Pragmatic Selection of R,D&E Investments in Primary Industries

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Information deficiencies make selecting investments in R,D & E projects a difficult and uncertain task. Gardner (2004) likened the challenges and uncertainties of choosing the right mix of R,D&E projects to that of recruiting football players or breeding racehorses. In this paper approaches are examined to improving the odds of selecting, from a myriad of choices, more of the investments that are likely to deliver sound economic, social and environmental outcomes in primary industries. Pragmatism rules. The approaches proposed are a pragmatic way of evaluating R,D&E investment opportunities ex ante under the conditions where research opportunities are almost unlimited and budgets limited and falling.

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1. Introduction

Each year the public and agricultural industries spend millions of dollars on research, development and extension (R,D&E) in primary industries. The Productivity Commission (2011) estimated that $1.5 billion was invested in Australian rural R,D&E in 2008-09, equivalent to around 3.3 per cent of the gross value of production.

1 We have used the Productivity Commission’s figures here but note that there is some debate about the exact size of the investment in rural RD&E and how it is shared.
These investments occur within, and are guided by, the National Primary Industries R,D&E Framework. The National Primary Industries R,D&E Framework was endorsed by the Primary Industries Ministerial Council in 2009 as a basis for strategic investment across rural R,D&E. The aim is to change the national R,D&E investment culture to more collaboration rather than competition. Doing so will improve productivity, competitiveness and sustainability of resource use by improving the efficiency and effectiveness of investments in R,D&E (Allen Consulting Group 2012). More specifically, the aim of the National Framework is to rationalize R,D&E activities of the Federal and State governments, industry, higher education institutions, and Cooperative Research Centres. The idea is that organisations take on lead and complementary support roles and allocate resources, develop projects and conduct R,D&E activity.

The National Primary Industries R,D&E Framework operates across 19 industry sector and 7 cross sector priority areas. Across these priority areas, each State Government has adopted various roles in relation to the R&D effort. These roles are identified as major, support and link roles. A ‘major’ role identifies the industry and cross sector areas in which a State Government will undertake a “lead national role by providing significant R&D effort” (Allen Consulting, 2012, p. 53). Support and link roles are associated with lower levels of R&D effort. NSW adopted the responsibility of a ‘major’ role across 16 focus areas and Victoria for 11. In addition both States provide a further ‘support’ role across nine other focus areas. Given the large number of potential projects across a range of different investment areas, there is a growing need for State agencies to have a theoretically sound process for guiding the investments that can be made with the limited funds available.

Public support for rural R,D&E has been traditionally justified on the basis of the public good attributes of research, namely the characteristics of non-excludability and non-rivalry. The absence of government intervention in these circumstances would result in an under-investment in socially desirable research by agricultural producers because they are unable to appropriate sufficient benefits. Although there are mechanisms by which government can address this problem (eg. strengthening property rights, levy arrangements to capture industry benefits and limit free riding), such mechanisms are unlikely to fully correct for the under-investment. As a consequence, public funding of rural R&D is still required to achieve efficient outcomes (Productivity Commission 2011).

Although there are sound market failure arguments to support public funding of rural R&D, and substantial evidence of generally high rates of returns arising from such investments (Mullen 1995, Mullen 2007, Productivity Commission 2007, CRRDC 2010), investments in agricultural R,D&E are being made in the context of increasing public awareness and scrutiny, and declining budgets. Increasing financial straits heightens the need for theoretically sound processes for designing proposed projects and deciding which projects to fund, in pursuit of maximum net benefits - keeping in mind the difference between making a good investment (as fully informed as possible) and the right investment (it turns out to be a winner). There is ultimately a high degree of risk and uncertainty about the performance of the research investment and the world in which the results of the successful research will be implemented.

It is inevitable that choosing investments that have potential to give high returns will also result in the selection of some investments that deliver low returns too. The key question for R,D&E organisations is ‘how to select investments and design projects to
give more of the former and less of the latter in their portfolio’. This paper is about meeting the challenge of improving the odds of selecting from the many opportunities more of the investments that are likely to succeed, and selecting less of the projects with the least potential to succeed. The focus is on how to identify and produce the information that is most relevant to improving project design and decisions about selecting investments from the many different opportunities. From a quantitative point of view, the process described in this paper starts at a basic level by identifying expenditure on all the current and proposed projects and how these investments address the risks and opportunities affecting primary industries. Without this information, there is limited scope for proceeding to reliable economic assessments of impact in key program areas of the department. Conducting comprehensive *ex ante* benefit cost analysis across all projects being considered for funding is not practically feasible or economically justified, even if the data limitations that often preclude a defensible BCA being undertaken was not a constraint.

In the following sections, an approach used by the Victorian DPI and a proposed approach for Agriculture NSW are presented. Both approaches aim to provide a base level of information relevant to making better decisions for resource allocation across the breadth of potential investment opportunities available. While there are some differences between the approaches, there are also some fundamental similarities which reflect the necessity of having a pragmatic approach. Pragmatism has to rule, particularly when choosing from a large number of potential projects of quite varied natures, with uncertain research outcomes. While benefit cost analysis (BCA) encompassing risk analysis is still part of the evaluation process, it is not appropriate for all potential projects. Under the constraint extant, screening criteria including threshold analysis are the central and common feature of a pragmatic approach, providing information which informs judgements about the merit of a proposal and also whether the more detailed BCA is warranted. The pragmatic approach is consistent with NSW Treasury guidelines for undertaking feasible economic appraisal (NSW Treasury, 2007) and with the approach used to evaluate and rank investments in agricultural R, D&E in the Victorian DPI.

### 2. Evaluation perspectives

Evaluation is recognised by many organisations as a way to explain why an activity is needed and why the proposed response or intervention is an appropriate choice. In some cases, an *ex ante* evaluation can explain why no activity may be the best course of action. In essence, without a formal and consistent approach to evaluation, the grounds on which some investments are selected above others, and the justification for anticipated benefits, cannot be made. This has implications for both the accountability of research organisations as well as the likely effectiveness and efficiency R,D&E programs.

The basis on which R,D&E investments are made has been the subject of a number of studies. In 2011 the Productivity Commission undertook a review of Rural R&D Corporations. The Commission recommended that (2011, p. 77):

> Government rural R&D programs should be premised on a consistent set of public funding principles. These principles should indicate: the role of investment in rural R&D and the basis for government contribution to its cost; the relationship of R&D policies to other policies intended to improve the
productivity, social and environmental performance of the rural sector; and design features that are likely to enhance the efficiency and effectiveness of individual programs.

The principles were recommended as a basis to guide consistent and effective assessments of public investment across the rural R&D framework. The Commission also stressed the importance of “good program design and robust accountability requirements” to help ensure that available funding is spent wisely. The Australian Government (2012), in its Rural Research and Development Policy Statement has accepted many of the Productivity Commission’s recommendation in this area.

In 2008 the Victorian Auditor General looked at the Victorian DPI approach to setting research priorities, and noted:

A fundamental goal for government is to ensure that public research funds are spent in ways that deliver the desired community outcomes. The process for determining research priorities should assure the community that public funds will flow to the areas of greatest potential economic, social and environmental benefit (p. 2).

The Victorian Auditor General made some recommendations about the Victorian DPI’s approach, suggesting:

- clarifying and communicating the nature and scope of its investment criteria and the method of funds allocation;
- implementing a quantitative analytical approach to prioritising research, based on return on investment and other measures (e.g. cost-benefit analysis);
- demonstrating how the key investment principles and elements will be implemented to ensure achievement of the new directions (this will require the preparation of a formal risk framework, and should include consideration and removal of possible barriers);
- clarifying how the various prioritisation elements, approaches and criteria will work as part of an integrated whole;
- embedding continuous improvement in the new approach; undertaking a more extensive ‘market validation’ process of proposed projects and programs; and
- demonstrating how a satisfactorily high-level of farming community input into decision making will be sought and utilised.

In NSW, economic evaluation by the former DPI and its predecessor organisations has traditionally involved ex post benefit-cost analysis of a limited number of individual projects which broadly aligned with corporate and State plans. Following the ex post review of five investment areas by NSW Agriculture, Mullen (2004) made four points about the relevance of economic evaluation for the department:

- the role of evaluation in meeting external requirements for accountability;
- a process to assist in providing information relevant to priority setting and allocating resources;
to support the design of projects through clearly defined objectives consistent with the role of public institutions; and

to establish a greater appreciation of the paths by which departmental activities have an impact.

Although these points are broadly accepted, the process to implement evaluation and for creating a culture of accepting evaluation is far from straightforward. As noted by Mackay (2011, p.v) in a World Bank report on the Australian Government’s Performance Framework, “… it is not an easy or quick endeavour to build an evaluation system”. Added to this is the fact there is usually not the time or funding to undertake comprehensive economic evaluations of all past and proposed projects.

It is evident that a consistent and sound basis for undertaking project evaluation is not only desirable but also will increasingly become a requirement for the review of activities funded through the National Primary Industries R,D&E Framework. The Productivity Commission (2011, p.95) stated that:

“Because policy and program responsibilities in the rural R&D area are shared between the Australian and State and Territory Governments, introduction of a set of overarching public funding principles would need to occur on a cooperative basis.”

In the following sections, a pragmatic approach for ex ante project evaluation is described. The approach aims to captures the key elements of the public funding principles as set out by the Productivity Commission (2011, Recommendation 4.1) while recognising the challenges associated with economic evaluation of R,D&E investments.

3. Challenges for economic evaluation of RD&E projects

Despite widespread support towards efforts to improve the efficiency and effectiveness of R,D&E, and the specific role that economic evaluation plays, there are many challenges for economists. A basic problem concerns the nature of the outcomes or product of agricultural research itself. Outcomes from investments in agricultural research, across the applied to basic research spectrum, include new knowledge and technologies and changes in methods of science and farming; as well as sometimes expanded knowledge about what does not work and what has potential. “Successful” research can be thought of as supplying new knowledge that helps solve problems. It can include projects that do not deliver an adoptable technology or change in practice as the outcome, but generates knowledge with implications for directions of future research. The new information need not solve the problem; knowing what does not work also has value. The wide range of types of outcomes from different types of research make ex ante evaluation particularly difficult. And, even when, ex ante, there appears to be one most likely avenue to tackle a research problem, history tells that parallel investigations of alternative approaches to solve the same problem can prove valuable. The unlikely prospect comes through surprisingly often.

The challenges of assessing the potential effectiveness of public sector investments in research, extension and regulation/policy, have long been recognised (Alston et. al. 1995; Office of Technology Assessment 1991; Pardey and Smith 2004; Trimmer 2004; Horstkotte-Wesseler et al 2000; Mullen 2004). Reasons include:
the output of activities often being an intermediate product providing input into political or other decisions (Gardiner, 2004);

- the difficulty in establishing a causal link between the activity and the ultimate outcome observed (Trimmer, 2004);

- the nature of public investments being directed at market or regulatory failure problems where benefits often cannot be clearly quantified or measured (Trimmer 2004; US Congress Office of Technology Assessment 1991; Mullen 2004); and

- Long lag times from research discovery to significant adoption.

These points relate to problems of identifying, attributing and measuring the outcomes of public sector investments. In combination, they make estimating the returns from investment a universally difficult and uncertain task.

Many methods are used to try and overcome these issues. For example, Gertler et al. (2011) and Cobb-Clark and Crossley (2003) focus on establishing causality and attribution of benefits and review of methods that can be used to help establish a valid counterfactual, so the impact of a program or project may be estimated with a greater degree of confidence.

Some of the benefits from R,D&E investments relate to environmental improvements or to the supply of intermediate goods. Non-market valuation techniques have been increasingly used to assist in the valuation of environmental benefits (see Treadwell and Short 1997), whilst proxies (such as research publications and number of citations) are sometimes used as indicators (see OTA, 1991) of intermediate outputs arising from investments in R&D projects.

Horstkotte-Wesseler et al. (2000) advise that the method or combination of methods used to support investment decisions will vary depending on the type of data available, resources, staff skills and time available, as well as the economic importance of the decision.

### 4. Experiences and Approaches

#### 4.1 Experiences of Victoria DPI and NSW DPI

Evidence suggests that the odds of selecting projects with good science, good management and high expected taxpayer payoffs are greatest when investment selection uses: the best available information; a structured organisation of information; contemplation of plausible futures, risk, honesty and completeness (Malcolm 2009; Pannell 2012). The capacity to demonstrate an informed and structured approach to project design and resource allocation decisions provides greater confidence that National R,D&E objectives can be met, and an accountability as to how the National R,D&E Framework is implemented by lead and support agencies. The challenge for agencies is to establish processes through which the most relevant information can be identified, and then structured for input into project design and investment selection decisions.

In 2007-08, the Victorian Auditor-General reviewed the Department of Primary Industries agricultural research function and recommended ‘...a quantitative analytical approach to prioritising research, based on return on investment and other measures
(e.g. cost-benefit analysis)\(^1\) (p. 4). Subsequently the Public Accounts and Estimates committee concurred with the Department that when prioritising research the approval process should consider both qualitative and quantitative data. In short, the message was that good public policy required some form of **ex ante** assessment of benefits, costs and net benefits whether it be a research project, a policy change or a specific regulatory reform.

At the same time, it has to be recognised that formal quantitative benefit-cost analysis (BCA) where benefits are valued and streamed over time can be complex, expensive and time consuming. The Agriculture and Fisheries Services (AFS) of the Vic DPI have 600-700 projects underway at any one time. Similarly in NSW there are approximately 900 research projects underway. It is not practical (nor cost effective) to undertake this type of analysis for all projects in Vic and NSW DPI. Yet, improved project appraisal approaches are required.

Until 2004, evaluations in the former NSW DPI largely took place within the Science and Research Division to assess the impacts of particular past research activities. There is little formal evidence that these **ex post** evaluations were used in resource allocation decisions or program planning and design more generally. Although concepts such as the appropriateness of issues, efficiency of investment principles and effectiveness of R&D approaches are recognised in the Department, there has been no clear process by which these concepts are actually implemented in practice. Furthermore, the issue of how to consistently assess the relative merits of a large number of small RD&E projects prior to making a financial commitment for their inclusion to the R&D portfolio has persisted.

The approach adopted in both States has been that, as a general rule, all large projects or programs need a higher level of rigor and investigation such as undertaking a cost-benefit analysis as part of a business case. For smaller projects a less costly approach is adequate. DPI Victoria identified that of its investment criteria used for projects, the net benefits criterion assessment – encompassing rigorous identification of market failure and genuine costs and benefits – was the weakest link and consequently a net benefits analysis was developed and piloted, based on the benefit-cost way of thinking. The process was intended to be generic across the Agriculture and Fisheries portfolios across DPI.

Two key features of the net benefits approach of the Victorian DPI that seem to work well are:

- It is based on economics, not finance. That is, best bets are identified prior to consideration of how these bets may be funded and by whom.
- Economic criteria such as market failure, and identification of the nature and extent of benefits and costs are identified by staff with training in economics, while the process of evaluating all the screening criteria and threshold analysis is done collectively by expert interdisciplinary groups, including economists, scientists, industry specialists.

This approach allows the relative merit of R&D projects to be evaluated in a consistent manner by the same people, and furthermore, by people who understand both the

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\(^1\)For higher level, larger budget programs (eg >$5 million) within NSW Trade and Investment, a Program Evaluation Framework is used which consists of: issue identification and program objectives; option identification and program design; and option assessment (Strategic Policy and Economics, 2012).
science and the economics. The importance of a knowledgeable panel for evaluating R&D projects using screening criteria and threshold analysis cannot be overstated.

In Victoria, an evaluation of the net benefits approach has been conducted each time it has been applied, using a structured discussion. Some findings from this evaluation were:

- The process was suited to assessing projects with a primary focus on economic benefits from agriculture research, development and practice change.
- The training was important for people to have the skills and knowledge to utilise net benefit analysis of projects.
- While the approach facilitates the identification of externalities, it does not support adequately the valuing of environmental and social benefits which are considered in benefit-cost analysis. Projects with significant social and environmental benefits will require separate analysis.
- The process was not tested with policy, regulatory and compliance functions. More tailored approaches would be needed for applications in these areas.

The former NSW DPI endorsed the principles of appropriateness, efficiency and effectiveness as a useful means to structure information relevant to improving both the design of projects and decisions about resource allocation (see Appendix A). The principles are broadly defined as:

- Appropriateness: the extent to which the actions proposed are consistent with organisational objectives and the role of government;
- Effectiveness: the extent to which the actions identified are likely to achieve the objectives proposed; and
- Efficiency: the extent to which objectives can be achieved for a given level of resources.

These principles have been used to structure the screening criteria proposed for NSW DPI.

In Victoria the DPI uses similar criteria, albeit described in different language (see Appendix B). The DPI Victoria talks of criteria such as:

- fit with strategy;
- market failure justification;
- good science;
- nature and size of benefits, costs, net benefits;
- breakeven benefits required; and
- risk.

The first two points align with the concept of appropriateness; good science with effectiveness; and the last three points with the concept of efficiency.

A process that can provide consistent information across projects based on characteristics related to appropriateness, efficiency and effectiveness provides a starting point for understanding the tradeoffs associated with a decision to proceed with one project in preference to another. Although concepts such as the appropriateness of
issues, efficiency of investment principles and effectiveness of R&D approaches are recognised within some areas of the NSW DPI, as are the concepts of market failure and net benefits in the Victorian DPI, processes to implement these concepts are ‘works in process’.

The approach to apply the investment principles described here uses selection criteria and threshold analysis. The qualitative screening criteria and simple quantitative ‘threshold analysis’ focus on strengthening project design and improving information available for selection decisions by:

- clearly identifying the problem or opportunity that is to be addressed;
- ensuring the information and assumptions underlying expert opinion are available and have been subject to review;
- focusing on the attribution of benefits to project activities by documenting the linkages assumed between the activities proposed and the level and extent of change expected as a result; and
- if there are community decisions to be made about the level of change desired, ensuring the costs and tradeoffs associated with those decisions are transparent so informed decisions about the potential outcomes and acceptable costs to taxpayer can be made.

The qualitative and quantitative criteria are discussed below. It should be noted that the methods described cannot be used to identify an ‘optimal’ portfolio of R&D&E investments. Given the scarcity of data, cost of analysis and variety of objectives, such an analysis would in most cases be an exercise in futility. Like any investment portfolio there has to be a balance between risk and reward, including short term benefits (applied research and extension) and enabling longer term advancements.

4.2 Qualitative screening criteria

The rationale for using screening criteria is to make transparent the process of selecting projects from a large pool of potential opportunities and to assess the likely feasibility of those projects. The criteria also provide a basis for describing the current set of investments and how those resources have been allocated in terms of: the issues addressed; industries affected; the actions to be taken by government; the expected benefits; and funding levels and sources. This information can help to inform refinements to the design and selection of new projects and identify key areas where change in the portfolio balance may be needed. Data describing a common set of criteria for current R,D&E investments would represent a significant advance relative to the presently-available set of information.

The screening criteria proposed are used to identify the nature and extent of the problem or opportunity, whether there is a need for intervention (i.e. an investment activity) and if the activity can be done such that a positive change or impact is achievable. The criteria are used to highlight where there are problems relevant for public research and where there may be potential to make a cost-effective intervention (i.e. where the expected returns from public investment are likely to be highest). Emphasis is on a clear definition of the problem or issue and importantly, identifying the logical linkages between the activities proposed and the intended result.
The screening criteria are presented as a set of questions (see Appendices A and B). The two State Departments of Agriculture have tackled the screening process similarly, with some different emphases, as explained below:

(i) screening proposed for NSW DPI uses more than the 7 questions used by Victorian DPI;

(ii) the NSW DPI questions are set out under the broad project evaluation headings appropriateness, effectiveness and efficiency;

(iii) the screening approaches of both State DPI’s were set up so people could do them quickly (for NSW, by selecting responses from drop down lists) and to avoid the tendency for researchers to do large cut and pastes from project applications; and

(iv) Some of the information obtained in the NSW DPI method is not collected in the Victorian DPI process, which is specifically focused only on its net benefit criterion, which commences with tests of ‘fit with strategy’ and ‘market failure’. For example, NSW screening identifies expenditure by funding source by type of issue (e.g. to see if public funds are generally being spent on market failure type areas and industry funds on productivity type areas).

(v) The process used in Victoria involves several stages of peer consultation, from the project proponent initially presenting to a large group of fellow scientists and economists at a Division-wide conference, followed by selected presentation to a multidisciplinary group of senior staff and research managers, to the net benefits ranking process conducted by a small group including an economist, senior scientists and industry specialists. The recommendations from this group are then considered and adjudged by members of the Directorate in a parallel process, and projects selected and decisions about funding of projects are made.

The criteria developed in each State were intended to be generic across the range of primary industries investments undertaken, reflecting the scope of the National Primary Industries R,D&E Framework. The information collected through the screening criteria needed to be relevant for managers seeking to:

1. understand where resources are currently allocated across a wide-ranging portfolio – what issues; what industries; what actions; what benefits; what funding;

2. understand where refinements to the portfolio of investments are possible, in terms of priorities for new areas of work, or areas where investment can be reduced;

3. identify the characteristics of projects with the highest potential payoffs – essentially those that exploit economies of scale and scope and those that exploit spill-in effects, that is, where research undertaken elsewhere can be adapted and applied to a local context (Byerlee and Traxler p.164 in Alston et al. 2001).

4. identify major areas within the portfolio where more comprehensive benefit-cost analysis is warranted.
At a minimum, to justify investment in a project there must be a level of confidence that the benefits will exceed the costs and that the intended outcome would not have been achieved without the proposed activity or intervention (Productivity Commission, 2011).

Many public sector programs will be associated with benefits to the community in the form of improved environmental, social, health or knowledge outcomes. These benefits are intrinsically difficult to measure. In these cases, the assessment of benefits at the screening stage will usually be limited to a description of benefits in terms of type and size of the benefit (e.g. 10% reduction in runoff of nutrients into waterways). As noted by Mullen (2004) subjective judgements from relevant experts about the benefits and costs will continue to be relied upon as part of any assessment process. A key consideration in the design of the screening criteria has been to ensure that the information and assumptions underlying expert opinion are available and have been subjected to review. The intention is to limit the capacity for unrealistic expectations about the size and nature of benefits generated through the activities of a particular project and to provide some basis for considering the payoff from the alternative investments that could be made on behalf of the community. The process of multidisciplinary peer review and discussion in the early stages of a project has been implemented in the Victorian DPI, particularly in terms of ensuring realistic assumptions and expectations are provided in the information used in the project selection process.

Discussion about the appropriateness of a project centres on whether the proposed actions or interventions are consistent with organisational objectives (broadly, the role of government). At any time, the role government plays in practice is essentially based on a consensus about what services the community is willing to pay for and what risks the community is willing to share. Over time the role of government with respect to primary industries has tended to shift away from being a provider of services and more towards a regulator and provider of funding for the provision of services where there are other potential service providers.

4.3 Quantitative screening: Threshold analysis

Threshold analysis is used to provide a base level of quantitative information about a project by providing specific numbers on the scale and scope of impact (change) needed for the benefits to exceed costs (e.g. White, 1999). Providing information in terms of a threshold, switches thought or focus toward the change required (e.g both the level of change and when it takes place), in order to generate benefits needed to achieve a target rate of return given the investment cost. In this way, threshold analysis requires researchers to make their assumptions explicit and available for critical review before an investment commitment is made. It provides the opportunity to think about whether these assumptions and the opportunity for benefits to exceed the costs are realistic and achievable. The plausible counterfactual case (that is, the likely outcome if the investment were not made) must also be made apparent when the scale and scope of impact described.

Threshold values can be particularly useful when a project is expected to have impacts across areas which do not have market values for example social, environmental and health outcomes. By identifying the types of community benefits expected and the public funds contribution, thresholds can be presented in terms of what must be
achieved such that community benefits to exceed the public cost of a project. The threshold for expected community benefits provides information important for considering whether the costs to provide social, environmental and other non-market outcomes are acceptable to taxpayers. In table 1, an example of threshold analysis is shown for both the community benefits and total project benefits. The threshold values shown in columns 4 and 7 are the levels community and total project benefits respectively, would need to achieve in order to recover the public and the combined industry and public contribution to research costs. The thresholds indicate investment costs amortised over 20 years plus a 15 per cent return. To quantify the threshold values, the screening criteria included questions to identify the potential target area or range relevant to the research (Qu. 3 in Appendix A). Using this information, and assuming a conservative level of adoption across only 10 per cent of the potential range identified (see table 1 footnote), a threshold for the annual community benefit per unit of impact could be estimated (column 5). State government funds proposed for the project are shown in column 8 as a proportion of the total project cost.

The information from threshold analysis is intended to support a discussion around effectiveness and efficiency: how realistic the expected community benefits are; the likelihood of the research realising such benefits; and whether the estimated threshold values for the community benefits are acceptable to the public. While threshold analysis cannot be used to rank projects, the likelihood of a project achieving the stated community benefits could be scaled as either, high, moderate or low. The scaling would be based on information provided in the screening criteria about the level and type of change expected and the logical links between project activities and the expected change. These rankings have would need to be based on consensus from experts and relevant research managers about how realistic or strong the assumptions were.

Included in information in the screening and threshold analyses is judgements about relative risks of alternative investments, with risks encompassing (i) risk of the research being successful in achieving its stated objectives, (ii) risk associated with the identification and the size of the benefits which encompasses variability around the mean yields, prices and assumed rates of adoption and (iii) risk associated with the identification and size of the costs in the analysis.

Understanding the risk involved in public investment, or in public and industry co-investment, is not straight-forward because it depends to an extent on the scale of the investment in question. In the theory, in the context of large scale public investment, the public is naturally hedged across projects and through time. This means that the investment appraisal is only interested in the expected value of the net benefits; the relative risks as evidenced by different distributions of possible net benefits from different investments is not relevant. A different situation applies at the smaller scale of total investment that is typical of State Departments of Agriculture and which usually involves a mix of public and private (industry) funds. The involvement of private funds and the small scale of the investments means that the appropriate risk analysis approaches are more akin to the standard approaches used in private investment analysis, viz: probability analysis, scenarios, sensitivity testing, thresholds. Ultimately, in the face of risk and uncertainty, the investor can only be brutally honest, rigorous, complete and transparent about what is known, what occurrences lend themselves to forming probabilistic judgements about likelihood, and what aspects of the investment are unknowable.
<table>
<thead>
<tr>
<th>Project</th>
<th>Problem addressed</th>
<th>Expected community benefit(s)</th>
<th>Threshold value Annual for annual community benefits per unit*</th>
<th>Likelihood of achieving intended community benefit</th>
<th>Annual threshold value of benefits to cover NSW CR investment</th>
<th>NSW CR contribution as % of total project cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Herbicide resistance in major weeds of northern farming systems.</td>
<td>Environmental and health benefits from reductions in chemical use or through improved practices. Delay in the onset of resistance to herbicides with low environmental impact.</td>
<td>$47 443 per ha</td>
<td>High/moderate/low</td>
<td>$196 980</td>
<td>24%</td>
</tr>
<tr>
<td>B</td>
<td>Increasing the productivity and resilience of grazing systems through the development and use of low improved tropical perennial pastures, legumes and related agronomic practices.</td>
<td>Provide forage for livestock enterprises, reduce water consumption reducing the affects of drought etc and climate change and the need for govt assistance.</td>
<td>$37 300</td>
<td>High/medium</td>
<td>$55 511</td>
<td>67%</td>
</tr>
<tr>
<td>C</td>
<td>Understanding the impact of future climates on wheat production in mixed farms future climates.</td>
<td>Reduced exposure to calls for industry assistance due to the resilience of farming systems that are resilient to moderate/low future climates.</td>
<td>$15 976</td>
<td>High</td>
<td>$62 307</td>
<td>26%</td>
</tr>
<tr>
<td>D</td>
<td>Reducing groundwater accessions, improved water quality, reduced erosion and land nutrient loss, salinity, increasing soil biodiversity.</td>
<td>Improving soil health (erosion, degradation, nutrient loss), preservation of grassland biodiversity while increasing productivity in mixed grazing systems</td>
<td>$191 791</td>
<td>High</td>
<td>$306 555</td>
<td>63%</td>
</tr>
<tr>
<td>E</td>
<td>EPIC has hydrology research sites</td>
<td>Cost efficient data collection on amount of water which is required to provide to the downstream uses.</td>
<td>$8 129</td>
<td>High</td>
<td>$22 028</td>
<td>37%</td>
</tr>
</tbody>
</table>

^ per year threshold values based on a 15 per cent return over 20 years.

* “Agricultural technologies are typically adopted over 10 to 60 per cent of their potential range, depending on a well understood range of factors, including economics, the complexity of the technology, and its compatibility with current management systems” (FFI CRC Interim Business Plan 2007-08 to 2013-14, p. 44). A conservative assumption of adoption of 10 per cent of the area specified has been used to estimate the cost per unit which the project has relevance to.
5. Concluding comments

Investing in good projects which provide useful and relevant contributions to industry and scientific knowledge is an objective of each State government engaged in primary industries R,D&E. While each State has their own unique set of circumstances, there are common considerations and much that can be learnt from efforts to improve the processes used for investment selection for a diverse portfolio of R,D&E investments. From the approaches discussed in this paper two broad conclusions emerge.

First is that although there is no single approach to divine which projects represent the highest payoff projects before an investment is made, there are similarities in the information considered useful for improving project design and for selecting more of the projects likely to yield positive results. This information has been presented in the examples of selection criteria (Appendix A and B) and discussion of threshold analysis. At the very least, application of these methods should allow projects which are highly unlikely to meet the three criteria of appropriateness, effectiveness and efficiency to be identified and (hopefully) avoided.

Second is that pragmatism has a role to play if resources are to be used wisely in the process of assessing high payoff projects from the large number of opportunities addressing the diverse range of issues. The approaches here provide a reasonable starting point for gaining a perspective across investment opportunities that takes into account the information most relevant to increasing the odds of selecting good projects for an R&D portfolio, in a consistent and transparent way. These approaches are still works in progress but having a theoretically sound and workable approach to \textit{ex ante} project assessment is increasingly important as budgets decline and decisions about whether to continue, increase or cease lead agency responsibilities under the National R,D&E Framework need to be made. Importantly, organisations will need to recognise the importance of and opportunities provided by \textit{ex ante} assessments if public sector R,D&E resources are to be maintained and justified as used to the best community advantage.

The approach of using selection criteria is a pragmatic approach to \textit{ex ante} investment evaluation. It starts with collecting enough of a range of information about the research and the industry to which it is relevant across a large number of projects, to undertake a basic appraisal, including a threshold analysis of benefits and costs. This information, in a form guide along with robust screening criteria about fit with strategy, market failure, appropriate agency, quality of science, size of industry and risk factors, make for better informed bets of scarce research resources on unlimited research chances.

There are links between improved project design and selection and improvements in the productivity of R,D&E agencies – productivity improvement being particularly important in times of declining budgets. Sound project design and selection can generate improvements in the productivity of R,D&E functions by reducing the risk of scarce labour and capital being used on projects unlikely to realise useful or informative results. Theoretically sound processes need to support investment decisions so as to improve knowledge about what works and what does not work. This is particularly important when outcomes are sought through changes in farming and natural resource systems where biological interactions are complex and vary over time and by location.

It is worth noting that, ultimately, the pragmatic approaches discussed in this paper only work effectively when the culture of the organisation is compatible with an evaluation ethos. In particular, the key to effective implementation of R,D&E investment
evaluation, as found in the Vic DPI experience, is having disciplinary specialists working together, and all working closely with staff with economics training. In the battle against uncertainty and ignorance, pooled knowledge is the best weapon.

References


Rural Research and Development Council, 2011. National Strategic Rural Research and Development Investment Plan, Department of Agriculture, Fisheries and Forestry, Canberra.


Appendix A. Proposed NSW DPI Screening criteria for projects

The following screening criteria are designed to collection information specifically in relation to RD&E projects addressing primary industries issues. The criteria are designed to collect a base level of information to enable more detailed consideration of:

- whether the intervention method being proposed is appropriate given the nature of the problem identified and likely public and private benefits;
- the causal relationship between the activity proposed and the result intended;
- whether there could be more cost-effective alternatives for achieving the intended results;
- the need or scope for cost-recovery.

Screening criteria for projects are broadly grouped according to three investment principles (see Section 4.1):

** Appropriateness
  - Extent to which the actions are consistent with organisational objectives and role of government.

** Effectiveness
  - Extent to which the actions identified are likely to achieve the objectives proposed.

** Efficiency
  - Extent to which objectives can be achieved for a given level of resources.

Note that efficiency criteria draw on information collected under appropriateness and effectiveness in order to assess thresholds and indicators for efficiency. It is intended that the information collected through the screening criteria (including the threshold analysis) be presented to a panel for peer review, discussion and decisions on the projects that will be supported for inclusion in the RD&E investment portfolio.

The approach presented here relates to RD&E projects. For higher level, larger budget programs (eg >$5 million) within NSW Trade and Investment, a Program Evaluation Framework is used which consists of: issue identification and program objectives; option identification and program design; and option assessment.

Basic information is collected on the project such as Title; Unit; and Program. The following screening criteria are then worked through.
<table>
<thead>
<tr>
<th>Screening criteria</th>
<th>Purpose</th>
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<tr>
<td><strong>APPROPRIATENESS</strong></td>
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</table>
| 1. Which areas of the organisation’s strategic plan does the project relate to:  
  (list Key Result Areas to select from)                 | This question identifies whether the project is aligned with and contributes to specific areas of government responsibility as set out in the Strategic Plan. This information would be used to document the level of investment and activity taking place across strategic plan priorities. |
| 2. Which industry group or cross sectoral issue does the problem (or opportunity) affect or relate to?  
  - User to select from list of the National RD&E Priority Areas  
  - For industry sectors, key statistics such as area, gross value of production, number of producers can be used to consider how realistic expectations are regarding the potential scope and significance of the issue being addressed and the proportion of the industry that could reasonably be affected by the proposed activity (ie in following questions). This provides a reference point on the magnitude or importance of the issues or industry being addressed.  
  - When collected across all projects, the responses to this question can be tabulated to show the number (and cost) of investments made and proposed across each R,D&E Priority Area. | These industries and cross-sectoral issues align with the National Primary Industries R,D&E Strategy and provide information about which R,D&E priority areas the project relates to. For industry sectors, key statistics such as area, gross value of production, number of producers can be used to consider how realistic expectations are regarding the potential scope and significance of the issue being addressed and the proportion of the industry that could reasonably be affected by the proposed activity (ie in following questions). This provides a reference point on the magnitude or importance of the issues or industry being addressed. When collected across all projects, the responses to this question can be tabulated to show the number (and cost) of investments made and proposed across each R,D&E Priority Area. |
| 2. What is the specific problem (or opportunity) being addressed? | This is a brief and succinct description of the problem or issue the project intends to address – ideally a single sentence that gets straight to the point. This is not a recite of the project objective. |
| 3. What is the scale of impact of the problem (or opportunity)?  
  (eg Number of hectares affected; tonnes of grain; numbers of livestock affected, total ML.) | Estimating the scale of impact of a problem will indicate the significance and scale of the issue being addressed. (eg Number of hectares affected; tonnes of grain; numbers of livestock affected). |
| 4. What is the basis or reasoning for the scale of the problem indicated above? | A brief statement supporting the basis for the above scale of impact associated with a particular problem or opportunity – only a single sentence is required. For example:  
  - this issue affects X per cent of the NSW wheat industry – equivalent to approximately XX tonnes and XX hectares.  
  - Water quality indicators indicate X and Y. Annual nutrient runoff from agricultural land use in the catchment is a major contributor. |
| 5. Which of the following broad areas does the problem identified relate to:  
  a. Degradation of the resource base (either land, | This section categorises some of the main market failure and government failure issues. Issues not addressing such areas identify services that should be charged for using appropriate principles of cost-recovery. |
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<td></td>
<td>water, air, fisheries);</td>
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<td></td>
<td>b. Coping with extreme events (either climate or market related);</td>
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<tr>
<td></td>
<td>c. Reputation of product quality (such as disease or contamination-free status, animal welfare);</td>
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<tr>
<td></td>
<td>d. Control of disease and pest incursions;</td>
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<td></td>
<td>e. Identification or testing services;</td>
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<td></td>
<td>f. Provision of key information not available through other sources;</td>
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<td></td>
<td>g. Uncertainty of key information;</td>
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<td></td>
<td>h. Policy uncertainty;</td>
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<td></td>
<td>i. Ineffective policy;</td>
</tr>
<tr>
<td></td>
<td>j. Other.</td>
</tr>
</tbody>
</table>

6. What type of activity is being proposed?
   a. Science and Research;   
   b. Practice Change and Adoption;   
   c. Skills Development;   
   d. Commercialisation;   
   e. Regulation.   

These are the main categories of government intervention used by the department. Information in this field provides a snapshot of the activities being used to address particular issues. Project may involve combinations of activities, for example (a) and (b).   

7. How will the NSW community benefit from the activity proposed:
   a. Better environmental outcomes (eg water quality, GHG emissions, land degradation; biodiversity);   
   b. Improved food safety for consumers;   
   c. Lower market prices;   
   d. Protecting public health (eg animal disease, surveillance and control);   
   e. More reliable and consistent food supplies;   
   f. Improved animal welfare outcomes;   
   g. Reduced need for industry assistance (ie EC);   
   h. Reduction in biosecurity risks;   
   i. Increased knowledge of food qualities (ie source of nutritional values);   
   j. Improved product information systems (eg NLIS);   
   k. Maintenance of germplasm;   

This question seeks to identify at a broad level the nature and extent NSW community benefits offered by a proposed project. This listing is based on an internal review of activities undertaken across Agriculture NSW in 2007 prepared by John Mullen. This information can be used to see if the anticipated community benefits are realistic and logical given the issue being addressed and the activities proposed to generate the change needed.   

As with several of the screening criteria, answers to a question can be used to examine the efficiency aspects of a project by aligning responses with information on the funding source. This can provide a base insight into the rationale behind level of public funds contributed and the types of community benefits anticipated across all projects.
1. Conservation of biodiversity; 
   m. Maintenance of critical scientific capacity (e.g. spillovers to human health and environment); 
   n. Industry or private benefits only; 
   o. Not sure.

8. Provide a specific example(s) of the above community benefit.

### EFFECTIVENESS

10. The activity will achieve results through changes that affect:
   - Disease, pest and weed management;
   - Plant improvement;
   - Livestock improvement;
   - Soils management;
   - Water management;
   - Food Safety;
   - Disease surveillance;
   - Animal welfare;
   - Emergency management.

11. Which of the following areas will be affected by the activity:
   - Production systems (i.e., changes to input costs or yields)
   - Markets (e.g., access)
   - Environment
   - Human health
   - Animal welfare

12. What level of change could be expected:
   - With the project?
   - Without the project?

Questions 10 and 11 relate to documenting the causal relationship assumed between the activity proposed and the intended results.

The areas through which change will take place to bring about an intended result (i.e., the results pathway) are important to document so as to discern if logical and sound pathways for impact are built into the project design.

This question provides an indication as to how the proposed action will generate a change, and broadly whether there are market and/or non-market effects anticipated.

Information from this question can be compared with information about the source of funding for projects. For example, projects mostly in the area of production systems and markets would be expected to be associated with high levels of industry funds, while in areas of environment, human health, and animal welfare, the level of government funds would be expected to be greatest.

This area collects information for the counterfactual case (i.e., what would most likely occur if no action were taken) so the change attributable to the project (as opposed to other factors) can be more clearly understood.

Projects may lead to change in one or more areas. The user can select from a list of adopter-level changes in: yield; quality; area; practices; costs; institutions (laws, regulations, policies); attitudes; risk; or research capacity. The list of adopter-level change areas is based on the
13. Are there alternative ways this problem could be addressed?
   a. Yes;
   b. No;
   c. Don’t know.
   There may be many ways to achieve a given outcome. The least cost way of achieving a particular level of outcome is always preferred. If yes or don’t know are selected, this indicates additional information about the alternatives may be sought.

14. What indicators could be used to help measure or verify the expected result?
   Identify suitable possible indicators to measure or verify extent to which an expected result is realised.

15. Are there any factors that would cause you to reconsider investing in this project?
   These are the risks or factors beyond the department's control which could affect the value of the investment made.

16. The outputs of the project are in the form of:
   a. New/ Improved management practices
   b. Trained human resources
   c. New germplasm
   d. Storage of genetic material
   e. Knowledge on policy and better understanding of the socio-economic environment
   f. New institutions
   g. Advances in science (methods, techniques, discoveries).
   These main project outputs were based on material from the CGIAR Science Council, Strategic Guidance for Ex Post Impact Assessment of Agricultural Research. These may be revised to better reflect the activities undertaken by Agriculture NSW.

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**EFFICIENCY**

17. Project costs (ie salaries, operating, overheads) by funding source:
   - State CR (salaries, operating, overheads);
   - Commonwealth CR (salaries, operating, overheads);
   The split of project funds by cost type and funding source provides transparency for what types of costs are covered by different funding sources. Understanding how projects, either currently or intend to, recover costs is important to understand the relative share of costs between different beneficiaries. This accountability can help to ensure principles of cost recovery are correctly and consistently applied and will make the expected benefits for both State and Commonwealth tax payer groups clearer.
<table>
<thead>
<tr>
<th>Industry levies (salaries, operating, overheads);</th>
<th>Threshold values can then be identified using the information provided under the appropriateness and efficiency headings above to indicate the extent of payoff to the NSW community from the investment made on behalf of taxpayers, but also for industry and broader national interests.</th>
</tr>
</thead>
<tbody>
<tr>
<td>other private sector (salaries, operating, overheads)</td>
<td>This question seeks to provide an indication of the composition of the activity based on the main categories of government intervention.</td>
</tr>
</tbody>
</table>

18. Estimated percentage of budget allocated to:
   a. Science and Research;
   b. Practice Change and Adoption;
   c. Skills Development;
   d. Commercialisation;
   e. Regulation.
Appendix B: VICTORIAN DPI NET BENEFIT ANALYSIS: THE SEVEN KEY QUESTIONS

An Introduction for Project Proponents

This information sheet provides a brief introduction to undertaking a simple assessment of net benefits analysis for ex ante evaluation of projects or programs. This does not substitute for economic advice when a detailed net benefit analysis is required, but provides key factors for proponents to think about in initial development and design of new projects or programs.

The net benefits analysis is one of the mandatory selection criteria used by Project Assessment Groups for determining investment in projects and programs in the Agriculture and Fisheries Group Investment Framework. It needs to be considered in conjunction with all the investment criteria and after the role of government and alignment to strategy criteria, plus the ‘good science’ criteria have been assessed and met.

Net Benefits are defined as ‘the marginal benefits minus the marginal costs no matter whether the benefits and costs are economic, environmental or social in nature’. At a minimum to justify any investment, the expected benefits need to exceed costs, to deliver a net benefit. Determining who receives the benefits and incurs the cost will then inform the potential need for co-investment by the beneficiaries.

A ‘fit-for-purpose’ approach is to be used in applying the net benefits analysis depending on the size or ‘sensitivity’ of the investment in the Agriculture and Fisheries Investment Framework. As the size and the sensitivity of the investment increases, so does the need for the greater rigor with quantification and validation of the estimated benefits. As a general rule, all large projects or programs (i.e. greater than $1,000,000 pa in value) should be analysed using formal quantitative Benefit Cost Analysis / Return on Investment and Risk tools. The analysis should be developed and key assumptions tested with economists, technical experts and next users/end users. Economic expertise held in Divisions and Economics and Policy Research Branch can provide advice on the quantitative tool to use. For smaller investments, where the benefits are primarily economic, such as farm productivity R,D&E, the value of benefits may be able to be estimated using a gross annual benefit analysis. Where the benefits are primarily environmental or social, it may be very difficult to put a monetary value on the benefit and may be limited to a description of the benefits in terms of type and size of the benefit (e.g. reduction of 10% runoff of nutrients into waterways).

The net benefit analysis should expose and test underlying key assumptions (e.g. estimated adoption rate) so that there is no major exaggeration of the benefits. Testing the assumptions with some key people outside the project team with an understanding of the area or industry, with technical expertise and economic expertise will help confirm the assumptions being made. It may be important to monitor and measure these assumptions in any ex post evaluation of the project or program.

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Defined as total project investment including external fund sources.
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<tr>
<th>Key Question</th>
<th>Potential Specific Questions</th>
<th>Comment</th>
</tr>
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</table>
| What is the extent of problem being addressed?   | What is size of the problem, issue, industry or sector that might be affected by the results of the project.  
Note: benefits are always defined as all gains above what would otherwise have happened without the innovation.                                                                 | This provides a reference point on the magnitude or importance of the issues or industry being addressed. Care needs to be taken that figures are realistic and not inflated beyond the impact or influence of the project. For example if the benefits of a project are solely in terms of on farm productivity then farm gate prices and volumes should be used. Where possible figures should be used for Victoria but this does not exclude also incorporating Australian figures, where there are expected to be significant spillover benefit for over states or the project has a national context. Any facts or figures should be referenced where possible. The Australian Bureau of Statistics, Australian Bureau of Agricultural Economics and Sciences and DPI's statistics intranet page are a useful reference. If figures are extrapolated, this assumption needs to be stated and should be tested with economists or experts in the field. |
| What are the types of benefits that will be involved? | What is the likely nature and form of direct (primary) benefits of the product or service. Define the likely benefits to next users/end users (e.g. changes in profitability, or costs avoided on-farm) following adoption and successful implementation of the output of the investment. Indirect (secondary) benefits are dealt with separately in the section on Externalities below.  
Note: benefits are always defined as all gains above what would otherwise have happened without the innovation.                                                                 | This question identifies the type of direct (primary) benefits in terms of the change it will bring about in addressing the outcomes in the Agriculture and Fisheries Four Year Strategy where possible in quantitative terms (e.g. increased productivity through a 10% yield increase in wheat, reduced environmental impact through a 5% reduction in methane emissions, half the time in incursion identification). Other indirect or secondary benefits – such as improved environmental quality - are dealt with separately in the section on Externalities below. Estimations should be based on any available evidence of previous similar work in the area and tested with technical experts. |
| What is the value of the primary benefits?        | What is the likely monetary value of the primary benefits in dollar terms?                                                                                                                                                     | This is only likely to be possible if the benefits are primarily economic. Try to translate into dollar net benefits on the individual farm business (e.g. net increase in income) or if more appropriate at the industry level (e.g. reduced eradication/control costs of incursions. The key assumptions or factors that will influence the value of net benefits need to be clearly described. For large investments formal economic tools may needed whereas for smaller investments it may be sufficient to estimate the net annual benefit (for more advice speak to an economist and/or senior manager) |

In estimating the value of primary benefits, all costs of adoption for landholders to changing their practices or compliance to regulations need to be included.
<table>
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<tr>
<th>What is the likely extent of adoption?</th>
<th>Furthermore, costs can also be in the form of reduced benefit. This step translates the value of benefits from within an agriculture system (such as at an individual farm business level) to the macro scale in terms of economic, environmental or social benefits to an industry / State of Victoria. Estimates need to be made of expected rates of adoption or compliance taking into account whether the project is targeted at any particular segment in the market or industry or area of the State. For example a practice change that involves substantial capital investment by landholders (e.g. precision farming) may only be likely taken up by producers that have the scale to realise the benefits. A time should be provided when the estimated/target level of adoption will be achieved.</th>
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<tr>
<td>What is the risk of achieving the benefits?</td>
<td>In qualitative terms, how risky are and what are the ranges for the estimates of the benefits? This refers to the probability of success in being able to deliver the outputs of the project (technical success) as well as the probability of the outputs being adopted and resulting in the desired outcomes (market success). The approach to risk involves being honest, complete and rigorous. Identify all the sources and types of risk and how these affect the key variables in the proposal. There needs to be an indication of the level of sensitivity and confidence (e.g. low medium or high) around the key variables (e.g. yield, price, adoption rates). It may be useful where there are one or two factors that strongly influence the estimates to calculate the break even point (e.g. the level of adoption for when the net benefits are at least zero or positive.</td>
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<td>What is the Primary cost of the investment?</td>
<td>What is the total primary or direct cost of the proposed investment? This includes the financial costs in dollars of the research and the implementation of innovations, and other direct costs, whether or not a dollar value can be attributed to them. How does this compare relative to other actual and proposed investments in the portfolio? Also define and estimate costs of adoption and implementation of next users /end users. In qualitative terms, how risky are the estimates of the cost? The primary or direct cost includes all costs to get the product to the end users whether by government or industry through co-investment. A sense of the level of investment by DPI in this area compared to other investment by DPI to address this industry or issue is useful to understand whether the project is scoped at the right size.</td>
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<tr>
<td>Externalities</td>
<td>What secondary (indirect) benefits, might be generated as a Positive secondary effects need considering. Secondary benefits are those benefits.</td>
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result of the roll-out of the product or service, whether they can be valued or not? (e.g. increased negative externalities or reduced positive externalities?)

that are not a key driver for undertaking the work. For example, conducting an extension program may have the secondary benefit of increasing farmers resilience through the social interaction of the network formed. Also if an innovation reduces a negative technical externality from a system, this is a positive secondary benefit to identify at least, and quantify if possible. Secondary economic effects, such as increased economic activity in a region as a result of the innovation often described as multiplier effects, are not usually genuine benefits and should be ignored. Reduced economic activity in an area is not a genuine secondary cost unless the resources affected are to be permanently unused forever.

These are also negative externalities (i.e. cost imposed on society from an activity), or reduced positive externalities, that could result from adoption of the intervention. These externalities are of a technical or non-pecuniary nature, such as increased pollution or animal welfare issues for example due to more intensive practices...

Where relevant, these negative secondary effects should also be identified and quantified if possible.