An *ex-ante* economic framework for evaluating the returns to agricultural research and development projects

Andrew Barnes, Alistair McVittie and Joana Ferreira

**Key message**: in times of increasing austerity within the public sector justifying the continued allocation of public funding is paramount. We developed an economic framework for evaluating returns to investment in agricultural projects which includes social and environmental benefits.

**Key Findings**

- An ex-ante methodology was developed for economic evaluation of research and development (R&D) projects
- The methodology included both economic as well as social and environmental benefits
- This was tested on two projects and found to exceed the Government prescribed hurdle rate for public investments

**Introduction and Rationale**

Technological interventions, and the underpinning role of research and development (R&D), is a prominent driver of growth within the animal, crop and horticultural industries and the UK public sector has a role in supporting and providing research for these sectors. Then multifunctionality of agriculture challenges research providers to fully assess the impact of its funding on societal challenges. These goals for agricultural production include maximising productivity, or minimising the production impacts on environmental and social distribution. Hence, evaluation of the public good of funding is complicated by these multiple goals and the highly technological nature of processes, interventions and multi-disciplinary nature of research funded.

**Methods and Findings**

An *ex-ante* methodology was developed for evaluation of future economic, social and environmental benefits from research funding in livestock, crop and horticultural sectors to calculate the rate of returns to the investment.

Figure 1 gives an overview of the process developed for the evaluation and spreadsheet itemising the inputs required.

---

1 This research was undertaken within the Scottish Government’s Strategic Research Programme 2016-2021. This represents an output for RD 2.3.12 Uptake of Best Practice. For more information see: http://www.gov.scot/Topics/Research/About/EBAR/StrategicResearch/strategicresearch2016-21/srp2016-21

2 *Ex-ante* refers to a methodology which predicts the effect of an intervention before the effects have been felt.
These can be summarised as:

**Scope:** the cost of the research, the length of time of the research, the objectives and the funding model, e.g. public-private.

**Outcomes:** the outcomes expected. Overall there are 20 outcomes identified for the model including ‘Productivity improvements’, but also ‘Enhanced aesthetic, amenity, and recreation values’

**Quantification:** this measured the impacts of the research compared to a counterfactual and relies on a series of economic and non-economic valuation methodologies to derive the benefit for the economy and society generally

**Scale:** this requires assumptions on the level of adoption (e.g. the percentage of the population expected to uptake the R&D), the lag of the adoption, (e.g. how long the benefits will last) and the shape of the adoption (e.g. how the technology would spread)

**Reconcile:** this takes the information from previous sheets and estimates both the internal rate of return and the modified rate of return (namely a percentage return per annum of the investment). This gives the rate of return against the initial costs of the research, discounted into today's prices.

The methodology described above was translated into a spreadsheet model. This was flexible enough to apply to a series of research projects in order to test the model.
### Selected Screenshots: Screen 2: Outcomes

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Outcomes for government agencies, rural communities, agriculture, on economic activities
- Productivity improvements
- Improved policy decision-making, government, for example, monitoring, priority setting, and accountability decisions
- Variable or capital cost reductions at the farm level
- Improvements to produce quality
- More effective infrastructure management
- Assistance of a reduction in the likelihood of stimulating non-revenue
- More sustainable water resources
- Improved water quality
- Improved biodiversity
- Reduced greenhouse gases
- Reduced, particulate and other impacts
- Increase in individual and community health and quality
- Enhanced aesthetics, amenity, and recreation values
- Enhanced wellbeing, pride, and confidence
- Reduced anxiety
- Predictive in health outcomes
- Preparation offsets values
- Improved cultural/diachronisation conservation
- Improved results

### Selected Screen Shots Screen 3: Quantification of Benefits

#### Example Table:

<table>
<thead>
<tr>
<th>Description</th>
<th>Base Case</th>
<th>Revenue</th>
<th>Cost</th>
<th>Profit</th>
<th>Adjusted Impact</th>
<th>Adjusted Impact 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Analysis of selected agencies, communities, agriculture, on economic activities
- Argument improvements
- Improved policy decision-making, government, for example, monitoring, priority setting, and accountability decisions
- Variable or capital cost reductions at the farm level
- Improvements to produce quality
- More effective infrastructure management
- Assistance of a reduction in the likelihood of stimulating non-revenue
- More sustainable water resources
- Improved water quality
- Improved biodiversity
- Reduced greenhouse gases
- Reduced, particulate and other impacts
- Increase in individual and community health and quality
- Enhanced aesthetics, amenity, and recreation values
- Enhanced wellbeing, pride, and confidence
- Reduced anxiety
- Predictive in health outcomes
- Preparation offsets values
- Improved cultural/diachronisation conservation
- Improved results
Table 1 shows the rate of return in terms of direct affects (e.g. increase in yield), indirect (e.g. reduction in pesticides), spin-off effects (establishment of further ventures) and total benefits (the sum benefits over costs). We examined two projects within the SRP portfolio, one with more direct productivity aims and one with wider social aims (in reducing carbon).

<table>
<thead>
<tr>
<th>Project 1</th>
<th>Direct Benefits</th>
<th>Indirect Benefits</th>
<th>Spin-Off Benefits</th>
<th>Total Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>21%-27%</td>
<td>29%-36%</td>
<td>2%</td>
<td>27%-36%</td>
<td></td>
</tr>
<tr>
<td>Project 2</td>
<td>16%-23%</td>
<td>32%-44%</td>
<td>9%</td>
<td>29%-44%</td>
</tr>
</tbody>
</table>

Both projects exceed the Government prescribed hurdle rate, even at low expectations of adoption within the industry and long term price forecasts. Whilst there is equity in total benefits, there are differences in the types of benefits estimated for the two projects.

---

3 This is to demonstrate proof of concept and therefore we have maintained anonymity of the projects examined and we are grateful for PI’s of these projects for their time and inputs.

4 The MIRR is an improvement on the standard internal rate of the return methodology and accommodates for more realistic assumptions around positive cash flows.
Implications for Policy and Industry

Clearly in times of increasing austerity within the public sector justifying the continued allocation of public funding is paramount. A methodology for evaluation needs to be both flexible, to accommodate the range of outcomes expected from publically funded agricultural R&D, and robust, to meet Government prescriptions for evaluation of publicly funded projects. In addition, to minimise the cost burden of administrating the evaluation we recommend for the following practices for researchers and research funders both before and during the research project:

- **Offer more specific reporting guidelines for researchers**: Funding agencies should provide clear guidelines towards qualifying the impact or placing the burden on the researcher to provide evidence of impact using a specific reporting template. This would focus the natural science towards an outcome which matches the rationale for public intervention.

- **Encourage researcher interaction with the evaluation methodology**: A common framework has the attraction of providing transparency in application and offers guidelines for the evaluator to identify and attribute the range of costs and benefits from the project. Interaction with the evaluation framework itself would raise awareness of the outcomes desired by the funding agency, and ensure more consistency in aligning results against these outcomes.

- **Ensure transparency of assumptions**: This includes ensuring that benefits directly and indirectly related from the project have not been over or under estimated. Application of a technology will imply scaling up of impacts to reflect the communities affected. These can be quite specific, e.g. land used for strawberry growing, or quite general, e.g. visitors to the countryside.

- **Consider costs of evaluation**: The methodology here has attempted to provide a cost-effective means of gathering data for an evaluation. Specifically, promoting the use of a structured inception meeting to ensure and record agreement on outcomes, direct and indirect impacts and any spin off effects. Nevertheless, the evaluation will be improved through increased interaction with researchers and policy makers to ensure that vital information is available. This, naturally requires cost in terms of hours worked to conduct the evaluation for policy makers, researchers and the evaluator themselves. Hence, in order to ensure acceptance a specific part of the research budget should be allocated to these evaluations.

For more information, please contact: Pr Andrew Barnes, Land Economy, Environment and Society Research Group, SRUC. T: 0131 535 4042; E: andrew.barnes@sruc.ac.uk; W: https://www.sruc.ac.uk/info/120037/land_economy_environment_and_society