degree or form of government intervention in research. Research priorities should ultimately reflect social priorities. Thus, broad areas of research and associated degrees and forms of intervention should be determined by representatives of the community, or their delegates, who are responsible for reflecting community preferences. Value judgments on social priorities are inescapable in deciding on the levels and form of government intervention necessary to bring about higher levels of investment in research. Although these decisions would be subjective to the persons charged with the responsibility of deciding social priorities, they would be objective (i.e. something to be taken as given) to the research managers having to develop research programs. Social priorities in research should be decided in the light of information provided by special interest groups, administrators, scientists and other professionals. The role of professionals and scientists would include the provision of information on the implications of alternative priorities and research strategies.

Once broad areas for government intervention are delineated, they would need to be translated into research goals, which are general statements of social ends in relation to research. These goals may be defined as statements of the aims of public research policy, and embody the preferences of special interest groups. A possible 'model' for clarifying the multi-level and sequential procedure required for deciding research priorities is as follows:

1. Areas of government intervention in research: These need to be determined in relation to social priorities and community preferences.
Goals of research: Once the areas of research for public intervention are selected, they need to be translated into research goals, which are policy statements on where research is required. These research goals may be achieved by public funding of research and/or by recourse to alternative (non-funding) avenues for stimulating appropriate levels of private investment (see below).

Aims of research programs: Once the research goals are identified, the aims of research programs, within the ambit of the goals, can be decided by research administrators in the light of perceived information/technology gaps. This involves the identification of a portfolio of research programs when public funding is involved.

Objectives of research projects: The objectives of one or more research projects combine to constitute a research program within the ambit of the program aims. These research objectives need to be decided by specialists and professionals, under the direction of research managers.

Some types of research yield results which, on adoption, reduce production costs. These gains will vary depending on the several considerations shown below. These factors would be helpful in determining research priorities among rural industries. Bearing in mind that exceptions can be identified to each of the following, the major factors which have been identified by Edwards and Freebairn (1981b) as important in determining the gross national gain from research-induced reductions in the costs of producing commodities are:

- the size of the cost saving for each unit of output produced (the greater the reduction, the greater the gain);
- the rapidity with which the cost savings are realised (the sooner, the better);
- the size of the industry (the larger the industry, the more widespread the cost savings);
- the rate of growth in a particular industry (the more rapidly increasing the industry, the greater the benefits of a given cost saving);
- the uniqueness of the result to Australian circumstances (the less able other countries are to benefit from the result, the greater the gains to Australia);
- the proportion of Australian production in world production (the greater the proportion, the greater the benefit); and
- the ability of Australia's exports to affect world prices (the smaller the ability of Australian exports to affect world prices, the greater the benefit).

Choosing the appropriate form of government intervention does not involve a wholly objective procedure because decisions on forms of intervention other than government funding involve judgments about the
acceptability of their distributional effects. The following procedure may be helpful in determining the appropriate form of government intervention.

Having identified the goals of research, it would first be necessary in a market economy to examine whether legislative changes in property rights would stimulate higher levels of private research expenditure in a manner consistent with distributional goals. To the extent that it does, public funding would not be required. In practice, the granting of property rights alone is not likely to meet the objectives of research policy fully, either in terms of the levels of investment or its distributional effects.

If the granting of property rights is regarded as unsuitable for some reason, it would then be appropriate to see whether the benefits of the research are specific enough to the industry to justify the collection of levies from producers to fund the research - in effect, circumscribing property rights of individual firms to determine their minimum level of research expenditure. If some of the benefits from the research are expected to flow to the general community because, for instance, the information influences the policy-making process, then supplementary funding from consolidated revenue would, prima facie, be economically justified. However, most applied (as distinct from basic) research in the physical sciences would be internal to the industry and should therefore be funded from compulsory levies. Basic research, and research in the social sciences, often provide more widespread benefits, thereby rendering levies unsuitable as a funding source. The suitability of levy collections for research also depends on whether the distribution of the ensuing benefits are regarded as acceptable to industry bodies allocating funds for different research programs and projects.

If the benefits from the research can be internalised to the State or a collectivised industry group, the research can be left to be undertaken by the State Government, agency or appropriate industry body.

Finally, if private research is perceived to be inadequate and the research has national relevance and cannot, for some reason, be stimulated through legislation affecting property rights in one way or another, then Commonwealth funding has a distinct role. This funding could either supplement private research investment costs or, in relation to some types of research where the benefits are widespread, meet fully the costs of the research in the interests of the community at large.

Because of the necessity for matching research priorities with social priorities and the need to examine the ramifications of alternative forms and degrees of government intervention and research strategies, there would be gains from co-ordinating research programs, maintaining a national inventory of research, and monitoring and evaluating research activities in relation to changing national priorities. There are different ways this could be achieved, although not without cost. The IAC (1976) in fact suggested the establishment of a Bureau of Rural Research for these purposes. Presently, the Standing Committee on Agriculture only
partly fulfils this role through its Advisory Committee on Priorities in Rural Research and Extension. For such a co-ordinating committee to have any influence on the extent and nature of rural research, access to computing and manpower resources specifically allocated to the above tasks is required. The Advisory Committee does not presently have such specialised resources at its disposal. Some progress has been made by State departments responsible for agriculture and the Bureau of Agricultural Economics in developing specialised research inventories, but little progress has been made in the establishment of national inventories of rural research. Availability of timely national inventories of research is essential to sound decision making on levels and priorities in rural research. Again, specialised resources allocated to this task are not presently available.
SUMMARY LIST OF AREAS REQUIRING FURTHER
TECHNICAL AND ECONOMIC RESEARCH

This summary of areas of potential payoff for future research by industry has been prepared as part of a joint BAE-CSIRO study (1981) which examines the factors influencing the research needs of rural industries. The list is not exhaustive since it covers only the major rural industries.

In addition, there are a number of broad research areas which transcend specific industry requirements and which require continuing research. These include assessment of market outlook, the adjustment process of farmers in response to changing market outlook, and the long-term decline in the ratio of prices received to prices paid, energy requirements, availability of skilled labour, assessment of water resources, control of salinity, etc.

A.1 Extensive Livestock Industries

On-farm

. increased availability of feed supply
. development of labour-saving technology
. improved feed conversion efficiency
. improved reproductive efficiency
. better animal health, including obtaining better estimates of the real economic costs of animal pests and diseases and the most economic control measures
. increased efficiency in wool harvesting

Off-farm

. further progress in objective measurement of meat, including benefit and costs of introducing an industry-wide system
. increased efficiency of operation of meatworks, including optimal size and location
. reduction in transport and handling costs in general beyond the farm gate, including use of high-density bales of wool to reduce transport and handling costs
. reducing economic losses associated with transporting livestock

A.2 Extensive Cropping Industries

On-farm

. reduced cultivation techniques
. plant breeding for improved regional adaptability, particularly in new cropping areas
. agronomic-economic comparison of competing crops in both summer and winter rainfall dominant regions
. increased efficiency of machinery design and utilisation
. rotation of summer and winter crops and pasture
plant nutrition, including optimal use of fertiliser and use of legume crops to fix nitrogen
more efficient application of pesticides and herbicides
soil conservation practices to reduce erosion losses, including application of residue farming and stubble mulching
better control of pests, weeds and diseases including better estimates of the real economic costs of plant pests and diseases and the design of the most economic control measures

Off-farm

cost efficiency studies concerning the design and construction of grain storage systems, including faster receipt and discharge from country silo through to shipping terminals
control of insects and pests in stored grain through grain protectants and alternative storage technologies
review of current sampling and grading systems at silo receipt
optimisation of transport facilities for bulk lines in order to reduce transport and handling costs

A.3 Dairy Industry

On-farm

increased uptake and development of existing technology
improved labour efficiency
minimising seasonal fluctuations in milk supply
development of more efficient breeds for less favourable environments, such as the tropics
application of computer technology to shed management and herd recording
improving animal health, particularly minimising sub-clinical losses

Off-farm

efficiency of operation of dairy factories
development of new products
examination of the possible impact of new technology, such as UHT milk on the location, structure and future profitability of the industry

A.4 Pig Industry

On-farm

improved nutrition and development of new feeds, including economic advantages associated with grazing field crops
design of economically efficient housing and improved environmental control
improved sow productivity
genetic improvement including further development of performance testing and selection
application of microcomputer technology to performance testing, breeding, etc.
improved feed conversion efficiency

19
Off-farm

- further development of the objective measurement of meat
- market research on the 'too rich, too fat' image and impediments to
  the more widespread adoption of superporkers

A.5 Poultry Industry

On-farm

- feed conversion efficiency
- flock management, including feeding methods, random tests etc.,
  including economic costs associated with changed management practices
- control of diseases
- improved design and efficiency of sheds and associated equipment,
  especially in environment-controlled housing

Off-farm

- egg quality, including cholesterol levels and impact on human
  consumption
- impact of hen quotas on profitability and industry structure

A.6 Fruit and Vine Crops

On-farm

- development of new cultivars which are high yielding, early bearing
  and disease resistant
- development of more efficient planting systems
- spray technology, herbicides and biological control
- control of the alternate 'on' and 'off' bearing pattern, including
  economic costs
- salinity control in irrigation areas including development of
  salt-tolerant cultivars, alternative water pricing policies and more
  efficient water usage
- increased mechanisation of farm operations and associated orchard
  construction

Off-farm

- further research into the development of cheaper and better packing
  materials and handling systems

A.7 Potato Industry

On-farm

- development of better yielding, disease resistant varieties suitable
  to different growing areas
- storage of seed and processing potatoes
- handling and packaging to economise on costs and minimise damage
- alternative production technologies using irrigation and
  labour-saving technology
Off-farm

- refinement of national and regional potato supply forecast to assist growers' planting decisions
- provision of better information on prices for different grades and qualities
- market research to identify consumer needs and improve product image

A.8 Nursery Industry

Little is known about this industry.

On-farm

- pest control - chemical, biological and integrated systems

Off-farm

- assessment of export potential

A.9 Cotton Industry

On-farm

- optimal irrigation strategies to improve efficiency of water use
- improved varieties for more efficient water use and better pest control
- examination of the economic and technical constraints to dryland production
- effect of cropping practices on soil structure and the design of long-run rotational practices
- integrated pest and disease control

Off-farm

- economic analysis of existing cotton industry in order to identify constraints both at the growing and processing level

A.10 Oilseeds Industry

On-farm

- agronomic aspects of growing oilseeds under commercial conditions
- allied with the above is the incorporation of oilseed types such as grain legumes into crop-pasture rotations
- higher yielding varieties or improved yields of existing varieties
- further research into the integration of oilseeds into farm management strategies, including economic aspects of competition of oilseeds with traditional cereal crops

Off-farm

- assessment of market opportunities for oilseed meals
A.11 Rice Industry

On-farm

- more efficient distribution and use of water
- development of higher yielding varieties, particularly the long-grain types which command market premiums

Off-farm

- development of wider range of economic uses for rice hulls
- increased milling efficiency.
Appendix B

SUMMARY OF EXISTING COMMONWEALTH GOVERNMENT INVOLVEMENT IN RURAL RESEARCH THROUGH THE DEPARTMENT OF PRIMARY INDUSTRY

B.1 Performance of Research by Organisations within the Department of Primary Industry

Bureau of Agricultural Economics

The BAE is an independent research agency within the Department of Primary Industry and is responsible for a broad program of economic research relating to both rural production and marketing.

Bureau of Animal Health

The BAH is responsible for animal health programs, including research into the epidemiology of animal diseases. In addition, the BAH provides an input to the Australian National Animal Health Laboratory (which is operated by CSIRO).

Australian Plague Locust Commission

This Commission engages in operations to combat outbreaks or potential outbreaks of the Australian plague locust. In fulfilling its aim, it conducts research into a number of aspects of locust biology and control measures.

B.2 Administration of Industry-Specific Research Funds

The Department has a significant involvement in the administration of research funds for which statutory schemes involving industry and Commonwealth funds have been established. At the present time, such schemes exist to support the following industries:

- barley
- chicken meat
- dairying
- dried fruits
- fisheries
- honey
- meat (beef, sheep and goat)
- oilseeds
- pigs
- poultry (eggs)
- tobacco
- wheat and
- wool.

Funds for research in these industries are administered through trust accounts under the provisions of the relevant Act governing their operations.
B.3 Administration of Non-Industry-Specific Research Funds

These funds are provided to finance Commonwealth contributions for research into rural industries not covered by a specific industry scheme. The bulk of funds in this area are expended on horticultural industry research and are made available from the Commonwealth Special Research Grant.

In addition, the Department provides funds for a number of projects sponsored by the Australian Agricultural Council.

B.4 Extension Funds

The Commonwealth has, in previous years, provided funds for assisting State extension services under the Commonwealth Extension Services Grant. In addition, for those projects outside the scope of individual States, funds known as the National Projects Portion were also provided. However, following the recommendations of the Committee of Review of Commonwealth Functions, the Government decided that assistance for rural extension services would be absorbed into general revenue grants to the States.

B.5 Co-ordination of Rural Research and Extension

Australian Agricultural Council/Standing Committee on Agriculture

The Australian Agricultural Council and its associated body, the Standing Committee on Agriculture, perform an important role by liaising and co-ordinating research activities between Commonwealth and State Governments and agencies. The Department of Primary Industry provides secretariat services for the two bodies and many of the specific committees and subcommittees established to examine specific aspects of Australian rural industries.

Commonwealth Council for Rural Research and Extension

This body was established in 1978 to advise the Minister for Primary Industry on aspects of rural research and extension. It was established as a result of recommendations contained in the IAC's 1976 Inquiry into the financing of rural research. Although the Council commenced meeting in 1979 and a number of reports were prepared by its secretariat, it was abolished during 1981 on the recommendation of the Committee of Review of Commonwealth Functions.

B.6 Financial Aspects: Research and Extension Funding: 1980-81

Bureau of Agricultural Economics

- Total budget

  $5.4m

Bureau of Animal Health

- Estimated science and technology related items

  $41.1m (of which $0.2m intra-mural research and development)
Plague Locust Commission

- Estimated science and technology related items $0.3m (of which $0.06m intra-mural research and development)

**Rural Industry Research Funds** (Commonwealth and industry funds, except where indicated)

- Barley $0.0m (commenced 1981-82)
- Chicken meat $0.4m
- Dairying $1.1m
- Dried fruit $0.1m
- Honey $0.0m (commenced 1981-82)
- Meat $7.5m
- Oilseeds $0.6m
- Pigs $0.7m
- Poultry $0.2m
- Tobacco $1.1m
- Wheat (Commonwealth portion only) $2.6m
- Wool $12.7m

**Non-Specific Research Funds**

- Commonwealth Special Research Grant $0.2m
- Australian Agricultural Council sponsored projects $0.2m

**Extension Grants**

- Commonwealth Extension Services Grant (abolished after 1980-81) $5.09m (of which $0.2m is National Projects Portion)

**Note:** Funds allocated to the administrative and regulatory duties of the Department are not included in this table.
REFERENCES

ASTEC (1978), Science and Technology in Australia 1977-78, AGPS, Canberra.


Department of Science and the Environment (1980), Project Score: Research and Development in Australia 1976-77, All Sector Results, AGPS, Canberra.

Department of Science and Technology (1981), Science and Technology Statement 1980-81, AGPS, Canberra.


____ (1981b), Economic issues in measuring Australia's returns from rural research and in defining the role of government in research. Contribution to a Symposium on Communication Responsibilities in Agricultural Research, organised by the Australian Institute of Agricultural Science (Victorian Branch) and the Victorian Farmers and Graziers Association, Bundoora, Victoria.

Harris, S.F., et al. (1974), Rural Policy in Australia: Report to the Prime Minister by a Working Group, AGPS, Canberra.

IAC (1976), Financing Rural Research, AGPS, Canberra.


Martin B.R. (1977), 'A case for less Government assistance to rural research', Farm Policy 16(4), 91-110

