ALTERNATIVE STRATEGIES FOR FUNDING RURAL RESEARCH AND DEVELOPMENT IN AUSTRALIA

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Public sector support for rural research and development has a long history in Australia. The recent Industry Commission report into research and development largely accepted the continuance of the present compulsory levy regime, backed by the research and development corporation structure. In this paper, a number of strategies for funding rural R&D are proposed, and in particular one involving voluntary contributions from individual producers is developed. Such an approach has both theoretical support and is practically feasible. Furthermore, it is suggested that it will specifically address some of the problems identified by the Industry Commission in the area of rural R&D.

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Introduction

The past decade has seen significant changes in the research and development environment in Australia. Government initiatives to encourage private sector research and development have accompanied major changes to the structure, operation and funding of government research organisations. For agriculture, the period has been characterised by the establishment of Research and Development Corporations (RDCs), funded by a system of industry levies and matching government contributions. These changes represent an important step in introducing a 'user pays' system for funding R&D, and are consistent with general changes in government philosophy over the last decade. Overall, the changes can be characterised by an attempt to facilitate increased commercialisation of research and development by both the public and private sector

It is likely that the government's budgetary constraints will continue, resulting in a further reduction in public sector support for rural R&D expenditure in Australia. The Industry Commission's recent report into research and development in Australia (Industry Commission 1994, 1995a and 1995b), flags at least a partial winding back in public sector support for rural R&D. In response to this, the Industry Commission proposed that the present system of compulsory industry levies be largely maintained, albeit with changes to the government's contribution schedule (Industry Commission, 1995b, E.3-4). Although uncertainty remains about the government's commitment to implementing the recommendations contained in the Industry Commission report, the prospect of RDCs facing a future with reduced public sector support remains. In these circumstances, increasing pressure is placed on the various rural industry research and development corporations and councils to seek alternative and innovative sources of funding to maintain or increase current levels of rural R&D.

In this paper a number of alternative strategies for funding rural R&D are proposed. In doing this, economic and institutional aspects of rural R&D activities are examined which are important when considering the funding issue. It is important to stress, however, that the issue of raising funds for rural R&D cannot be addressed in isolation. It is inter-related with matters such as: from whom the funding is to come; how the funding is to be collected; how the funds are to be allocated (to whom and on what); and, the total level of funds which should be made available for rural R&D.

The approach taken in this paper is to first discuss the issue of the collective funding of rural R&D, highlighting the issues of property rights and collective provision of goods. Taking into account practical and theoretical considerations, five strategies are proposed for funding rural R&D. The rationale for each of these strategies is discussed, and the views of some individuals involved in the rural R&D funding process as to the feasibility of these alternative strategies set out. The results of these discussions give some indication of if and under what circumstances, the alternative strategies proposed may be feasible to develop for alternative funding sources for rural R&D. Finally, conclusions are drawn as to how rural R&D funding may be developed in the future.

The Economics of the Collective Funding of Rural Research and Development

It is generally accepted that the characteristics of rural industries pose special problems for funding R&D activities. The most obvious of these is the exclusion of non-contributors from the benefits of R&D, which is often extremely costly or even impossible. In addition, however, rural industries may be characterised by a large number of geographically dispersed and/or small producers which makes the funding of large projects difficult. The combined impact of these two characteristics is likely to lead to a less than ideal level of funding for R&D by a rural industry.

In this section, discussion is confined to a number of the theoretical features of funding rural R&D, especially funding of R&D on a collective basis. 'Collective', as used in the present context, refers to funding in which more than one party contributes to the cost of R&D activities. The reason for focussing on the collective funding of R&D is the general recognition that appropriate levels and types of R&D in the rural industries can only be achieved through some form of collective arrangement.

The Economics of Property Rights

One perspective on the R&D funding issue can be obtained by using the concept of property rights. The notion of property rights is useful for elucidating the economic relationships between parties and why the outcome of those relationships may be considered less than ideal. Property rights have been defined as specifying, ' ... the proper relationships amongst people with respect to the use of things and penalties for violating those proper relationships ... ', (Randall, 1987, p. 157, Furubotn and Pejovich, 1972).

Property rights are important because it can be shown that if a set of property rights has certain characteristics, it can affect economic efficiency in the allocation and use of resources. The sufficient condition for a Pareto efficient allocation of resources is that, in the absence of transactions costs, property rights are *non-attenuated* (Cheung, 1970).[1] A non-attenuated set of property rights possesses the four properties of exclusivity, full specification, transferability and enforceability. Hence, given a non-attenuated set of property rights and a distribution of those rights, a Pareto efficient outcome is attainable. Rather than being costless, however, the specification, enforcement and transfer of property rights is typically costly. In these cases, government intervention in various forms may result in a better outcome than unfettered market transactions. For example, the institutional and funding arrangements in rural R&D in Australia may be seen as a means of attempting to overcome the lack of R&D activity resulting from the difficulty of appropriating the benefits from R&D outcomes.

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[1] Assuming that there are no monopolies in the economy, non-rivalry in consumption and that costs of production do not continuously decline (Randall 1987, p. 157).

Appropriation of the outcome from R&D may be difficult because of the non-rivalry and non-excludable nature of outcomes associated with R&D (Lindner, 1994). As a result, the specification of property rights, and therefore the attainment of efficiency may be impeded. This problem arises because the output from rural R&D activities is 'knowledge'. As a 'good', knowledge or information is non-rival in nature. This means that the 'consumption' of knowledge *per se* by any one individual does not reduce the amount of knowledge or information available to be consumed by others (Randall, 1987, p. 169). Similarly, knowledge or information is often characterised by non excludability, or excludability only at a high cost. That is, it is often difficult and/or costly to ensure that someone an agent does not want to 'consume' the knowledge generated by the output of R&D, in fact, does not consume it. The fundamental problem posed by non-rival and/or non-excludable goods is that it is often difficult, impossible or costly to establish a set of enforceable property rights for the good.

The intellectual property rights system attempts to partially overcome this problem by acting as a mechanism through which the results of R&D activity can be captured by specifying a legally enforceable property right, in what otherwise would be a non rivalrous and partially non-excludable good. By protecting the knowledge or creative output associated with R&D activities, the system vests 'ownership' of it in agents (Besen and Raskind, 1991, p. 5). It is feasible to do this because often the inventive or creative knowledge associated with R&D is embodied in a good, process or technique in which a property right may be specified. The good, process or technique may itself be made rivalrous and/or excludable. In this way, the knowledge or information generated from R&D may indirectly be made at least partially rival and/or excludable.

The Australian intellectual property rights system is broadly consistent with those established in other developed countries (Golvan, 1992). Nevertheless, there is potential for the Australian intellectual property rights system to be made more complete, especially in relation to the creation of new life forms through genetic manipulation techniques.

Although the intellectual property right system provides a legally sanctioned form of protection for the creative and inventive activity expended by agents, it is not the only means by which protection is afforded to persons undertaking such activities. In the rural sector in particular, it is possible that non-legal mechanisms provide a means by which creative or inventive activity can be exploited. For example, in the case of plant breeding activities, F1 hybrids possess a natural 'plant breeder's right' in that they cannot be successfully reproduced without access to the parent lines (Stallman and Schmid, 1987).

In the same way, the inter-temporal nature of production points to another mechanism through which an informal property right may operate and allow the exploitation of inventive endeavours. In rural industries, timeliness and accessibility to information may be critical, and it may represent a substitute to the specification of a legally enforceable property right. The ability of producers to remain competitive and profitable can often depend on the ability to remain a step ahead of rivals. Even with a well defined intellectual property rights system,

developments and advances in production systems may be quickly copied by others. It is reasonable to suggest therefore, that this time aspect is critical in the ability to remain competitive and profitable, and also offers an informal property right in inventive endeavours.

Collective Provision of Research and Development

In this paper, arrangements in which more than one party (excluding the government) contribute to the cost of R&D activities will be referred to as 'collective funding' arrangements. The 'need' for collective funding of rural R&D by more than one agent arises for a number of reasons. The principal reason generally cited is that in industries characterised by a large number of small producers, no one individual will be able to fund a project by themselves. On one interpretation, this phenomena may simply be characterised as a capital market failure (Hanel and Palda, 1992).

While capital market failure may necessitate funding by more than one agent, collective funding arrangements in Australia and overseas have generally been of the form of compulsory contributions, usually in the form of a levy on production. The rationale for compulsory contributions can be attributed to the belief that with a large number of small producers, non contributors may free ride (Industry Commission, 1995a). Clearly though, there is no fundamental imperative for collective funding to require compulsory rather than voluntary contributions (de Gorter and Zilberman 1990; Martin, Zacharias and Lange 1991).

The theory of collective action attempts to explain how problems requiring the action of two or more agents may be solved. In attempting to characterise situations in which co-operation amongst diverse agents may be required to achieve an outcome, the theory of collective action takes into account a number of matters, including; the nature of the problem; the number and type of agents for whom the problem is relevant; the relationship of these agents to each other and those not directly affected by the problem at hand; the type of solution which is most likely to arise in any given institutional framework; and the ideal solution to any given problem.

The study of collective action was given impetus by Olson (1965), who set out some of the principles associated with collective action situations. Olson's basic themes are that: group size is, in part, a root cause of collective failures; heterogeneity amongst group members in terms of preferences and/or endowments is related to collective failures, or failure to attain an optimal solution; collective failures may be overcome through selective incentive mechanisms and appropriate institutional design. These principles are general, however, and collective action scenarios are likely to be problem specific.

When agents decide to solve a problem collectively, there are invariably costs associated with doing so. These costs are analogous to the transactions costs described above in relation to property rights and represent the costs of organising a group, negotiating an agreement with respect to cost and benefit sharing, and, monitoring and enforcing any agreement. In addition, the behaviour of agents is likely to be strategic so that any one individual's decision will

depend, at least partly, on the actual, potential and/or perceived actions of others. In the case of rural R&D, the exact nature of the strategic behaviour by an agent, is likely to depend on a number of considerations including the size and competitive structure of an industry, the type of R&D which is involved, the ability of any one agent in a market to use the R&D, and dynamic considerations (Bendor and Mookherjee, 1987).

Central to the consideration of any collective action problem is the nature of the institutional structure which develops to solve the problem of coordinating actions between agents. As noted above, in the case of rural R&D funding in Australia, the collective action problem has been addressed by imposing compulsory levies on agents (generally producers) in specific industries. In addition, systems involving voluntary contributions also operate in a limited number of circumstances. For example, the *Horticultural Research and Development Act* 1987 provides for project related voluntary contributions to be instituted and matched by government on a dollar-for-dollar basis. In 1993/94, the Horticultural Research and Development Corporation received approximately $6 million in voluntary contributions, and $3 million from statutory levies (Horticultural and Development Corporation, 1994).

An important consideration in collective funding arrangements for rural R&D is that of the incentive mechanisms which may be available to funders of rural R&D. These may take the form of matching contributions from the public sector up to a specified level, or tax deductibility of private contributions. The nature and quantity of funding provided by an institutional regime is likely to have a significant influence on the outcome generated in terms of level and type of R&D.

Collective Action and Clubs

In the context of collective action, and as a precursor to some of the issues considered later, it is worth considering the notion of a club. A club is a voluntary organisation or group in which members derive utility from sharing some cost, benefit or member characteristics. Club theory focuses on club goods, that is, impure public goods with excludable benefits and partial non-rivalry in consumption. Under some circumstances, the output from R&D activities can be described as a club good. Club theory is concerned, amongst other things, with deriving the ideal institutional structure of a club under alternative hypotheses about the nature of (potential) members, exclusion costs and transactions costs (Cornes and Sandler, 1986, pp. 6-9).

For a potential member of a club to join, it must be the case that the benefits from membership and consumption of the club good exceeds total benefits from non-membership. Total membership of the club will influence both the cost of providing any given level of the club good for members, and the benefits derived from the consumption of the club good if it exhibits congestion costs. Congestion may be thought unlikely to apply to R&D activities, as consumption of the outcome from R&D is unlikely to be characterised by crowding. Further, clubs are generally characterised by the presence of an exclusion mechanism which allows members of the club to prevent non-members from enjoying the benefits of membership.

Finally, clubs are characterised by dual decisions in that decisions in relation to membership of the club must be accompanied by decisions with respect to the appropriate level of club good provision.

It is reasonable to suggest that one possible funding mechanism for rural R&D may take the form of a 'research club' of some form. This approach does pose some problems, however. Firstly, it is clear that the ideal membership of a club devoted to financing R&D is not necessarily limited. With a larger membership, the cost of a specific R&D project to an individual producer falls. In the words of Sandler (1992), R&D may be characterised by a lack of congestion in consumption, and therefore be classified as an 'inclusive' collective good (p. 65). In these circumstances, the economic rationale for restricting club size may be ambiguous. Nevertheless, where the club undertakes a series of yet undefined projects, there may be a benefit in restricting membership of the club. With fewer members, the ability of any one individual member to influence the R&D portfolio to his/her advantage may be enhanced. Hence, there may be benefits from restricting or limiting membership. Moreover, to the extent that membership gives club members a competitive edge over non members, there may be an advantage in limiting membership, thereby restricting any advantages associated with membership. Thus, mechanisms for ensuring that advantage become important.

Alternative Strategies for Funding Rural Research and Development

In this section, five potential strategies for funding rural R&D are proposed and developed. For each strategy, some considerations are set out which highlight how and why the alternative strategies should be applied. It will be clear that any given approach is unlikely to resolve the R&D funding issue. However, it is argued that all approaches have a role to play in generating R&D outcomes which are more economically desirable. As part of the development of these strategies, individuals in a number of research and development corporations including those covering meat, horticulture and wool were approached, and their opinions sought on the various alternative strategies. Comments arising from these discussions are referred to so as to give an insight into the practicability of different strategies.

Funding by way of exploitation of property rights

Under appropriate circumstances, the appropriation of property rights to fund R&D activities may result in the ideal level and nature of R&D activities being undertaken. In particular, under conditions in which transactions costs are zero and a non-attenuated set of property rights may be specified, and, perfect price discrimination can be practised, a first-best level of R&D should be funded by private agents. Profit maximising agents will ensure that the optimal level of R&D is undertaken, as it will be possible to capture the full benefits from R&D.

It should be stressed that in deriving the optimal social solution, the outcome will not resemble the usual firm profit maximisation problem. The reason for this is that although property rights allow the benefits of R&D to be appropriated by holders of the rights by making them

excludable, the knowledge created by the R&D process retains its character as a non-rival good. In the public finance literature, it is referred to as a price excludable public good (Lindner 1993, p. 8). The ideal or optimal solution will be one in which the amount of R&D undertaken (or knowledge produced) is consistent with that associated with public goods. That is, the total valuation placed on an additional unit of the public good is equal to the cost of producing an additional unit of the public good (Stiglitz, 1988, pp. 131-32). As noted above, this may not pose a problem if perfect price discrimination can be practised.

Even if transactions costs are non-zero, exploitation of property rights by private agents may be the best mechanism through which to fund R&D. The reason for this is that funding via exploitation of property rights may still represent the best attainable solution when the ideal or first best solution is not attainable. Property rights may not be completely specified, but given the level of transactions costs, the level of R&D undertaken by profit maximising agents represents the best achievable outcome.

From a practical perspective, acknowledging that the appropriation of the benefits of R&D activities by the use of intellectual property rights is unlikely to provide the ideal level of R&D does not lessen the need to exploit them appropriately. Under the relevant legislation in Australia, various research corporations and councils (RDCs) are required to commercialise the outcomes of R&D which they fund (see for example, s. 11 *Primary Industries Research and Development Act* 1989). Moreover, while there appears to be a general recognition of the importance of intellectual property rights by the RDCs, only small amounts have been recouped through the exploitation of intellectual property rights by some organisations. For example, in 1993/94 the Meat Research Corporation recouped only $169,000 from royalties and license fees on a research budget of approximately $40 million (Meat Research Corporation, 1994, p. 63).

This lack of success is not for want of trying by the RDCs in some instances. The view was expressed by some individuals that the various RDCs are working hard to get everything possible out of intellectual property rights through the use of tightly worded contracts. Research and institution dependent contracts are signed with researchers which ensure that an appropriate share of the ownership of any intellectual property is vested in the RDC. Similarly, some organisations are viewing intellectual property rights as simply part of their increasingly proactive role in R&D management. Interestingly, it was noted that as part of this more proactive stance, indicators of performance are becoming increasingly important, and one of the key indicators is patents, royalties and licensing agreements generated by the R&D that is funded. This highlights an important aspect of intellectual property rights, namely, that in addition to generating funds they may prove important as a performance indicator for certain types of research.

In contrast, other organisations appear to take a relatively low key stance in relation to the allocation of intellectual property rights, leaving them to reside with the research agency rather than the funding organisation. One reason for this suggested was that the organisation saw its

input into R&D as a contribution, rather than ownership *per se*. The organisation attempts to ensure that the industries which it serves can benefit from the R&D it funds through mechanisms such as prior or preferential access to the resulting technology (compared with overseas companies), or royalty participation payments.

Not surprisingly, individuals associated with RDCs expressed the view that the low levels of returns from intellectual property rights are a reflection of the type of R&D funded by the organisations. For example, one individual's organisation funded predominantly generic or industry wide R&D, and the view was expressed that intellectual property was not really relevant to this type of R&D. Where intellectual property rights may be available, the R&D was seen by the organisation to be the prerogative of private agents. Similarly, it was put by one organisation that if R&D which is potentially protectable by intellectual property rights is funded by the research and development corporations, then private firms may be 'crowded out'. In particular, the total amount of R&D undertaken may be reduced if the leverage effect of research and development corporation funds is undermined by an additional emphasis on intellectual property rights.

Resourcing the exploitation of intellectual property rights is clearly also an issue for the RDCs. The management of intellectual property rights requires resources and expertise that are not always readily available to the organisation, and as a consequence the organisation may be reluctant to get involved.

Compulsory rural research and development levy

Reference to a 'compulsory rural sector levy' here is a reference to a compulsory levy imposed on *all* primary producers, the proceeds of which can be used to fund rural R&D of a basic or fundamental nature. Such an approach is, in fact, canvassed by the Industry Commission in its report (1995b, p.720), but not pursued as a viable option. The concept is of a central fund raised by an impost on all primary producers, through which basic or fundamental rural R&D is funded. The rationale for such an approach is that the transactions costs associated with other collective funding systems are too high to ensure that an appropriate level of this basic or fundamental R&D is undertaken.

This approach is distinguished from the previous one in that the decisions on the level of funding and use of funds would be influenced and possibly determined by the 'government', rather than simply being the prerogative of the private firm or agent. The objective being to maximise welfare (supposedly in the rural sector) by specifying a level of funding of basic R&D by the rural sector, consistent with the aggregate benefit derived from the R&D. The aggregate benefit will include spillovers between industries in the rural sector, and other sectors of the economy.

One issue which may have to be faced with respect to a compulsory levy of this form is that the large spillover which it is generally assumed is associated with basic R&D requires funds other

than those raised from the rural sector be used. In discussions with industry organisations, consolidated revenue was suggested as a possible source of funds, reflecting a strong belief that a 'public benefit' accrues from this type of R&D, and that it is appropriate for society to contribute to the R&D through the taxation system. Other alternatives may be general industry levies across different sectors, with contributions to 'basic research' from levy pools in accordance with the proportion of benefit derived from basic R&D.

A number of individuals argued that if the R&D was properly classified as basic R&D and the outcome or resulting benefit public in nature, then it is the responsibility of government to fund it. Similarly, it was suggested that unless the government is seen to put resources into the fund resulting from a compulsory rural levy it may be unlikely to be acceptable to producers who would view it simply as another tax.

A major issue identified by the RDCs with this approach is the likelihood that different industries would have substantially different views about their basic research needs, and this may cause administrative problems. The issue of different rural industries having different basic research needs was been highlighted by some industry participants, who saw the 'rural sector' as consisting of two relatively independent sectors. The divide is between the traditional broadacre industries, and the newer intensive industries such as horticulture. Importantly, the basic research needs of the two sectors are considered different, with little cross over between the sectors. As such it is argued that a general R&D fund financed by a single levy on all producers is unlikely to capture these differences, as the spillovers of basic R&D occurs within intensive industries, and within traditional broadacre industries. The approach may potentially result in the loss of industry specific requirements being met.

Compulsory industry-based levies

The idea of compulsory industry-based levies is similar to those operating at present in which all producers (and sometimes processors) in a defined industry contribute to an R&D fund via a compulsory levy. The approach rests on two fundamental principles. The first is that large numbers of small and/or dispersed producers require collective funding arrangements. The second is that without compulsion, free riding would act as a block to much R&D being undertaken. The approach is used extensively in Australia and overseas (Euro P.A. and Associates, 1994), and aims to generate a quasi user pays system on the basis that members of an industry are the primary beneficiaries of industry related research.

Generally speaking, in Australia compulsory industry-based levy arrangements are imposed at the 'request' of industry participants. The views of the industry members are generally expressed through their producer organisation, after an appropriately organised referendum on the question. Any one member of an industry could be expected to agree to a levy if it was believed that the benefits from doing so equalled or exceeded the cost of contributing to the cost of R&D via the levy. This cost-benefit comparison and decision of an individual agent may be

captured by examining the actions of the median agent in a voting situation (Martin, Zacharias and Lange, 1991).

In the case of a levy to fund R&D activities, benefits will broadly speaking take two forms. Firstly, benefits will accrue to those who contribute to the cost of the R&D and are able to capture or appropriate the returns, either in the form of exploitation of intellectual property rights or from early access to the results. In addition, benefits will fall to those who do not contribute but are able to benefit from the R&D for the reasons described previously, that is the spillover effect. The decision of the median voter can reasonably be expected to be based on an assessment of the benefits and costs which accrue to the median position after voting one way or another. If the expected benefits exceed the costs from contributing, then a vote in favour of the levy could be expected.[2]

It would be expected that the costs for this type of R&D funding approach would be known with reasonable certainty and include the cost of initiating a compulsory levy; the cost of collecting a compulsory levy; the government's type and level of contribution to the cost of the R&D; and the cost of administering the R&D fund. Given that levies of this form usually have a fixed life (for example, the situation in New Zealand), the funds will most likely be used to fund a portfolio of projects over time. Therefore, an individual agent may incur an additional cost to ensure that the R&D which is funded actually meets its own needs. That is, a lobbying cost will be involved which may be a function of the number of levy payers and the relative size of the individual levy payer.

Other considerations which are likely to influence the decision of industry members to decide in favour of a compulsory levy or not include the length of time a compulsory levy will be imposed; the accountability of those who administer such an arrangement; the nature of the research associated with such a scheme including its impact for the industry and stochasticity of results; and the ability of those who contribute to the levy to influence what projects the levy is expended upon.

As a proposal similar to that which is in place across a number of industries at present, our particular interest in this issue relates to how compulsory levy schemes could potentially be made more efficient, possess greater accountability and be more equitable. The view was expressed by those to whom we spoke that the establishment of the RDCs provided a vehicle by which accountability could be increased, with research funders and users having a greater say on research priorities and projects undertaken. RDCs were seen also as a means of increasing contestability in research delivery. Although anecdotal information exists which indicates that the RDC model has enhanced accountability, no formal review has been undertaken of how effectively the RDCs are fulfilling this expected role, and how their performance can be improved upon in this respect. It may be timely for such a review to occur.

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[2] Note there is no reason to believe that any one individual will know that s/he is the median or decisive voter in a given situation. Indeed, if the median voter was known, then this may induce some bargaining or strategic behaviour on the part of over voters or coalitions of voters.

In relation to the development of research objectives, individuals from the RDCs pointed to levy payers expressing their research needs through various state and/or regional committees, which passed on the concerns of levy payers to the organisation. This approach to research priority setting by the R&D organisations varies, although all those we spoke to have in place mechanisms designed to allow the payers of the levy to express their research needs to those who decide to which projects money is allocated. In short, all research organisations appear to have taken a more proactive stance in research priority setting than they had in the past. Some industries appear to have developed good consultative processes, with meetings between research organisations and producers/growers used to determine which projects are funded. A potential difficulty cited in involving producers in the research setting process is this manner, however, is that the problems nominated by the growers may be considered by the research community as being 'not researchable'.

With respect to the setting of levy levels, the view was strongly expressed that the levy payers ultimately control the rate at which a levy is set. The ability of individual producers to influence this, and their willingness to do so, varies across industries. Whereas some industries such as meat and mushroom engage in rigorous debate about levy rates, others seem to accept levies with little deliberation. The nature and level of debate depending on the type of industry (in terms of structure, product, etc), growers sophistication, and the role played by the grower's peak industry organisation. It should be noted that at least one individual highlighted the concomitant costs associated with greater discussion and debate before levies are imposed. For example, had a formal plebiscite been required in the relevant horticultural industries then levies may not have got up and running in a number of those industries served by the Horticultural Research and Development Corporation.

Given the importance attached to the free riding issue by those favouring compulsory levies, it was interesting to note that although many of the statutory (and non-statutory) levies are theoretically compulsory, some leakage of funds was acknowledged by those with whom we spoke. This varies between industries and sectors and it can depend, for instance, on the tightness of the definition of the product for which the levy is collected and the efficacy of the collection process. For non-statutory levies there is potential for leakage when the agents at the levy collection point in the production process do not co-operate fully, and there is a lack of coercive powers which may be called on to enforce it.

Voluntary funding arrangements

In line with the proposal for a voluntary funding strategy, it is proposed that a new type of organisation be defined, which for descriptive purposes can be termed a 'research club', through which R&D can be funded on a voluntary basis. Voluntary in this context refers decisions by *individual agents*, whether or not to contribute to the cost of a project(s). This approach would overcome the problem associated with the large number of relatively small producers in a rural industry who would not otherwise be able to fund R&D, even if

economically justified. The *raison d'etre* of such a 'club', would be the collective provision of research benefiting 'club members'.

Given that membership of a research club would be on a voluntary basis, the private benefits from membership for the individual agent from joining it must exceed the private cost of doing so for membership to be taken up. This notion of the private benefits exceeding the private costs is similar to that discussed in the previous strategy in that private benefits must actually, or be perceived to, exceed the private costs of joining the club (voting affirmatively in the previous strategy). The strategic choices open to the individual agent here, however, are different to those in a voting situation. In this case, other than the threshold requirement that a certain number of agents must agree to fund the project(s) or commit sufficient funds for it (them) to go ahead, it will not necessarily be the case that all agents in an industry end up contributing. Even if others do not contribute, some individuals may decide to fund the R&D.

The distinguishing feature of this strategy is to define an organisation consisting of voluntary members, to which are attached certain benefits consistent with providing an incentive for agents to collectively fund R&D. As discussed previously, it could reasonably be assumed that agents would only contribute to the cost of R&D on a voluntary basis if the benefits from doing so exceeded the costs of doing so. Whether or not this was the case would depend on a number of factors, not the least of which is the type of R&D undertaken. For this reason, it would reasonably be expected that research clubs financed on a voluntary basis would undertake R&D of specific benefit to members.

There is evidence to suggest that schemes based on voluntary contributions can and do operate effectively in relation to the provision of funds for rural R&D. Within the United Kingdom, at least one organisation undertakes R&D funded by voluntary levies. The Processors and Growers Research Organisation (PGRO) has existed since 1944, and funds an extensive R&D programme by voluntary crop levies on growers. Activities include plant breeding, and the agronomy and harvesting of new varieties. Crop information is provided by the PGRO through various written and oral forums, open days, regional trial demonstrations, and field advisory services. Although voluntary, few farmers opt out of levy paying because, '... they accept the need for commodity levies and we [the PGRO] provide a value for money service on pulses ...' (personal communication, G.P. Gent, Director PGRO).

The PGRO is an exception in that other United Kingdom rural research organisations operate on the basis of statutory levies. Even so, there are other organisations including those in Australia which operate on similar lines to the PGRO. For example, the Kondinin group in Western Australia is a farmer organisation which funds various activities from voluntary membership. Like the PGRO, results from its surveys and tests are available through field days, seminars and the group's publications which are readily available to members.

Both the PGRO and the Kondinin group illustrate the notion that voluntary arrangements can be used effectively to fund activities which have traditionally been considered to be public

goods, or largely non-excludable. One method for 'internalising the externalities' associated with R&D activities is to undertake research which only benefits contributors. Where this is infeasible, other mechanisms must be developed to ensure that private benefits associated with membership are sufficiently strong. In the case of the Kondinin group as well as the PGRO, benefits accrue to contributors by way of privileged access to the output generated by the funds raised from membership. Note that the information may be available from other sources, and to that extent remains a non-excludable good. However, by providing ready and easy access for contributors, a private excludable benefit is linked with the voluntary membership.

It is one of the defining features of club theory and collective action processes more generally that although the good produced may be non-rival (at least up to a point), it will also exhibit excludability. Therefore, it is reasonable to expect that research clubs would undertake R&D projects which offered benefits exclusively or almost exclusively to members. Where non members cannot be prevented from enjoying the benefits of the clubs' activities, those benefits accruing to non members must not be so great as to encourage the membership to be abandoned. An additional question concerns what incentives might be necessary for research clubs to form and operate effectively. In particular, should some taxpayer funded benefit be provided to club members such as matching funding for projects undertaken by the R&D clubs, or additional tax benefits for membership fees paid to research clubs. Importantly, both the nature, quantity and method of payment of that taxpayer benefit are likely to be significant from the point of view of club membership and the amount and type of R&D funded.

For a member, the costs of membership would seem to be reasonably clear. These would be a function of direct membership contributions to the club including organisation costs of administering the funds; any incentives provided to form the club by the government; and administrative costs associated with being a member. More generally, given a research program, the cost of membership would largely be a function of the number of members in the club and the size of the research portfolio undertaken. Benefits from membership in the case of a voluntary research club would be a function of the actual outcomes from the research undertaken, taking into account its stochastic nature; the type of research undertaken (basic as opposed to applied and the accompanying problem of both intra-and inter-industry spillovers); and the competitive structure of the industry and the characteristics of the member compared with the R&D undertaken by the club.

The rural R&D industry participants with whom we spoke emphasised the fundamental problem associated with voluntary arrangements like that proposed here is that of free riding. If research was to be undertaken from which a potential levy payer could not be excluded from appropriating the benefits without contributing, then a greater total benefit is obtained by not paying the voluntary levy. As expected, this had the implication that the range and types of research outcomes to which voluntary levies could be applied was limited.

Voluntary funding arrangements, it was generally agreed, had potential to operate for well defined or localised problems. Further, it was suggested that such regimes would have greater

chances of success in concentrated industries such as chicken processing, where a small number of processors and producers may co-ordinate their actions. Whether region specific problems are addressed well by the current rural R&D funding arrangements is open to question, and voluntary funding arrangements may well have a role to play for these types of problems. However, it was argued that with voluntary regimes, major national issues would not be addressed. That is, the 'big picture research' (especially strategic research) might not be undertaken over the long term to the detriment of an industry. The wheat industry was cited as one example of an industry which had suffered because in the past, its R&D organisational structure did not allow truly national issues to be examined.

In a similar vein, the view was expressed that the approach was more likely to work for industries with higher valued products (possibly partially processed), and where the industry was 'entrepreneurial' in its outlook. It would not work for larger extensive industries or for larger horticultural industries such as the apple or pear industries, as these are characterised by only a few entrepreneurial growers, and a lack of cohesiveness amongst the growers.

In addition to industry structure matters, it was suggested that for such a voluntary system to be feasible it would also be necessary for the benefits from the R&D to be tangible to those who had actually contributed to its cost. This highlights a more serious barrier to voluntary funding of R&D, namely, a lack of sophistication amongst industry agents about the benefit from R&D. If growers do not see R&D as being important, then they are unlikely to contribute to its cost on a voluntary basis. This was cited as a greater problem amongst producers in industries with a large number of participants. Members of smaller intensive industries, such as the mushroom industry were, it was argued, sophisticated enough to understand the importance of R&D and see benefit in funding it even if the benefits were not immediately apparent.

Another issue raised by industry participants in relation to voluntary arrangements was the continuance and stability of this type of funding. It was argued that if the levy were to become voluntary, then around 80 per cent of growers, for instance, would contribute initially but that this proportion would fall over time. Contribution levels if dependent on the state of the industry, may have adverse impacts on the R&D undertaken over time as industry fortunes fluctuate. This may have particularly detrimental effects for the research community if consistency of funding was not provided. Finally, from an operational point of view, for voluntary funding arrangements to work, it is likely that they would require substantially different approaches by the research and development corporations. For example, it was suggested that if research and development corporations or similar organisations may be required to act as 'middle men' in these types of arrangements. As a result, there would be a need to balance industry wide concerns, not necessarily strictly commercial in nature, with the commercial aspects of decisions associated with R&D. Currently, it is the organisation that takes care of industry matters, and producers concern themselves with commercial matters. If the organisation were to administer or act as a broker in a voluntary arrangement, this may give rise to potential conflicts of interest between the interests of the industry and the commercial

interest of any one producer. For such an arrangement to function effectively, the relevant organisation would have to take a disinterested co-ordination role. Importantly, this points to a need to define clearly the role of various industry organisations in these circumstances.

Public funding of rural R&D from consolidated revenue

This alternative relates to the use of consolidated revenue as a viable financing option, at least for part of the rural R&D portfolio. The public funding of rural R&D raises questions such as the appropriate total level of funding, types of R&D performed and allocation processes. Intuitively, depending on the type of R&D performed, this approach presents basic problems in terms of the application of the user pays principle, crowding out effects of publicly funded R&D, incentives provided to those involved in the R&D process including producers and researchers, and the potential for conflicts in the distribution of funds.

A potential model for this type of approach is New Zealand, where the Foundation of Research, Science and Technology (the Foundation), is required to develop and implement a system of contestable funding for R&D, the output from which generates public or non appropriable benefits. The appropriate source of funds for this so-called 'public good research' is regarded as the public sector, leaving firms and industries to fund research with appropriable private benefits. The Foundation administers the Public Good Science Fund, subject to the priorities set down by the government as identified in the government's Sciences Priorities Statement. In so doing, it acts as the government's agent in the purchase of R&D services that generate wide public benefits. The allocation of funds by the Foundation is conducted on a contestable basis, after a process of rigorous review of all applications (Sandrey and Reynolds, 1990).

The individuals interviewed generally agreed that there was scope for additional public funding for research, particularly where the benefits could not be appropriated by any one industry in particular. It was also generally agreed that identifying this type of research posed problems, as it was difficult to identify research for which benefits could not be appropriated by an industry or its members. The associated problem of how funds may be distributed was also cited by a number of individuals as a potential cause for concern, as industries would likely be highly competitive in this regard.

Conclusions and further development

In this paper, there has been an attempt firstly to elucidate on the economic principles which underlie the R&D funding issue. Hence, the issues of property rights and collective funding were discussed so as to make clear why and how problems arise in relation to the achievement of an efficient level of rural R&D. Further, some insight into how institutional structures can be arranged to ensure an outcome as close as possible to an ideal level is attained was gained. Secondly, alternative strategies were presented as ways in which to overcome the R&D funding issue. The strategies described were selective, and served to highlight that there is an

infinite possible number of strategies which could be applied to the problem of funding rural R&D

A number of important conclusions can be drawn from the discussion in this paper. On a fairly intuitive level, there is a need to ensure that the current intellectual property rights system is used to the fullest extent possible, and that compulsory levy arrangements be improved to enhance their equity and efficiency. This is consistent with the Industry Commission recommendations regarding the continued use of compulsory industry based levies.

On a more radical level, the alternative strategies which were described serve to highlight that in the long term, more substantial changes to rural R&D funding arrangements may be required or desirable, than those suggested by the Industry Commission in its report. These changes may take the form of the development of new property rights which provide enhanced protection for intellectual effort, novel institutional arrangements to facilitate voluntary R&D funding arrangements, or the development of technologies which can use the existing legal and institutional regimes to achieve maximum possible efficiencies. It is difficult to identify and predict exactly what form these fundamental changes to the funding regime may take. The development of club arrangements has been mooted as one significant change which should be investigated. Indeed, a development of this nature could potentially address the need for user pays arrangements with R&D being driven by those who derive the benefit from it, and overcome the need to use compulsory levies to avoid free riding. Although some work has been taken to analyse this approach in a more rigorous framework (Martin, Zacharias and Lange, 1991), more development is clearly necessary.

Furthermore, the discussions held with various industry participants has highlighted the fact that R&D funding is a multi faceted issue which is unlikely to be solved simply. Differences across industries point to the need for a multi layered approach to the problem of achieving an efficient use of resources in relation to R&D. Hence, a tiered level of funding approaches, attuned to the needs of individual industries and different R&D problems, needs to be developed.

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