Estimating the returns on investment of a Cooperative Research Centre: the case of the Invasive Plants CRC

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Summary  To achieve funding for renewal a Cooperative Research Centre (CRC) is required to demonstrate that it will meet a number of key economic criteria. In particular, a CRC must show that it will contribute substantially to Australia's economic growth and provide a suitable return on invested funds. An economic analysis was undertaken to provide support to a renewal bid by the proposed Invasive Plants Cooperative Research Centre (IPCRC). This analysis indicates that such an investment in weeds research generates a benefit to the Australian economy of $2,071m over 25 years, and generates a high return on investment with a benefit-cost ratio of 56:1.

Keywords  Weeds research, productivity, benefit-cost analysis.

INTRODUCTION

The Cooperative Research Centre for Australian Weed Management was initiated in 2003 and completes its current term in June 2008. A new Invasive Plants Cooperative Research Centre (IPCRC) has been proposed to continue the work of weeds research and development at a national level.

There are four assessment criteria by which any renewal proposal for a Cooperative Research Centre (CRC) are judged (https://www.crc.gov.au/):
1. The outcomes will contribute substantially to Australia's industrial, commercial and economic growth.
2. The path to adoption (commercialisation/ utilisation) will achieve the identified outcomes.
3. The collaboration has the capability to achieve the intended results.
4. The funding sought will generate a return and represents good value for the taxpayer.

To meet these assessment criteria requires a rigorous economic evaluation, particularly pertaining to criteria 1 and 4. The purpose of this paper is to present the findings of such an economic evaluation of the returns on investment of the proposed IPCRC.

MATERIALS AND METHODS

CRC Structure  The proposed IPCRC is structured into three business units, each with a number of research programs. Each program also has a number of research themes. The business units and programs are summarised as follows:

Business Unit 1: Integrating people, products and delivery
- Program 1.1 Regional capacity
- Program 1.2 Skills building
- Program 1.3 Communication
- Program 1.4 Landscape integration

Business Unit 2: Production systems
- Program 2.1 Cropping systems
- Program 2.2 Permanent pasture and forestry systems

Business Unit 3: Protection
- Program 3.1 Protection and restoration of natural assets
- Program 3.2 Prevention

This structure recognises the need for a more effective and coordinated dissemination of existing research information (Business Unit 1) as well as the need for ongoing weed research (Business Unit 2) and protection from new weed invasions (Business Unit 3).

Framework  The Allen Consulting Group, in reviews of the Australian Research Council grant system in 2003 and the Cooperative Research Centre program in 2005, recommended a 'top-down' method for quantifying research benefits from integrated programs based on measuring changes to industry productivity (Allen Consulting Group 2003). Identified were the following issues that CRC applications should address in the forward-looking economic impact statements that accompany their applications:
- The opportunity cost associated with investment into the project.
- The extent to which a final economic benefit will be attributable to a project.
- The costs incurred by end users in adopting or applying research.
- The time lags involved between commencement of research and achievement of a final economic benefit.
- The plausible quantification of future benefits that may be delivered.
The risk that a project will not succeed in delivering some or all of its intended outcomes.

The conversion of future economic impacts to net present value terms.

In an assessment of the proposed CRC for Beef Genetic Technologies, Griffith (in press) identified three types of economic benefits that could result from new research programs:

- Benefits that result from completely new research that has not been previously undertaken and would not have been undertaken without the proposed CRC.
- Benefits that result from enhanced research outputs that have a greater impact on the industries than would have been derived from other research programs that may be undertaken by the same agencies (i.e. better technologies that come out of the proposed CRC research programs that improve on the outputs of other programs in similar areas).
- Benefits that result from the extension to the industries of improved information that can legitimately be attributed to the proposed CRC activities (i.e. the faster and/or more widespread adoption of new technologies).

The potential benefits from the proposed IPCRC research appear most likely to fall into the second and/or third categories, where this investment adds to the level of research in the weed-affected industries and the CRC actively promotes the research outcomes. To be consistent in addressing these issues in the economic evaluation a ‘top-down’ approach was used to evaluate the proposed research programs of the IPCRC. This involved specifying appropriate ‘with-CRC’ and ‘without-CRC’ scenarios to account for opportunity costs, identifying differences in the underlying rate of productivity growth in relevant industries, adoption rates and lags, and the probability of success of individual research programs. Expert opinion was used to disaggregate the shares of potential productivity growth due to the IPCRC across the various outcome areas, and the benefits of the expected shifts in these outcomes were then estimated.

The industries considered relevant to the IPCRC evaluation are grains, beef and sheep. The grains industry is an aggregation of wheat, barley, oats, canola and pulse commodities, and the sheep industry is divided into separate sheep-meat (lamb) and wool industries. The DREAM research evaluation program (Alston et al. 1995) was selected as the appropriate modelling framework as it has been widely used in impact assessment studies over a number of years and is officially supported and sponsored by agencies such as the International Food Policy Research Institute and the Australian Centre for International Agricultural Research. It has a rigorous theoretical base and a credible history of applications. The ‘horizontal multi-market’ model option was adopted in DREAM, which allows evaluation of the economic impact of a new technology where the product is (relatively) freely traded across a number of regions (Alston et al. 1995). Such an approach has also been used to evaluate the Sheep Cooperative Research Centre (Vere et al. 2005). Each Australian state is represented in the model as a separate region along with major international trading partners and competitors. The market component of the model requires data on equilibrium prices, quantities and market demand and supply elasticities for each region.

**Data** The main data assumptions made in the evaluation relate to the change in productivity due to the IPCRC and how the contributions to a change in productivity are apportioned across the different research areas. Australian Bureau of Agricultural and Resource Economics (ABARE) data indicate that current actual annual productivity growth has been 1.8% for the grains industry, 2.1% for the beef industry, 1.6% for the lamb industry, and 1.2% for the wool industry. Using relevant industry adoption rates, the potential annual productivity growth rate are 3.6%, 8.4%, 8.0% and 6.0% respectively.

In the case of the grains industry, the historical (30 years) annual rate of productivity growth has been 3.3%, indicating a major substantial reduction over the past decade to 1.8%. This is likely due to a lack of new technologies (such as replacement herbicides and improved crop varieties) and an increase in environmental and pest problems such as herbicide resistance, salinity, soil erosion and crop diseases. We assumed that the IPCRC could contribute to ameliorating some of these problems by lifting productivity in all four industries. Considerable effort was made to be conservative in the estimates of potential annual productivity growth improvements due to an IPCRC and for the assumptions to be explicit and defensible. The assumed with-IPCRC and without-IPCRC productivity changes are given in Table 1.

The contribution to productivity growth with and without the IPCRC was disaggregated by region and by each research theme. For the grains industry the following research themes were identified:

- New technologies to control weeds in crops.
- Systems approach to weeds in cropping.
- Herbicide resistance management.

For the grazing based industries the relevant research themes are:

- Enhancing biological control.
• Productive management of unpalatable/unproductive grasses and shrubs.
• Better management of toxic and injurious species in pasture.
• Systems research for better weed management in grazing lands.

For each research theme data were derived through a workshop process. The key data were the contribution of each research theme to industry productivity growth, the probability of success from research, the lag (years) in research and development before industry adoption commenced, the maximum level of adoption within an industry, and the time taken to reach maximum adoption (adoption lag). The data (not reported here) were specified for the with- and without-IPCRC scenarios and regionally defined (north, south or west). Data were also obtained from the potential benefits of the Protection Business Unit.

Market data were obtained from a number of published sources. These include commodity prices, production and consumption quantities, and supply and demand elasticities.

The total costs of weeds research were estimated (over the seven year life of the CRC) to be: with-IPCRC $92.9m, without-IPCRC $49.8m, net-IPCRC $43.1m. Discounted to present values at a 4% discount rate, the research and adoption costs were $79.7m, $42.7m and $37.0m respectively. These discounted costs were then apportioned across each business unit and research theme. In this study Business Units 1 and 2 were combined for the benefit-cost analysis.

**RESULTS**

**Estimation of industry benefits** The industry benefits reported for all four industries (Table 2) are the discounted present value benefits derived over a 25 year period. The marginal benefit attributable to the additional investment in the IPCRC is a present value of $2,071m. This is derived from $2,721m in benefits from with-IPCRC less $651m research benefits from the without-IPCRC scenario. The beef industry is the largest beneficiary from the IPCRC ($881m), followed by the grains industry ($660m). These results do not include the costs of research or extension programs, which will be an important factor in realising the estimated benefits. Also, costs of implementing some of the technologies by end-users are unknown at this stage.

Of the total discounted industry benefit of $2,071m, approximately 87% ($1,830m) is derived from the combined Business Unit 1 and 2, and the remaining 13% ($262m) is from the Protection Business Unit.

**Benefits from enhanced adoption** The economic benefits derived from Business Units 1 and 2 ($1,830m) are an aggregation of the gains from increased productivity and enhanced adoption. The contribution of these two components was estimated by running the with-IPCRC scenario incorporating the without-IPCRC adoption parameters. The difference in the estimated present value of research and development benefits from the DREAM model between the two scenarios is a measure of the economic benefits of enhanced adoption. This resulted in an estimate of the benefit attributable to enhanced adoption by the CRC of $1,676 million, and the balance of the benefit ($154 million) is attributable to improved productivity (Table 3). The enhanced adoption benefit represents 92% of the total benefit from Business Units 1 and 2.

There were significant differences between the industries in terms of the contribution of enhanced adoption and improved productivity towards the total industry IPCRC benefits. Improved adoption accounted for $437 million (88%) of the grains industry

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**Table 1.** Potential rates of annual productivity growth with-IPCRC and without-IPCRC (%).

<table>
<thead>
<tr>
<th>Industry</th>
<th>With</th>
<th>Without</th>
</tr>
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<tbody>
<tr>
<td>Grains industry</td>
<td>4.35</td>
<td>3.60</td>
</tr>
<tr>
<td>Beef industry</td>
<td>8.70</td>
<td>8.40</td>
</tr>
<tr>
<td>Lamb industry</td>
<td>8.30</td>
<td>8.00</td>
</tr>
<tr>
<td>Wool industry</td>
<td>6.20</td>
<td>6.00</td>
</tr>
</tbody>
</table>

**Table 2.** Industry benefits for grains, beef, lamb and wool industries from investment in research with-IPCRC and without-IPCRC ($m).

<table>
<thead>
<tr>
<th>Industry</th>
<th>With</th>
<th>Without</th>
<th>Net</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grains industry</td>
<td>923</td>
<td>264</td>
<td>660</td>
</tr>
<tr>
<td>Beef industry</td>
<td>1,021</td>
<td>140</td>
<td>881</td>
</tr>
<tr>
<td>Wool industry</td>
<td>545</td>
<td>173</td>
<td>372</td>
</tr>
<tr>
<td>Lamb industry</td>
<td>231</td>
<td>73</td>
<td>158</td>
</tr>
<tr>
<td>Total benefits</td>
<td>2,721</td>
<td>651</td>
<td>2,071</td>
</tr>
</tbody>
</table>

**Table 3.** Economic benefit of the IPCRC disaggregated into adoption and productivity ($m).

<table>
<thead>
<tr>
<th>IPCRC benefit (Business Units 1 and 2)</th>
<th>With</th>
<th>Without</th>
<th>Net</th>
</tr>
</thead>
<tbody>
<tr>
<td>– benefit from improved adoption</td>
<td>1,676</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– benefit from improved productivity</td>
<td>154</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disaggregation of adoption benefits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– R&amp;D lag</td>
<td>640</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– adoption lag</td>
<td>418</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– adoption ceiling</td>
<td>248</td>
<td></td>
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</tbody>
</table>
benefit, $335 million (99%) of the wool industry benefit, $124 million (99%) of the lamb industry benefit, and $781 million (90%) of the beef industry benefit. The extremely high adoption benefits for the wool and lamb industries reflect the low rates of annual productivity growth in these industries combined with the relatively small productivity impact in these industries by the CRC assumed in this analysis.

For each industry, the benefit from enhanced adoption was further disaggregated into the separate components of the lag in research and development, the adoption lag and adoption ceiling. Overall, speeding up the R&D process generated the highest returns ($640 million), followed by a reduced adoption lag ($418 million) and higher industry adoption ceiling ($248 million).

**Benefit-cost analysis** The benefit-cost analysis is reported for the total IPCRC as well as the combined Business Units 1 and 2 and Business Unit 3 (Protection) (Table 4).

The without-IPCRC scenario indicates that reasonable benefits and returns on investment can be obtained from weed research with a discounted net benefit, or net present value (NPV), of $608m and a benefit-cost ratio (BCR) of 15:1. The with-IPCRC scenario results in substantially greater returns (BCR 34:1) and net benefits (NPV $2,642m). The marginal impact of investment in the IPCRC is given by the net-IPCRC results, with measures of NPV of $2,034m and a BCR of 56:1.

The benefit-cost analysis was also undertaken at the Business Unit level. For the net-IPCRC the combined Business Units 1 and 2 give a NPV of $1,785m and a BCR of 75:1, while the returns from the Protection Business Unit are somewhat lower with a NPV of $249m and a BCR of 20:1. The lower returns from Business Unit 3 are a reflection of the long time lags required to achieve many of the IPCRC benefits in this area.

### DISCUSSION

The investment in the proposed IPCRC provides a high return on public expenditure. Investing $30m of taxpayer funds into the CRC will leverage a further $63m of in-kind and cash contributions from research providers, and will generate an additional $2,071m in discounted benefits to the Australian economy. This result satisfies criteria 1 as the IPCRC can confidently claim that it can contribute substantially to Australia’s economic growth through the generation of benefits to the grains, beef, wool and lamb industries. The estimated marginal BCR of 56:1 from the IPCRC investment represents a high return to the investment thus representing good value for the taxpayer, and consequently satisfies criteria 4.

### ACKNOWLEDGMENTS

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### REFERENCES

