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Guidelines for assessing the impacts of ACIAR's research activities

ACIAR IMPACT ASSESSMENT SERIES 58

Research that works for developing countries and Australia

Guidelines for assessing the impacts of ACIAR's research activities

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The Australian Centre for International Agricultural Research (ACIAR) was established in June 1982 by an Act of the Australian Parliament. ACIAR operates as part of Australia's international development cooperation program, with a mission to achieve more productive and sustainable agricultural systems, for the benefit of developing countries and Australia. It commissions collaborative research between Australian and developing-country researchers in areas where Australia has special research competence. It also administers Australia's contribution to the International Agricultural Research Centres.

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Foreword

The Australian Centre for International Agricultural Research (ACIAR) has been systematically undertaking independent impact assessment studies of its portfolio of research activities for more than 20 years. More recently, for the last 5 years, we have added adoption studies to this program.

Three years ago ACIAR commissioned two reviews of the impact assessment studies. These summarised the overall return of ACIAR's research and development (R&D) investments and also assessed the consistency of the studies. Since a range of independent consultants are commissioned to undertake these assessments, and because these studies are complex and diverse, it was not surprising that the reviewers found that there was variability in the detail, rigour and presentation of the results.

To facilitate building on the substantial effort that ACIAR has placed in this area and also the review findings, we decided to develop a set of guidelines for all independent consultants to use as a basis for future assessments. The aim of the guidelines is to ensure consistency in the methodological approaches used, the treatment of information collected and presentation of the results. We have also developed a database to systematically record the results of all impact assessment and adoption studies, which complements these guidelines.

The guidelines also provide the basis for ensuring consistency between the impact assessment studies and adoption studies.

A draft of the guidelines was developed in 2006–07 and used by all consultants undertaking impact assessment studies and adoption studies during 2007–08. A workshop was held for the impact assessment group in August 2008, and feedback and comments on the practical use of the guidelines have been incorporated in this version.

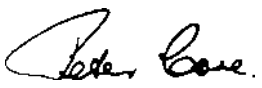
At the same time, the Special Panel on Impact Assessment of the Consultative Group on International Agricultural Research (CGIAR) Science Council was also interested in developing guidelines for its impact assessment activities. While both organisations collaborated closely in the activity, each has developed specific, separate documents.

The CGIAR system is made up of a diverse range of independent international 'research provider' institutions, so it required a more strategic set of guidelines. ACIAR, a small research-funding institution, has a specific, well-established impact assessment system that has been developed over 20 years. It needed guidelines to link the different components and ensure consistency, which is crucial to feed into the database it has developed for storing and interrogating its impact assessment studies. Despite the development of separate documents, I believe the collaboration has significantly enhanced the effectiveness of both.

ACIAR's guidelines will be used as the basis for all future studies in this area but will continue to be reviewed and updated.

I believe this is a very important development for ACIAR and further enhances the quality of this area of ACIAR's monitoring and evaluation program.

I would like to thank the Centre for International Economics, ACIAR staff and workshop participants for the considerable effort that has gone into the development of these guidelines.



Peter Core
Chief Executive Officer
ACIAR

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Abbreviations

ACIAR	Australian Centre for International Agricultural Research
ADIA	ACIAR Database of Impact Assessments
BCA	benefit–cost analysis
BCR	benefit:cost ratio
CS	consumer surplus
IA(s)	impact assessment(s)
IAS	Impact Assessment Series (ACIAR)
IRR	internal rate of return
NBIR	net benefit:investment ratio
NPV	net present value
PIAS	Project Impact Assessment Summary (ACIAR)
PS	producer surplus
R&D	research and development
RD&E	research, development and extension
WTP	willingness to pay
WTA	willingness to accept

Acknowledgments

This report has benefited from input from the independent consultants who undertook impact assessments and the project leaders who undertook adoption studies for ACIAR between 2006 and 2008. We greatly appreciate the comments and feedback we have received from these groups about aspects of these guidelines.

All of those who had undertaken impact assessment studies, or used the draft guidelines to undertake these studies, participated in a workshop in Canberra in August 2008. The workshop allowed detailed discussion of many aspects of the guidelines and of completed impact studies, significantly enhancing these final guidelines. Thanks go in particular to Vincent Fernandes (Grains Research and Development Corporation), Bob Lindner (Economic Research Associates), Greg Martin (IDA Economics) and John Mullen (New South Wales Department of Primary Industries).

Contributions from Jim Ryan (Special Panel on Impact Assessment, Consultative Group on International Agricultural Research), Cynthia Bantilan (International Crop Research Institute for the Semi-arid Tropics) and Bob Warner and Michael Monck (Centre for International Economics) are also gratefully acknowledged.

Executive summary

This report sets out guidelines for undertaking impact assessments (IAs) for the Australian Centre for International Agricultural Research (ACIAR). It provides a common approach for making three types of assessments of the impact of ACIAR investments:

- desktop reviews undertaken by ACIAR staff and others to make a quick assessment of expected impact
- adoption studies undertaken by the principal researchers to inform ACIAR of the success of a research activity in terms of progress in adoption, and observed and anticipated impacts 3 years after the projects finish
- full impact assessments (designed to be published in ACIAR's Impact Assessment Series (IAS)) undertaken by independent consultants to quantify the impacts of the ACIAR-funded research and document returns to the investment in that research.

Impact assessments set out to measure the changes, both intended and unintended, that result from research, development and extension. This report brings together the various methodologies that have been utilised by ACIAR and consultants undertaking impact assessments, with the aim of providing a consistent set of guidelines for future work.

The approach utilises a benefit–cost and results-mapping framework that traces progress:

- from the R&D and extension inputs to outputs that are adopted by the next users
- through to final users to result in outcomes—that is, changes in practice, products and policies.

Taken in aggregate these outcomes lead to impacts setting off a series of reactions before the final impacts are observed. The benefits are measures of the welfare changes that result from the impacts over time. These terms are defined to promote a common use and understanding by ACIAR staff, researchers and others involved in evaluation of ACIAR R&D investments.

The guidelines stress the importance of setting out the causal links between outputs, outcomes and impacts. At the desktop review level, the guidelines provide a checklist of questions to help the user make a qualitative assessment of the expected impact of the investment under consideration. At the adoption study level, summary tools are also provided to support a comparative analysis, and to encourage quantification of evidence where possible. At the impact assessment level, methods for quantification and the agreed approach for estimating summary statistics for return on investment for ACIAR impact assessments are set out in detail.

Appendixes to the report include a checklist that should be completed by staff undertaking a desktop assessment, researchers undertaking an adoption study and consultants undertaking an impact assessment. The electronic version of the checklist is constructed so that the information can be read into the ACIAR Database for Impact Assessments (ADIA). The ADIA can be interrogated to provide portfolio information on investments and the historical rates of return. These guidelines also provide a summary of the uses that can be made of the ADIA.

The guidelines are designed to enhance consistency rather than be prescriptive. They aim to encourage creative approaches to the collection of data and analysis of outcomes, impacts and benefits. A first draft of the guidelines was tested by practitioners and further

revision followed a workshop in August 2008. They were also shared with other organisations such as the Special Panel on Impact Assessment of the Consultative Group on International Agricultural Research Science Council and the Grains Research and Development Corporation, who were developing similar guidelines. The published guidelines should be regarded as a living document. It is anticipated that benchmarks and rules of thumb can be added that will assist in improving the quality and consistency of ACIAR impact assessments over time.

1 Introduction

1.1 ACIAR's impact assessment in context

1.1.1 A long history of impact assessment

The Australian Centre for International Agricultural Research (ACIAR) has a long history of undertaking impact assessments (IAs) of its research and development (R&D) investments. As at June 2008, over 50 full benefit–cost assessments had been published in ACIAR's Impact Assessment Series, and 49 adoption studies had also been undertaken. These assessments have provided valuable lessons in improving the selection, design and delivery of R&D projects. They have also been useful for demonstrating the value of ACIAR as part of Australia's international development assistance program. The credibility of the ACIAR impact assessments has been enhanced by several meta evaluations and the use of independent consultants to undertake the studies.

1.1.2 The purpose of impact assessment

Within ACIAR, impact assessment aims to identify, provide evidence of and, ultimately, quantify the impacts of its R&D investments. ACIAR's impact assessment activities provide an 'after the event' perspective within the comprehensive monitoring and evaluation (M&E) process ACIAR has in place. They provide accountability to stakeholders, as well as a clear measure of the returns to the funds ACIAR invests. Increasingly also, impact assessments provide a basis for improving the research selection process by acting on lessons learned from past projects.

Impact assessments are a valuable learning tool for project participants and project managers. The approach used can be applied at all stages of a project, from its conception and design, through to well after completion. Impact assessment of completed projects provides lessons on what works, what does not, and why. Understanding what creates value is critical for maximising the returns to ACIAR investments.

1.1.3 Collaboration in developing these guidelines

Development of these guidelines took place over a period of more than 2 years, during which time there were important interactions between ACIAR and other organisations with similar interests. In particular, during the early stages, close discussions were held with the Special Panel on Impact Assessment of the Consultative Group on International Agricultural Research (CGIAR) Science Council. It was initially felt that framing a joint set of guidelines that suited both ACIAR and CGIAR could be an efficient way to proceed. As the activities progressed, however, it became clear that the requirements of the two agencies were quite different. The CGIAR is a complex organisation of diverse and independent research-providing institutions, while ACIAR is a small research-funding agency with relatively clear impact assessment requirements and established systems developed over 20 years. It was therefore concluded that a single document would need to be relatively general and would add little to the large, established body of methodological knowledge. The discussions and sharing of drafts during the development of the ACIAR and CGIAR guidelines have nevertheless significantly enhanced their respective effectiveness.

In addition, during the pilot-testing phase of the ACIAR guidelines, other organisations, including the Grains Research and Development Corporation, showed interest in and were provided with copies of the draft guidelines. They used these, adapting them to suit their own circumstances. This final document has greatly benefited from the interactions between and feedback provided by the various organisations involved.

1.1.4 Ongoing improvement

The meta evaluations identified varying quality in the evaluations in terms of the scope of impacts assessed and robustness of assumptions made (the evidence base). While some of these problems are inevitable, due to the cost of collecting the required evidence, some can be avoided. Common approaches to inputs such as time periods of analysis and discount rates have been implemented. The development of the DREAM (Dynamic Research EvaluAtion for Managers) software improved the consistency of the analytical approach as it required market adjustments to be taken into account, but introduced new challenges when the impacts differed from those the software could easily handle. Nevertheless, differences in approaches remain, such as in the scope of impacts considered, development of counterfactuals (baselines) and benchmarks used to assess validity of assumptions.

1.2 These guidelines

1.2.1 Objectives

To improve consistency in undertaking and using impact assessments, ACIAR has developed these guidelines for use by consultants, project proponents in developing-country partners, researchers and ACIAR staff. They were trialled for over a year before being finalised and published in the Impact Assessment Series (IAS). They focus on assessments—qualitative and quantitative—of completed projects. They can be applied to:

- desktop reviews designed for quick assessment of expected impacts
- adoption studies undertaken by the principal researchers to inform ACIAR about the progress in adoption, and observed and anticipated impacts 3 years after the projects finish
- full impact assessments (designed to be published in ACIAR's Impact Assessment Series (IAS)) undertaken by independent consultants to quantify the impacts of the ACIAR-funded research and document returns to the investment in that research.

The guidelines have five main objectives:

- to set out the basic formats and requirements of results for consistency between assessments
- to set out minimum standards for the welfare analysis applied within the impact assessment, emphasising, for example, the use of economic surplus measures
- to raise a range of issues that needs to be considered in the analysis, without necessarily solving them in general
- to provide pointers to solutions to these issues that have worked in the past
- to indirectly provide a means to help with training and the transfer of knowledge.

This report should be regarded as a document to be updated and improved as ACIAR experience with assessments continues to evolve over time. Updates will be regularly posted on ACIAR's website to complement this published report.

1.2.2 Overview and structure

The guidelines are structured as follows. The remainder of this chapter discusses some very broad principles and approaches for impact assessment. These are further developed in subsequent chapters. In particular, Chapter 2 provides a general checklist for all types of assessments. The principles of good impact assessment are evident in each of these steps.

Chapter 3 looks at adoption studies in more detail, setting out the general process of identifying the ways in which adoption may take place. Chapter 4 looks at impact assessment studies in detail, considering a number of important issues that must be dealt with in every study. Chapter 5 looks at some special topics in impact assessment, including capacity-building impacts and the assessment of environmental effects.

Chapter 6 describes how ACIAR is placing the results of all impact assessments into a single database, thereby facilitating their use in supporting decision-making and demonstrating accountability.

1.3 Skill and judgment in impact assessment

1.3.1 Professional judgment

Impact assessment is inevitably a complex process requiring high skills. Understanding the results that emerge from complex R&D problems, and tracing through welfare linkages in developing countries where data are limited or non-existent requires patience, persistence and a methodical approach.

The tools of applied welfare analysis, in particular benefit–cost analysis, outlined below provide a framework within which to undertake the assessment. While these guidelines aim to provide a number of pointers for the analysis, ultimately there is no rigid formula for impact assessment. Those undertaking the task must be creative and flexible and will, in many instances, be called on to exercise considerable professional judgment.

1.3.2 Attitudes and approaches

While there is no formula, there are attitudes and broad approaches that make a big difference to the credibility of any assessment. Here are some broad pointers to keep in mind.

- Engage in conversation with researchers. Try to understand the science behind their work and listen carefully to what they say. Be a 'friendly sceptic', exploring their claims of impacts without being negative or threatening. Scientists will prove to be a goldmine of information. Many of them will have spent long periods in-country and will, of course, be experts in their field. Information from wide-ranging conversations, coupled with skills in welfare analysis, will allow you to discover many more impacts.
- Understand the context of the research under examination. What came before it? What is planned next? What other organisations are working in the same field? What other experts can provide context for the research?
- Understand the background and institutions of the partner countries. These will be important in helping understand the welfare effects of the research. If it is your first trip to a particular country, spend some time familiarising yourself with the basics of how it works.
- Prepare carefully for field visits. Send data requests in advance and adopt strategies for data collection that are consistent with the institutions and data capabilities of the partner country.
- Cast the net broadly, communicating with as many interested parties as possible. The impacts of research are not necessarily linear, and some impacts might initially appear peripheral.

1.4 Assessing the impacts: broad principles

1.4.1 The task of impact assessment

The fundamental task of impact assessment is to trace the way in which the research leads to changes in the world. The challenge is to identify what exactly changed (compared with what would otherwise have been the case) as a consequence of the research, what the further impacts of this change were (or will be) and how these changes are to be valued, so that the value of the research can be compared with its costs.

The process of tracing through the causal links between the research and the ultimate impacts is sometimes referred to as 'results mapping' or 'pathway analysis'. A results map or pathway is a description of how an output comes to deliver benefits, including through unexpected consequences. One project (or a group of projects working together) delivers outputs either ready for use, or needing transition to use, or that are inputs into further research. Outcomes are the changes in practices, products or policies that follow the adoption of an output by users. Aggregating outcomes across the final users gives the initial impact—changes in market, environmental or social conditions. This initial impact may trigger responses that can magnify or dampen the initial impact and flow through to other markets, natural systems and communities. The benefits are the positive changes in the welfare of producers and consumers in the affected markets, and the welfare of the individuals

in the communities who value environmental and social impacts. Costs are the negative changes in the welfare of producers or consumers that may result from indirect market interactions.

With these impact pathways identified, impact assessment then takes place within a benefit–cost framework that explicitly uses the broad theories of applied welfare economics (through the concept of economic surplus) to value inputs and outcomes. The benefit–cost discipline ensures that all inputs into delivering the benefits are recognised, including the up-front implementation costs, operational costs and the opportunity cost of unpriced inputs. A benefit–cost framework also recognises all impacts, whether intended or not, and all beneficiaries and losers. It also recognises time and the effect this has on welfare, as consumption today is preferred to consumption tomorrow. Finally, it considers the outcomes and impacts relative to a 'without R&D' situation—the 'counterfactual' or baseline.

Box 1 summarises some of the basic terminology used when undertaking impact assessment, while the basic steps of impact assessment within ACIAR are set out in Figure 1.

1.4.2 Eight principles for impact assessment

There are eight overarching principles for good impact assessment, regardless of whether it is quantifying impacts or making a qualitative assessment. These are introduced in Box 2 and elaborated in Chapter 2.

Box 1. Some definitions

Monitoring—recording observations of measures or indicators of results.

Evaluation—drawing conclusions as to the relevance, efficiency, effectiveness and impact of the investment:

- **relevance**—whether the objectives or targets of the investment are those desired by the investor
- **efficiency**—whether there is a lower cost way of achieving the target outcomes
- **effectiveness**—whether the outputs and outcomes achieved are the target outputs and outcomes
- **impact**—the comprehensive actual (intended and unintended) consequences of the investment. Impact can also consider the impacts on different groups.

Results frame or pathway analysis—the description of the causal links between inputs, outputs, outcomes and impacts:

- **inputs**—the cash and in-kind expenditures on R&D and extension to deliver outputs to the initial (and sometimes final) user
- **outputs**—results of the R&D that can be adopted or are inputs into further R&D; these may be intended or unintended and can be a by-product of the process of undertaking R&D
- **outcomes**—changes in practices, products or policy that result from adoption of the outputs by initial, next and final users—final outcomes are the changes experienced by the final users as a result of their adoption of the output
- **initial impacts**—changes in demand, supply, environmental and social pressures and exposure to risk at the community level due to the sum of outcomes at the individual level, or for common resources at the community level
- **impacts**—changes in markets (prices, input and output costs, quantities) and in the state of common resources (ecosystem health and biodiversity) and communities (livelihood opportunities, health, security, equity)
- **benefits**—value of changes in producer and consumer wellbeing and the wellbeing of the individuals in the affected communities.

The results frame is based on analytical and conceptual modelling to explore and test the underlying logic of investment in a project or program.

Community value—the sum of the values individuals in a community place on non-market outcomes. These arise from:

- **use values**—willingness to pay (WTP) (or accept compensation for loss) for the use of the resource or experience of the impact
- **non-use values**—WTP for the existence of the resources or impact, or for the option to use in the future.

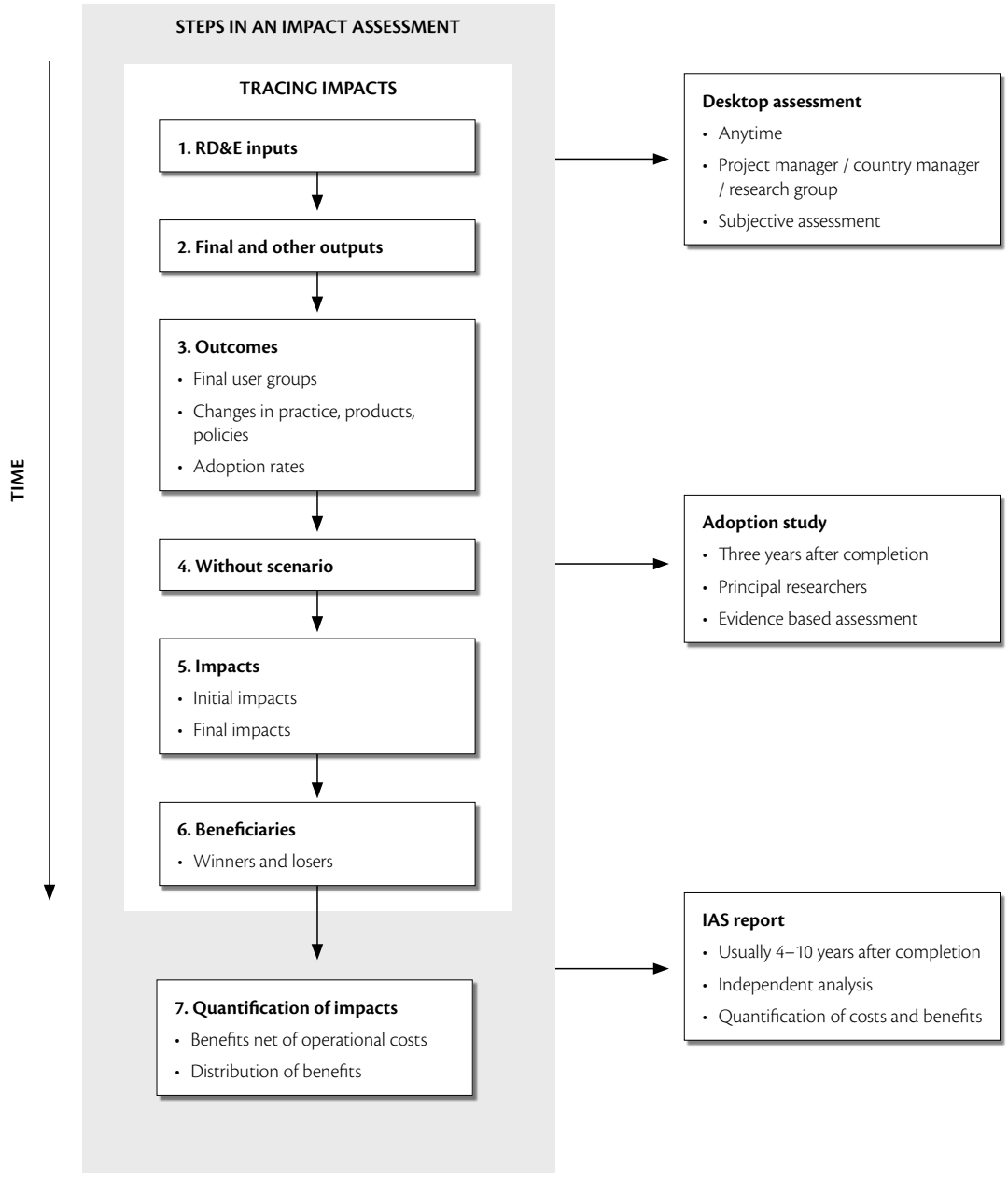

Figure 1. Approach to impact assessment

Box 2. Overarching principles for impact assessment

1. Clearly identify causal links between levels of results.
2. All outputs, intended and unintended should be identified.
3. Identify the preconditions and complementary investments required for the results to be realised.
4. Always measure change from a baseline (counterfactual) and make this counterfactual explicit.
5. Make sure opportunity costs are included in assessing impacts.
6. Final users are not always the only beneficiaries.
7. Attribution, in the absence of any other information indicating otherwise, is based on research, development and extension cost shares.
8. Validate estimates of results and report on the degree of uncertainty in the assessment of impact and benefits.

2 A checklist for all impact assessments

2.1 Using the checklist

The checklist summarised in Figure 2 sets out the steps in undertaking IAs. These steps are the same for a desktop assessment, an adoption study or an analysis for inclusion in the impact assessment, but there are differences in the level of evidence compiled and quantification. The checklist aims to help assessors to ask the right questions. It provides categorisations that may be useful in tracing the causal links between outputs, outcomes and impacts. While these categorisations are based on those often found for ACIAR investments, they are meant only as a guide to assist in the results mapping and in analysing ACIAR's overall investment portfolio. There may be additional or different links so the user should not feel bound to find a perfect fit. Where this is the case, add to the categorisations.

The checklist also aims to support a preliminary assessment of the significance of the different causal relationships and hence the possible magnitude of the resulting benefits. It is important to focus on the impacts that make a difference and not get entangled in numerous links that are never going to make a difference to the final scale of benefits.

The first six steps consider the links between inputs, outputs and outcomes. This phase is the core of good impact assessment and cannot be over-emphasised. The final three steps are about providing an overall impact assessment, including information on the degree of confidence in the assessment, and hence how much reliance can be placed on the results.

2.2 Step 1: Identify all the R&D and extension inputs

ACIAR projects may provide stand-alone R&D investments with outputs ready for adoption, or they may be part of a larger set of investments in R&D and extension that together deliver outputs ready for adoption. The first step of any impact assessment is to identify all the significant inputs that contribute to the identified outputs. This is sometimes called 'ring fencing'.

Both the overall magnitude of investment and the relative shares are important. Recognising the relative shares of investment provides a perspective on the return to ACIAR funding (see section 2.8.2).

When identifying inputs, consider:

- ACIAR projects that are causally related—which ones preceded and which followed on, and why
- ACIAR funding and funding contributed to ACIAR projects by research agencies and others
- other non-ACIAR investments in R&D and extension, often made by partner country research organisations and extension services, the Crawford Fund, the CGIARs, AusAID, and other donor agencies.

STEP 1 IN SUMMARY: Clearly identify all causal links between levels of results

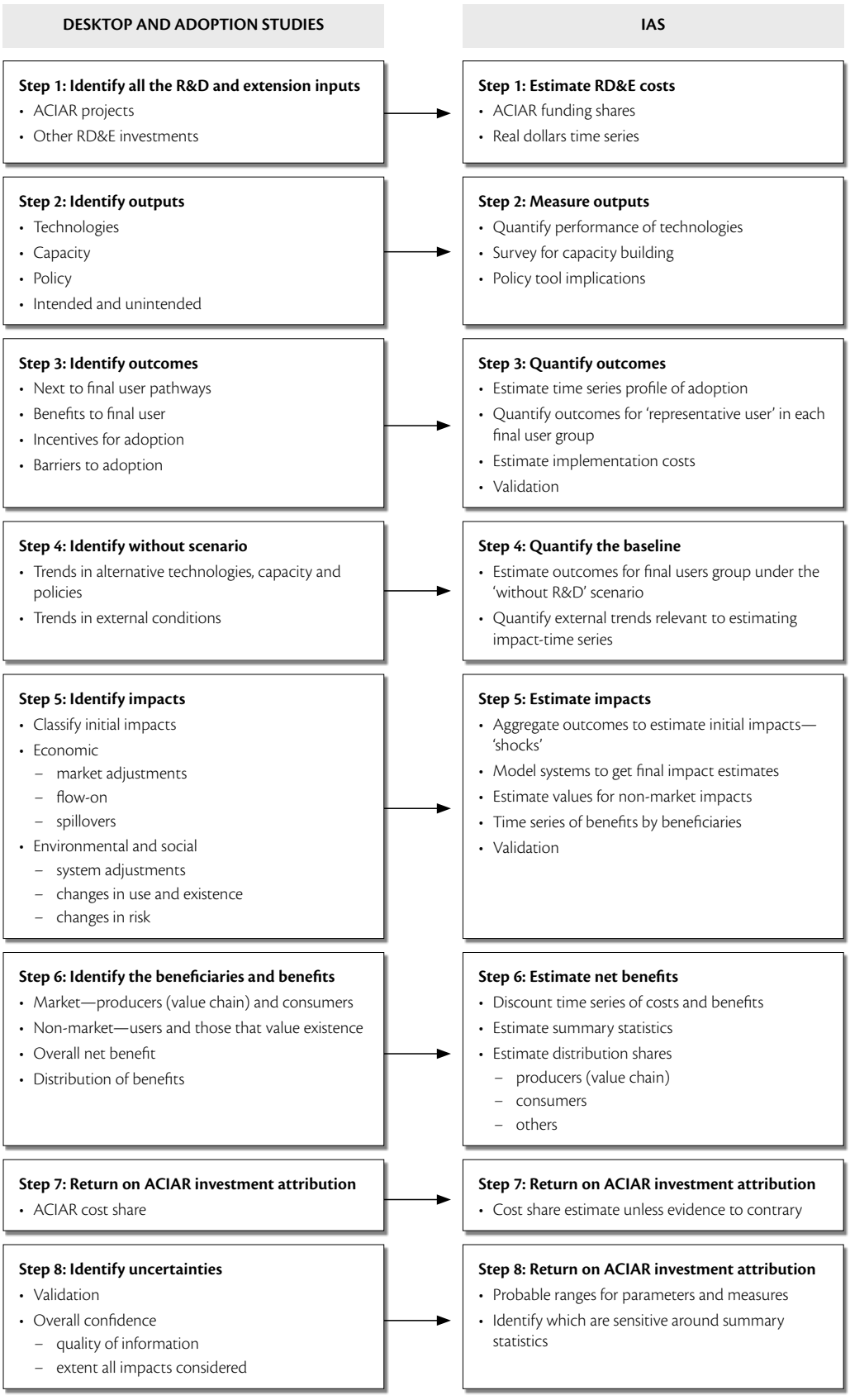

Figure 2. Steps in an impact assessment

2.3 Step 2: Identify outputs

Outputs are the deliverables from the R&D project. ACIAR outputs have three broad categories:

- technologies—new and better products, processes and approaches
- capacity—scientific knowledge, understanding (pure or basic science) and skills at the organisation and individual level.
- policy—knowledge, models and frameworks to aid policy and decision-making.

Some outputs are ready for adoption, others need to be commercialised, and yet others are inputs into further processes involving more R&D. Even technologies that are adoption-ready can often require several more transformations before they can be adopted. Moreover, tracing through the capacity and knowledge outputs to adoption-ready outputs can be a challenge. A guide to tracing capacity and policy outputs through to impacts is provided in Chapter 5.

In identifying outputs consider:

- the categories into which the outputs fall—technologies, capacity and/or policy
- whether the outputs are adoption-ready, require further transformation or are inputs and, if the last, whether there are identifiable outputs already achieved
- who are the next and final users for the outputs.

STEP 2 IN SUMMARY: All outputs, intended and unintended, should be identified.

2.4 Step 3: Identify the outcomes

2.4.1 Intermediate and final outcomes

The outcomes are the changes in practice, products or policy that result from the adoption of the outputs.

Intermediate outcomes require additional investment to generate changes in practice, products or policy that have community outcomes. They are important measures of progress toward achieving final outcomes and consequently impact, but in themselves do not generate impacts. An example is the stock of knowledge. There may be a threshold level of knowledge, skills and capabilities needed in a research organisation before it can generate information or products that are applicable to local farmers. The intermediate outcome is the increase in the stock of knowledge; the output of the application of this knowledge might be a new variety of crop that has a higher yield or improved resistance to disease. Adoption of this output then leads to a final outcome.

2.4.2 Adoption

Adoption is an action—outcomes are the result of adoption. Adoption happens when individuals or firms have an incentive to adopt—the pay-off from the change more than compensates them for the cost of making the change. The exception is where adoption is by coercion by, for example, changes in regulations. Tracing adoption of outputs from next to final users is an essential step in undertaking an impact assessment. Final users are usually at the community level, and it is here that the outcomes are likely to have the greatest impact. While final use of project outputs may be by other researchers, leading to savings in research costs, until they deliver new technologies or information that changes policy, the impacts are small. Similarly, capacity built (an output) has to be utilised (an intermediate outcome) before it generates an output that has a use at the community level.

2.4.3 Final outcomes and variation between final user groups

For an impact assessment to be undertaken, it must be possible to track the research, development and extension (RD&E) investments to final outcomes. If final outcomes cannot be identified, no claim of impact is possible, beyond small impacts arising from cost

savings due to research capacity outcomes, or rises in personal income due to human capacity built. Final outcomes have two components—the adoption rate and the change in practice, product or policy resulting from adoption. Both may vary between different groups of final users. Where different groups of potential users face different outcomes it is important to separately identify these groups or populations of final users. Outcomes vary between locations because of differences in characteristics such as climate and soil, enterprise or farming system (such as cropping mix), access to technologies and other inputs, and availability of other livelihood or resource-use opportunities.

2.4.4 Implementation costs

The costs of implementing policies, changing practices and introducing new or improved products need to be considered in assessing likely adoption by each next user and the final user groups. There are investment costs, such as the costs of commercialising a new variety of rice or investing in new processing machinery, that can pose hurdles to adoption. These costs are additional to the RD&E investment, but critical in adoption decisions. The costs need to be seen in the context of access to finance for the final user. In a developing country, difficulty in getting finance can be a major constraint on adoption.

Higher ongoing operational costs need to be fully offset by a higher financial return from the change in practice before final users will make such a change, unless they are required to do so by regulation. Any change in operational costs should form part of the assessment of *incentive* for adoption.

Figure 3 summarises the steps to this point. It shows the feedback loops that have to be considered as the exploration of adoption raises issues of other investments.

While implementation costs, or the perception of implementation costs, may influence the decision to adopt particular technologies, when undertaking the benefit–cost analysis of the overall research it is important to distinguish between implementation costs that arise in particular markets, and implementation costs that are public good in nature.

Implementation costs that arise in markets—for example, the cost of machinery that is part of a new technology—should be explicitly included in the economic surplus analysis. If the R&D leads to an on-farm productivity improvement that requires, for example, a new machine, then the annualised capital cost of that machine should be included as part of the estimated shift in the supply curve.

If, however, the implementation costs are public good (publicly funded extension services, for example) then these costs need to be explicitly included alongside the R&D costs in the cost stream in the benefit–cost analysis.

When identifying outcomes consider:

- whether outcomes are intermediate or final and, if intermediate, whether there is a clear set of links through to outputs that have final users and outcomes
- final user groups and differences between them in terms of outcomes from adoption
- incentives for adoption for each final user group—whether the outcomes for the final user would justify their adoption, given any implementation costs and changes in operational costs
- the time profile of adoption and changes in practice, products and polices.

STEP 3 IN SUMMARY: Identify the preconditions and complementary investments required for the results to be realised.

2.5 Step 4: Establish the 'without R&D' scenario

Determining the impact of any R&D activity requires an understanding of what would have happened in the absence of the R&D outputs that are attributed to the R&D funding under examination. This 'without R&D' scenario (sometimes called the 'counterfactual') cannot, of course, be observed, so it must be inferred from measured market conditions.

Establishing the 'without R&D' baseline is fundamental to the impact assessment. In general, the baseline should

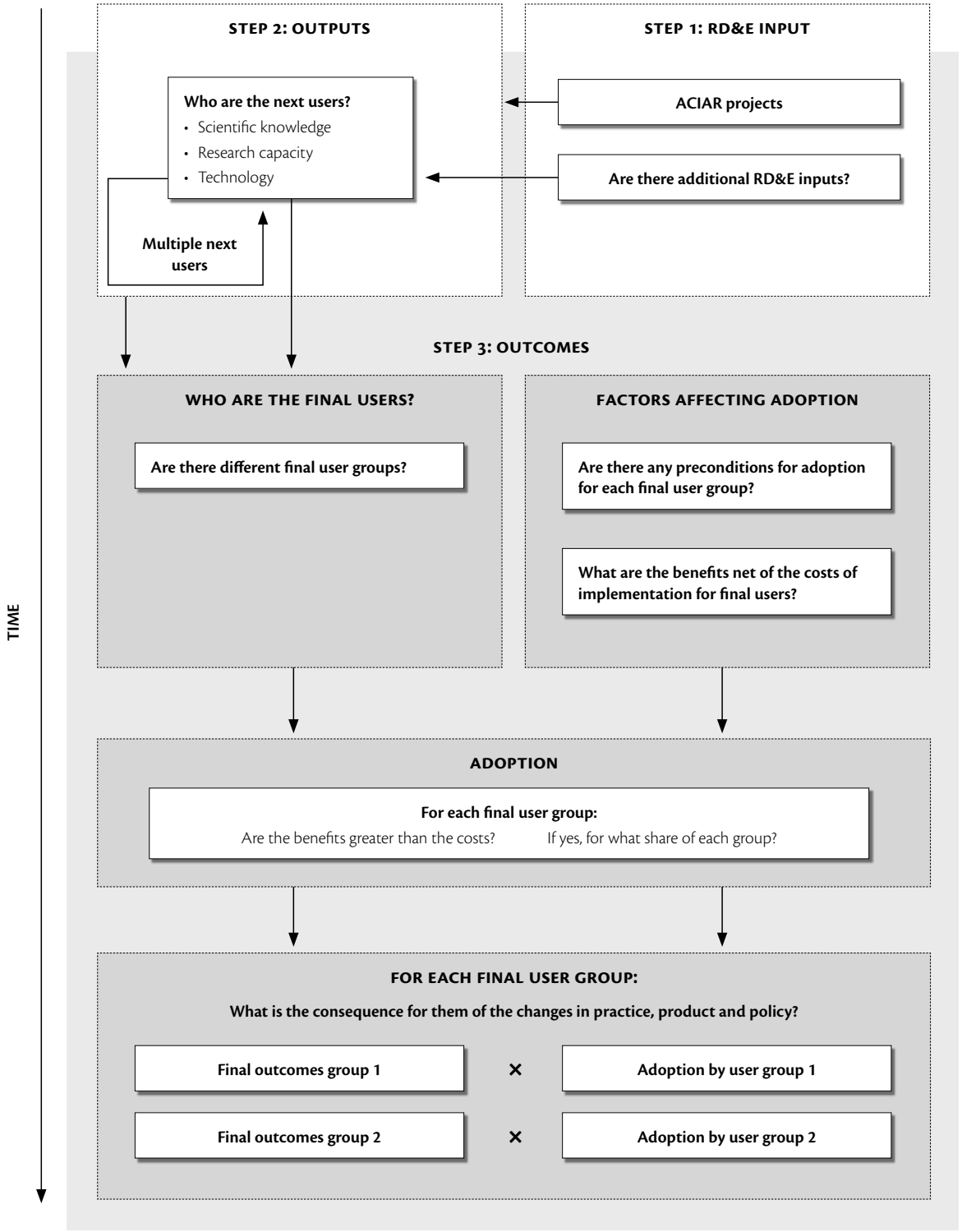

Figure 3. Steps 1, 2 and 3: Mapping from inputs to outcomes

be very carefully thought through and—particularly in full benefit–cost analyses—should be explicitly set out using the tools of applied welfare economics.

When considering productivity improvements, for example, shifts in the supply curve that would have taken place even without the research (shifts in the baseline or business as usual curve) should be explicitly considered along with the shifts in the supply curve that result from the R&D. In general, the gap between the 'with research' supply curve and the baseline supply curve will remain indefinitely over time. This should be the default assumption in the impact assessment unless there is an explicit reason to consider that this is not the case.

It is sometimes tempting to construct a baseline scenario that embraces the idea that 'the research would have happened anyway' so that the returns from the R&D under examination are only those relating to bringing benefits forward in time. In general, this 'it would have happened anyway' idea does not constitute a sound baseline and should be considered only if it can be rigorously demonstrated.

In assessing the 'without R&D' scenario consider:

- evolution of existing technologies, input markets and policy reform agendas and the improvements that these might have delivered over the same period
- changes in prices of inputs, product markets, and/or environmental conditions that are external to the adoption of the R&D and might affect the impacts (and adoption).

STEP 4 IN SUMMARY: Always measure change from a baseline (counterfactual) and make this counterfactual explicit.

2.6 Step 5: Identify the impacts

The impacts of the R&D are the aggregate effect of the changes in practice, products and policies by the final user groups relative to the baseline or counterfactual.

Like the outcomes, impacts arise over time, initially in the markets or systems directly affected, and subsequently in other markets and systems as the impacts flow through. The final impact depends on the reactions over time as the directly affected markets and systems adjust and, where flow-on effects are large, as related markets or systems adjust.

2.6.1 Initial impacts (shocks)

Initial impacts result from the aggregation of changes in practice, products or policies across the different final user groups. They can be described as changes in:

- demand—arising from changes in preference for products (due to new products, improvements in flavour or freshness and so on) or through changes in derived demand for products, themselves caused by supply shifts elsewhere in the production chain
- supply—arising from changes in the production function due to improvements in yield, reduced input requirements, lower input costs, joint products and other changes that shift supply. These changes can occur at any point in the value chain, which is the chain of production that starts with the supply of off-farm inputs, through the farming, then tracks the progress from the farm gate, through transport and processing to wholesale and retail to the final consumer. Supply shifts later in the supply chain may appear as the derived demand shifts at the farm level
- environmental pressures—arising from reduction in the use or degradation of natural resources due to protection, restoration or changes in the production process
- social pressures—arising from improvements in nutrition and other minimum basic needs, livelihood opportunities, control over and input into decision-making, improved access to social services, and to community activities and support
- risk—arising from greater certainty about income, lower exposure to harm for workers and consumers, and sources of reduced risk.

Risk is a crosscutting issue that has value in its own right (individuals, communities, governments and firms all prefer certainty) and through changing the probability of an adverse demand, supply, environmental or social outcome.

R&D that shows the way not to go can be of considerable value.

R&D that demonstrates that an approach or technology will not work in a target situation can still deliver value. It does this by avoiding the unproductive use of resources and, in some cases, by avoiding the potential to unintentionally create major new problems. Similarly, strategic R&D to improve the options available is valuable even if the option developed is not in the end utilised as the situation it was developed for did not arise. These kinds of impacts—that arise largely through a reduction in risk—should also be considered when making an assessment.

2.6.2 Final economic impacts—directly affected markets

Economic impacts are those mediated through the market for goods and services. Thus, for example, water efficiency and carbon credits can become economic impacts where there is a market for these products.

Changes in demand and supply for a product (good or service) generally stimulate a price and quantity response. For example, an increase in demand pushes up prices; then, as producers respond to price and supply increases, prices fall back somewhat. The net increase in price depends on the market conditions and how sensitive consumers and producers are to price. These sensitivities are represented as price elasticities of demand and supply. Exporters of products to the rest of the world tend to face fairly elastic or price-sensitive demand unless they are a major producer or have niche-market access. Producers that sell only in the local area may see their prices fall with a significant increase in the quantity of product on the local market. These sorts of transmissions need to be understood to assess not only the distribution of benefits (see section 2.7), but also the magnitude of the total impact and hence benefit.

The markets for inputs into production can also be directly affected if the resulting changes in supply lead to large changes in the demand for inputs. Again, the price sensitivity of demand for, and supply of, inputs will affect the input prices and quantities. In some developing countries, labour is in surplus in rural areas, so changes that demand more labour can see supply respond with little, if any, rise in wages. Supply of land tends to be more constrained, so land-using innovations may bid up the price of land with implications for other industries, as well as landowners' wealth. These opportunity costs for inputs—their value in the next-best use—must be recognised in assessing impacts.

2.6.3 Flow-on economic impacts and spillovers

Flow-on economic effects arise as changes in relative prices of inputs and other products flow through into changes in costs of production and consumption patterns. In general, the impacts on other industries (producers and consumers) are less than those in the directly affected markets.

There can also be dynamic effects arising from economic spillovers, such as increased skills in the labour force, new technology platforms that can be used by other industries, economies of scale or scope that lower transaction costs (cluster economies), and changes in institutional arrangements that can benefit (or sometime impose costs on) other industries.[1]

When identifying economic impacts consider:

- changes in demand (particularly derived demand) and supply for the markets directly affected
- sensitivity to price changes and whether this enhances or dampens impact
- flow-on effects due to competition for inputs or consumers
- spillover effects from upskilling labour, sharing technology platforms, cluster economies or institutional improvements.

[1] The Productivity Commission (2007) report on public support for science and innovation identified spillovers as the major justification for public funding as they are to a large extent public goods (unlike flow-on effects). That is, they are non-rival in consumption and non-excludable, at least to similar groups of users (club goods). They are rarely externalities in that the consumption is voluntary—firms can choose whether or not to avail themselves of the opportunities.

2.6.4 Final environmental impacts

Just as markets adjust to changes in demand and supply, natural systems adjust to changes in the pressures on them. Natural systems may be fragile and hence highly responsive to changes in pressures such as the level and timing of environmental flows to a river, or they may be robust and so experience little change with changing pressures. Robustness need not imply a good result. Severely degraded land may be robust, and so need very large changes in pressures, such as large-scale revegetation, to have a final impact that delivers value. Understanding how responsive systems are to the first round impacts is important for accurately representing benefits. For example, tree planting to reduce salinity has an observed outcome—trees have been planted. The first round impact could be a decrease in salt discharge in the planted area; the system impact depends on whether this area planted was a net recharge or discharge zone.

Environmental impacts often feed back into economic impacts where natural resources are used in production. For example, improvements in environmental services can lower the cost of water treatment. It should also be noted that some environmental outcomes can have negative economic impact, as when industry access to a resource is restricted.

Environmental impacts are often classified as externalities, as they impose or reduce the costs on consumers and producers. Reductions in pollution, revegetation, reduced pressure on soil and vegetation, and improved environmental flows are all initial impacts resulting from environmental outcomes such as changes in regulations, reduced grazing pressure and improvements in water-use efficiency. Final environmental impacts that are valued by individuals in the community (called 'community values' for short) fall into two main categories:

- ecosystem health—the sustainable (in a biological sense) functioning of natural ecosystems—terrestrial, riparian and marine
- biodiversity—protection of relatively scarce ecosystems and their flora and fauna and other life forms.

These categories are not mutually exclusive—protecting biodiversity requires sustainable ecosystems, but having sustainable ecosystems does not in itself protect biodiversity. Healthy ecosystems and biodiversity are valued for both use and non-use purposes. Use purposes include recreation, aesthetics and research, while non-use purposes are existence values and options values (option for later use). Changes in the risks to ecosystem health or biodiversity are also final impacts that are valued by the community.

When identifying environmental impacts consider:

- initial impacts on pollution, greenhouse gas emissions, native vegetation cover, water quality, soil quality and ecosystem disturbance
- changes in use and access to natural capital—non-market uses
- flow-on effects of ecosystem services on
  - inputs into production (economic impacts)
  - pollution and human health (social impacts)
  - climate change and production (economic)
  - dislocation of populations (social)
- spillover effects to ecosystem health and biodiversity
- changes in the risk to ecosystem health or maintaining biodiversity.

2.6.5 Final social impacts

Social impacts are variously defined in the literature, and studies have included impacts from market-mediated impacts where public funding is involved (as with medical costs) to moral and ethical issues such as the value placed on more equitable outcomes. The approach taken here is to include all categories of impact that might not be captured in the economic or environmental impacts. Three broad categories of impacts are identified:

- population health—changes in nutrition levels, prevalence and incidence of diseases, achievement of other minimum basic needs

- economic opportunity—increases in the diversity and/or quantum of employment opportunities for communities
- social opportunities—changes in access to education, health care, transport and other resources for human wellbeing, including the extent of community support and engagement, i.e. social capital.

Population health and social opportunities also flow through to economic impacts by improvements in the supply of labour. Such impacts tend to be long term and require considerable complementary investment. The share that can be attributed to ACIAR is very small, and is usually not considered in the impact assessment.

As with economic and environmental impacts, reductions in the risk of adverse impacts should also be identified. The value placed on an improvement in economic opportunity may arise in part from the lower risk associated with a larger number of options for generating a livelihood. This is in addition to higher incomes that might be generated and which are already included in economic impacts.

2.6.6 Assessing final impacts

Figure 4 summarises the approach to assessing final impacts.

In assessing final impacts consider:

- the significant first round changes—to demand, supply, environmental pressures, social pressures, and risks to any of these
- economic impacts—directly affected markets, flow-on and spillovers
- environmental impacts—initial impact and flow-on to ecosystem health and biodiversity, and links back to economic and social impacts
- social impacts—population health, social opportunity and changes in social exclusion

STEP 5 IN SUMMARY: Make sure opportunity costs are included when assessing impacts.

2.7 Step 6: Identify the benefits and beneficiaries

2.7.1 Identifying the beneficiaries

Project benefit is the sum of the net values of the project impacts to the beneficiaries (those groups of individuals who are positively affected by the project impacts) and to those made worse off as a consequence of the project.

Direct beneficiaries may include:

- final users (why else would they adopt the outputs) and their employees
- others involved in the production value chain from the suppliers of inputs to traders, processors, wholesalers and retailers
- consumers.

Other groups that may be affected include (either as beneficiaries or losers):

- industries competing for resources
- industries competing for consumers
- industries supplying products and services to the workers and owners of resources
- industries benefiting from spillovers
- those in the same industry that do not adopt the new technology.

Environmental and social impacts tend to affect a much wider population. Their benefits derive from:

- use values, which are associated with use by different populations of users. For example, a village next to a river may benefit from multiple uses of the water when its quality improves, while people using the river for transport may make less regular use
- non-use values, which arise where impacts have existence value such that the beneficiaries do not need to have physical access to the environmental or social capital. Even populations in other countries may value the impacts. This is the case with biodiversity protection, where developed-country populations may place a high importance on protection of endangered species found in a developing country. Options value is a non-use value only in the sense

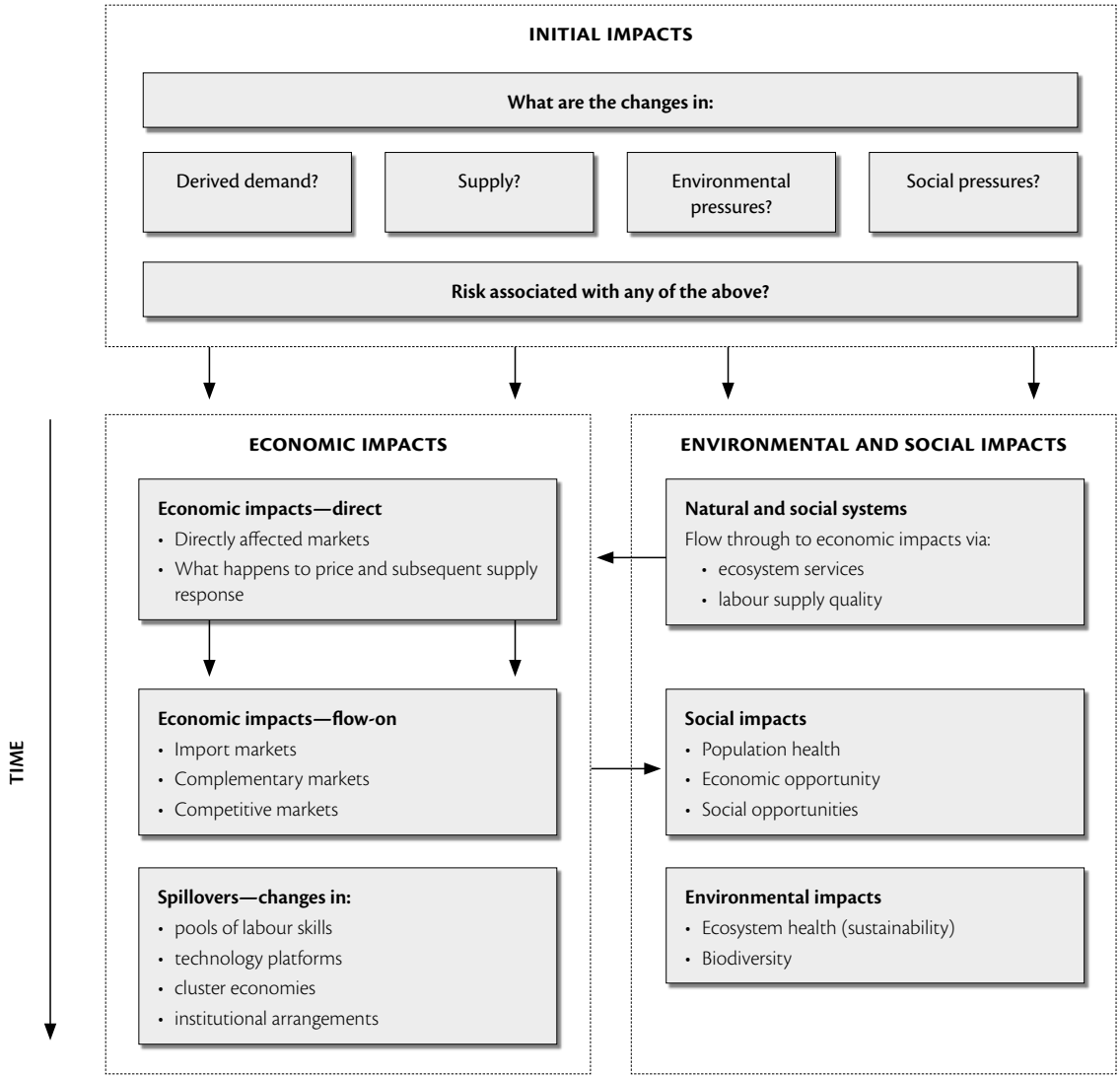

Figure 4. Step 4: Identifying impacts

that it is a future option on use. Consequently, the populations of non-users who value an impact for its existence or option for future use can be large.

2.7.2 Assessing the value of the impacts

Economic impacts are valued at market prices, with estimates made of the changes in total community welfare measured by producer surplus (profits) and consumer surplus (measure of welfare from consumption).

Environmental and social impacts generally do not have market prices. In the absence of direct market estimates, a number of indirect approaches can be taken. Costs incurred to address the impact (or costs avoided) can be used as an estimate of the value of the impact. Non-market use values can be estimated in a similar manner or by using willingness-to-pay (WTP) methods. Impacts can have both use and non-use (existence) values. For example, the restoration of biodiversity in an area has a use value to hikers and to communities that may use the resource to improve food security (reducing risk). The same impact has a non-use value for people who feel it is important to preserve biodiversity for its own sake, or for future generations (intergenerational equity). The resource has an option value to the community that use

it for food security. It can also have an option value for those who currently do not use it, but could do so in the future.

The values placed on the impacts can vary over time as market conditions change and community values evolve. Non-market use values can vary with user groups (and within groups). Existence values are the sum of the values of the individuals in a community who place a non-zero value on the impact.

2.7.3 Assessing the net benefit of the RD&E investment

The net benefit of an RD&E investment is the sum of the values placed on the impacts by the beneficiaries less the public good cost of the implementation (not already incorporated in the surplus analysis, see section 2.1.3) and project costs (see section 2.1.1). Net benefits tend to be large when:

- a major crop, grazing industry or fishery, or a large area of land or water, is positively affected
- there are high rates of adoption by large groups of final users (this also indicates a good return to the final user)
- economic opportunities were relatively low in the regions affected, and resources were not fully utilised or were used in low productivity enterprises.

2.7.4 Assessing the distribution of benefits

The final users will, in general, benefit the most. For example, the economic impacts arising from improvements in productivity lower costs and raise profits, but the producers' share depends on how much of the gain is passed through to consumers in lower prices. The relative price elasticities of demand and supply in the product market help to understand how the benefits generated are shared between consumers and producers.

In addition, benefits to producers will be shared along the production value chain, again according to relative supply elasticities and market conditions.

Understanding the ways in which market conditions and supply and demand responses potentially influence the distribution of benefits can provide insights into adoption rates.

Benefits will not, of course, be distributed to non-adopters of the new technology. This group will, in general, lose (as market prices decline from the actions of adopters, for example). It is important to identify non-adopters and incorporate their outcomes in the analysis. The relative share of production by these non-adopters is also an important determinant of the distribution of the total benefits. In many cases, this share overrides the importance of the relative supply and demand elasticities.

Environmental and social benefits accrue to the users and wider communities. The distribution of such benefits depends on the degree of use and the values placed on that use, the size of the communities and the average existence values held by the individuals in those communities.

Figure 5 summarises mapping from impacts to benefits and beneficiaries.

In assessing benefits and beneficiaries consider:

- changes in consumer and producer surplus and other appropriate measures of the total welfare change
- losses of producer and consumer surplus in the case of non-adopters or other losers
- sharing of producer and consumer surplus along the value chain
- environmental and social use benefits –
  - scale of use and use values (costs of alternatives and costs avoided)
  - scale of communities affected and their average existence value.

STEP 6 IN SUMMARY: Final users are not always the only beneficiaries.

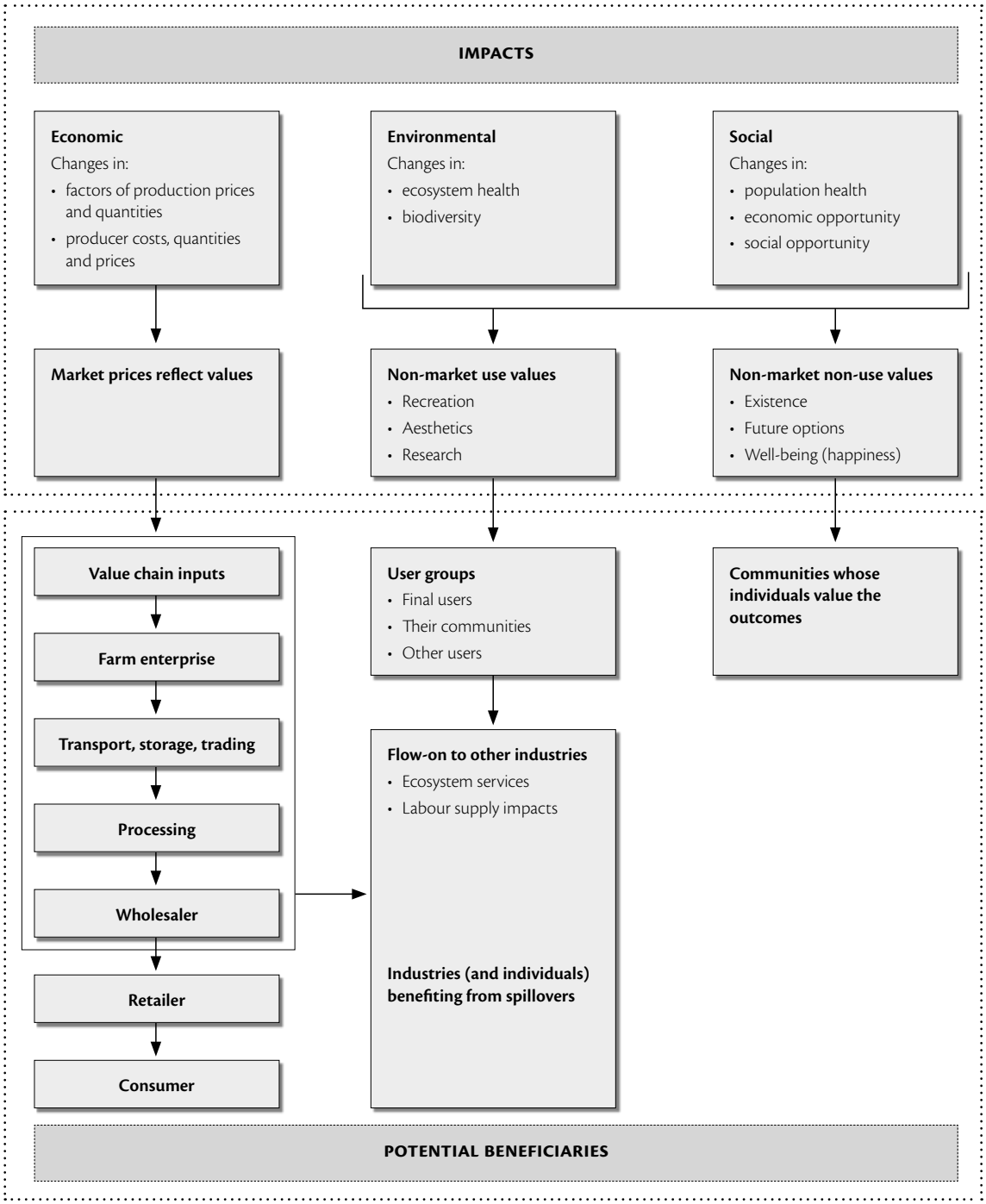

Figure 5. Step 6: Identifying benefits and beneficiaries

2.8 Step 7: Return on investment and attribution

2.8.1 Return on investment

The impact assessment studies quantify the benefits and costs to provide return-on-investment estimates. They report the present value of the flow of RD&E costs and the present value of benefits less implementation and operational costs. The ratio of this benefit estimate to the present value of the RD&E costs is the benefit:cost ratio. The standard discount rate applied by ACIAR is 5%. This means that each dollar earned is worth 5% less for every passing year. Consequently, the time profile of the net benefit flow has an impact on the return on investment. Investments that have benefit flows that accrue earlier will have a higher return on investment than the same benefit profile delayed by, say, 5 years.

The adoption studies and desktop reviews need only to make an overall qualitative assessment of the return on investment. The considerations outlined above, including the time profile of the benefit flow, should help in making this overall assessment.

2.8.2 Attribution to ACIAR

ACIAR is not, of course, the only agency funding R&D. In any impact analysis the question of how to attribute total benefits to ACIAR always arises.

The attribution problem is very closely related to the appropriate definition of the baseline or 'without research' scenario. Ideally, this baseline should be a 'without ACIAR-funded research' scenario. This scenario will often be difficult to construct because of the inevitably high levels of interaction involved.

In general, unless there is evidence to suggest a different attribution is appropriate, the analysis should work towards constructing a baseline that allows any attribution to ACIAR to be based on a cost share of the total RD&E investment. The cost share approach is based on all the RD&E investments being necessary but none alone sufficient for the outputs and subsequent outcomes to have been achieved.

Attribution can be different if some investments can be shown to have had a marginal (as opposed to average) contribution. For example, if ACIAR funding had brought forward the R&D investment, advancing the benefits in time, then the return on ACIAR's investment is the added return from the benefits arising earlier. Another example is where the ACIAR R&D can be shown to have raised the yield of a crop to 10% more than that which the other investments in R&D would have achieved. In this case, the return on ACIAR investment is the benefit arising from the extra 10% yield, regardless of the cost share.

In assessing the return on ACIAR investment consider:

- size and timing of the benefit flows net of implementation costs—all else being equal, earlier flows give higher returns than later flows
- scale and timing of the RD&E costs
- ACIAR's funding contribution to the projects relative to all other RD&E investments that were needed to deliver the outcomes.

STEP 7 IN SUMMARY: Attribution, in the absence of any other information indicating otherwise, is based on RD&E cost shares.

2.9 Step 8: Uncertainties in the impact assessment

Desktop reviews rely on judgments and on the program and country managers' knowledge of the project. There is a higher degree of uncertainty in the information in desktop reviews than there is in adoption studies and impact assessments. Therefore, as with all assessments, the level of confidence in the findings or conclusions should be made explicit.

2.9.1 Validation of information and evidence

Where possible, the information and measures of results—qualitative or quantitative—used in the impact assessment should be validated. Assessments often rely on subjective appraisals, and even apparently objective data (such as production figures or sales) can be highly

biased. Validation needs to be applied to the results mapping to test the strength of the linkages, as well as to estimates of the size of the results.

2.9.2 Assessing the confidence in the results

Assessing what degree of confidence can be placed on the results has several elements. Measurement error and modelling mistakes are dealt with to a large extent by validation approaches. In addition, there is often uncertainty in the true parameters used to estimate outcomes, impacts and benefits. These uncertainties may compound or offset each other. Sensitivity analysis is used for quantitative analysis to provide a measure of the confidence that can be placed in the point estimates of benefits. Where the results are not robust to changes in the value of any particular parameter, further effort may be needed to verify its validity, or the argument for choosing it may need strengthening. Sensitivity analysis is essential in impact assessments and recommended in adoption studies, to provide an indication of the range of outcomes that might be possible given the available evidence. Methods are provided in Chapter 4.

Confidence in the impact assessment also depends on:

- time elapsed since the completion of the R&D—ex-ante reviews, undertaken as part of proposal assessment, will inherently be uncertain. Three years after project completion, outcomes are more likely to be observed, too long out, and the outcomes may be difficult to distinguish
- evidence supporting the results map—where the links are well known and clearly established empirically, there is more confidence in the conclusions drawn about impacts, even if many have still to arise. Sound theoretical links are better than none, but evidence should be provided to support the application of theory to the circumstances under assessment
- evidence of outcomes and impacts—objective evidence of major outcomes and impacts such as volumes of production improves confidence, but must be analysed for potential alternative sources of the changes observed for this confidence to be justified
- the extent to which the impacts and benefits can be quantified—whether potentially large impacts have been left out.

In assessing the confidence in the impact assessment consider:

- evidence supporting the results mapping—both direct and from well-accepted linkages
- uncertainty in the estimates of the most significant outcomes and impacts
- the extent to which all potential impacts have been included in the assessment.

STEP 8 IN SUMMARY: Validate the results and report the estimated degree of uncertainty in the assessment of impact and benefits.

2.10 The desktop review

The eight steps just described are common to all classes of impact assessment, qualitative or quantitative. Desktop reviews may be undertaken for project proposals, during project implementation, on project completion and to help select projects for impact assessment. When undertaking an adoption study or an impact assessment, a desktop review is the first step.

2.10.1 The steps in a desktop review

There are eight steps in a desktop review.

Step 1:

- identify related ACIAR projects and, if possible, other RD&E investments
- record the expenditure on the ACIAR project and ACIAR's share of the total.

Step 2:

- identify the countries involved and commodities
- identify the significant outputs and classify them.

Step 3:

- identify the next and final user populations, and whether there are various final user populations. If there are no links to a final user population the impact assessment is 'no impact'
- identify the changes in practice, products or policy required of the next and different final users to adopt the outputs
- assess likely or actual adoption given the benefits and costs to next and final users.

Step 4:

- based on the expected adoption and consequences of the changes in practice, identify the first round impacts relative to the 'without R&D' scenario.

Step 5:

- considering the market characteristics for economic impacts and the systems for environmental and social impacts, assess the final impacts, identifying those that are significant.

Steps 6 and 7:

- for significant impacts, identify the beneficiaries and, considering their values (reflected in market prices, WTP), assess the overall level of benefits as high, medium or low.

Step 8:

- classify the confidence in the impact assessment as high, medium or low.

Given the way that desktop reviews are conducted there will usually be some uncertainty about the assessment of impact. The degree of confidence will vary between desktop reviews, depending on the reviewer's personal knowledge of the project and the extent of their contacts with the researchers and others involved. Consequently, the reviewer should make explicit the level of confidence they have in the assessment, relative to that in other projects they have assessed.

2.10.2 The Project Impact Assessment Summary

Desktop reviewers should complete a Project Impact Assessment Summary (PIAS) form. The PIAS form is provided as Appendix 1 and is available electronically in Microsoft® Word format. The form provides a template for completing the eight steps described above. It also provides a summary for adoption studies and full impact assessments, and so includes some fields that a desktop reviewer may not be able to complete. Where the reviewer lacks the information these fields can be left blank.

The categorisations set out in the steps above are available as drop-down menus in the electronic form. If new categories are needed, they can be added, so the reviewer should not feel constrained to the existing categories. The drop-down menus include the countries and commodities involved in the projects. This information is used in portfolio analysis. The most detailed categorisation should be used where possible; for example, if the project is on bananas this category should be selected rather than 'fruit'. Multiple choices are available for most categories, reflecting that ACIAR investments are complex and often multifaceted.

Completing the PIAS form allows the impact assessment information to be compiled in the ACIAR Database for Impact Assessments (ADIA). The desktop review PIAS also forms a starting point for undertaking adoption studies and full impact assessments.

3 Adoption studies

3.1 The purpose of adoption studies

ACIAR undertakes adoption studies for large projects (over $400,000), usually 3 years after their completion. The studies are undertaken by the principal researchers involved in the projects. Adoption studies provide a useful follow-up from a research perspective as they renew contact with the developing-country researchers and others involved in the RD&E. They are also used by ACIAR in assessments of the value of follow-up investments, investments in similar areas or investments in other areas with the same research partners. They form an important part of ACIAR's impact assessment program for reporting to stakeholders in the achievements of ACIAR investments.

3.1.1 Adoption studies annual reports

ACIAR publishes annual reports on the findings of its adoption studies. Each report presents the summaries of the adoption studies undertaken during the year and an overview that draws out the main findings of the studies and the lessons for ACIAR, under the following headings:

- Project outputs produced. These are classified into the three categories (technical, scientific knowledge and policy tools), with many projects having outputs in more than one category. They are summarised in a table, with a discussion of whether the projects had achieved the intended outputs and if there were also unintended outputs.
- Research capacity developed by the projects. This is classified as capacity built in terms of partner countries researchers and research infrastructure. There is a description of the ways in which these capacities are being utilised (or not) and why.
- Uptake of the R&D outputs—progress along adoption pathways. This classifies the approaches to adoption taken by the projects in the report, presenting a summary for each of the pathways used. The progress to date in all the projects is tabulated, together with the classification of adoption progress made by the authors of the adoption studies (progress toward significant adoption by next and final users). The overview should identify any patterns that emerge.
- Implications for the impact of ACIAR investments. The author of the overview should draw on the individual studies to make an assessment of the implications for the impact of ACIAR investments. High and early adoption rates tend to imply good returns to the final users. The discussion should identify these projects, as well as those with potentially large final user populations, and assess whether, given the information, the impact is likely to be high, medium or low. The main reasons for the judgment should be provided, together with a table presenting the assessments of the authors of the adoption studies and the overview. Differences in opinion should be discussed.
- Lessons. This should draw out reasons for high or low adoption and impact that provide some guidance for future ACIAR investments. A table presenting the factors contributing to, or inhibiting, uptake should be provided.

3.2 Structure of an adoption study

Adoption studies should follow the impact assessment steps, but the main effort must go into:

- setting out the results mapping and testing the initial premises underpinning the decision to invest in the R&D
- gathering evidence on the adoption of the outputs of the R&D by the next and final users
- analysing the outcomes achieved in practice by the final users—and quantifying them where possible
- analysing the costs and benefits to final users and hence their incentives to make the changes in practice, products and/or policies over time.

3.2.1 The adoption study template

ACIAR provides a template for the adoption studies (see Appendix 2), collecting information under the headings listed below. The template aims to improve consistency between adoption studies, most notably in the interpretation of what are outcomes, impacts and beneficiaries.

- Motivation for the project and what it aimed to achieve:
  - the motivation—the problem or opportunity being tackled and what the project hoped to achieve in doing so (this tends to be at impact level)
  - the objectives of the project (these should be defined at the outcome level)
  - the history of the project—this is a summary of the inputs, including related ACIAR projects and other investments in RD&E and the agencies involved, the partner countries, the commodities or issues, and how the R&D was undertaken.
- Outputs—what did the research produce? Outputs delivered—this should summarise outputs and how they differ from what was previously available under the three headings (where relevant):
  - technical outputs
  - policy outputs
  - capacity developed by the project—researcher skills and knowledge, and research infrastructure.
- Adoption—how are the project outputs being used? Outcomes achieved and expected in the future:
  - capacity utilisation
  - adoption to date—presenting evidence on adoption
  - adoption in the future and assessment of time to significant final user adoption
  - factors affecting adoption.
- Impact—what difference has/will the project make?
  - main beneficiaries
  - external factors affecting the impact
  - benefits for Australia
  - overall assessment of impact, including the level of confidence in the assessment.
- Lessons for ACIAR.

3.3 Tracing the results from outputs to outcomes: what has been achieved?

In undertaking an adoption study the authors should follow the eight steps set out in Chapter 2. The following discussion provides some additional tools that can be applied to help guide the analysis and provide some comparable estimates of elements of impact. These tools can also be useful in undertaking an impact assessment, especially where the outcomes have yet to be fully achieved, necessitating an ex-ante assessment of likely outcomes.

3.3.1 Identifying the next and final user groups: mapping the adoption pathway

The adoption pathway describes how the output gets from the R&D project to the final user. There are four broad pathways to adoption: commercialisation, communication, capacity building and regulation. There may be others, and these can be added as identified. The pathways are presented here to assist in identifying the next and final users and in assessing progress along the pathway, as significant impact usually requires adoption

by the final users. Successful projects often embed the pathways to adoption within the project. This might involve farmers participating in the research (action research), working with regulatory authorities that might develop and enforce policy (for example, banning use of a particular class of pesticides), or conducting field days and distributing 'how to' manuals. Adoption pathways should track through the next users (initial and intermediate) and final users, identifying what else needs to happen for adoption to occur. The four broad pathways are summarised in Figure 6. They are not mutually exclusive.

- Commercialisation. This pathway engages the market for the distribution of the product or practice. The clearest example is the involvement of a commercial partner in the development, marketing and distribution of a new variety of, say, a crop plant. This need not involve the licensing of intellectual property (IP), which may be provided free to firms willing to market the product. Practices can also be promoted through engagement with agribusinesses, which then offer advice on the practice as part of their packages of products and services.
- Communication. This pathway carries information directly or indirectly to the final user, and/or to organisations such as extension services that provide information to final users. Communication pathways include publication in academic journals and trade publications, information targeting extension or other change agents, communication products such as manuals or laminated posters for farmers, demonstration farms and field days.
- Capacity building. The transfers of knowledge and skills enables adoption as part of the R&D project. This could directly target final users by including them in the research (action or participatory research). It could work by including policymakers in the R&D, to gain their understanding and promote a supportive environment for adoption. It can also be indirect, through developing and promoting the delivery of training packages.
- Regulation. This pathway enforces or encourages adoption through compulsory (usually government) or voluntary (usually industry or cooperative) regulation. It includes adoption necessitated by the existence of monopoly services provided by governments or other organisations as, for example, when irrigation water is supplied by a regional water-management company that requires farmers to adopt certain procedures to gain access to their water allocation. Another example is compulsory vaccination of animals to enhance disease control.

Progress will depend to some extent on the number of users involved before the final user. For example, in terms of policy outcomes, the final users (consumers and producers) are those who change their practice, process or product in response to the change in policy. The penultimate users are the implementers of the policy, after ministerial approval, with next users being departmental staff formulating draft policies and advice, while the initial users may be policy research groups or university academics who provide policy analysis. Table 1 describes some of the pathways from initial users to final users. It should be noted that in some cases there is yet to be a final user as the project outcome was limited to input to other R&D.

In assessing applicable populations consider:

- the relevance of the technology or change to the current production system (for example, systems that require purchased inputs tend to be irrelevant to subsistence farming), and/or the production environment (for example, climate, soils, pests and access to markets)
- the desirability of the outcomes for the final users—for example, while adoption might increase income it might also require additional effort or introduce greater risk, making the change less desirable
- whether there is institutional support for the change.

3.3.2 Assessing the extent of adoption and potential adoption

Adoption studies should assess the extent of adoption at the time of the study and make a judgment about adoption in the future. They should:

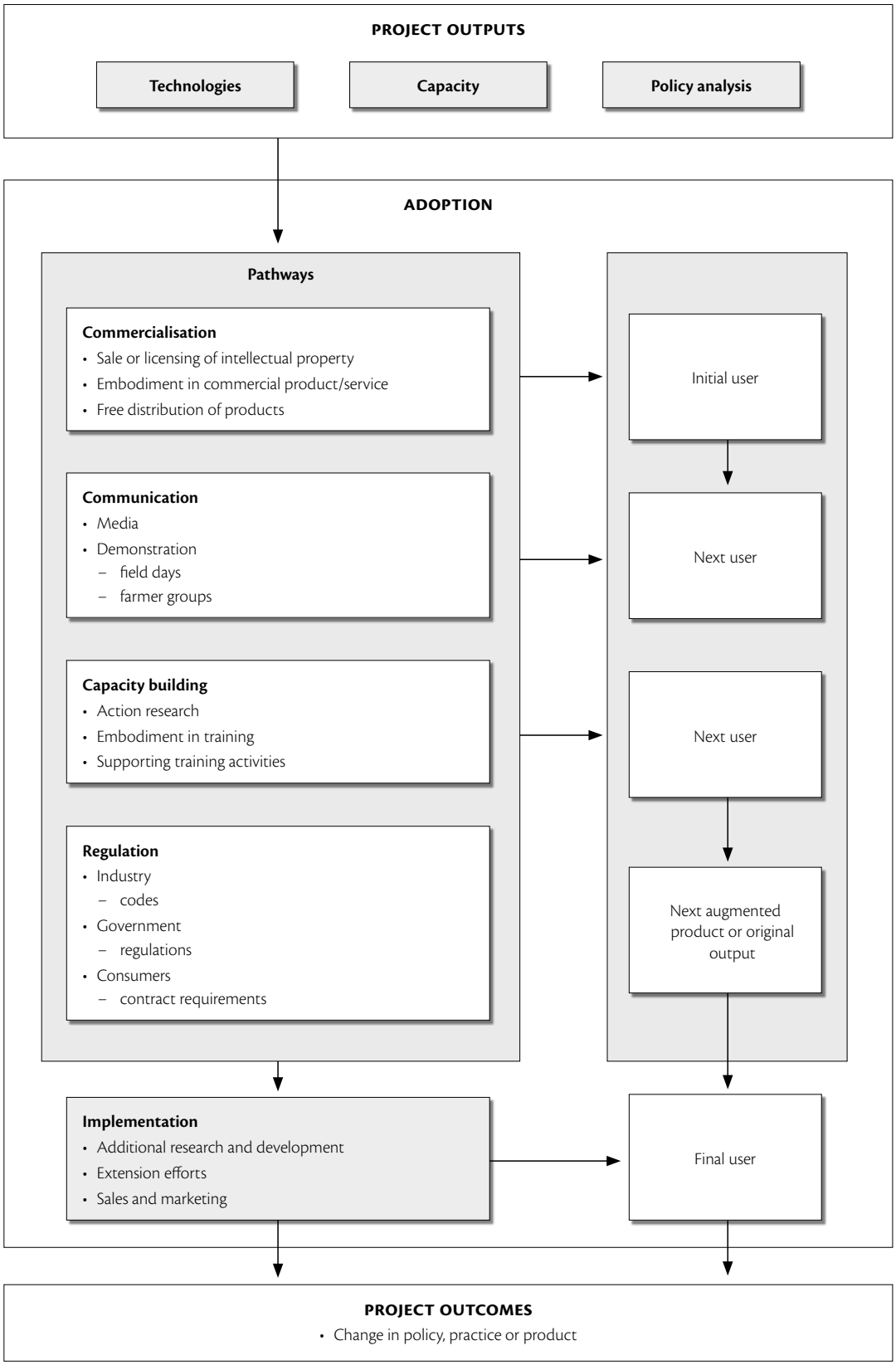

Figure 6. Adoption mapping

- assess who is currently using the project outputs—the initial, intermediate or final users and provide evidence to support this assessment
- describe the time profile for adoption by final users—if there has yet to be any adoption by final users, assess how long it will be before adoption is likely to start and the time before full adoption will be achieved, providing justification for the assessments
- what full adoption looks like in terms of the share of the potential users in each relevant group that will be using the outputs.

Table 1. Mapping of adoption pathways—next users to end users

Examples	Initial user(s)	Transfer process	Final user
Commercialisation			
Via licensing of intellectual property (with or without a royalty)	Commercial firm	Sales	Individuals/firms
Partnership with commercial firm	Commercial firm	Sales and service package	Individuals/firms
Public release varieties, technologies	Commercial firms, farmers	Sales, growing own seed	Individuals/firms
Communication			
Demonstration farms, field days	Volunteer farmers	Observation	Individuals
Targeted materials distributed directly to final users	Final user	Receipt of materials, acting on information	Individuals
Targeted materials distributed via industry media	Industry media	As above	Individuals
Targeted materials made generally available to extension providers	Extension advisers	Provision of advice that is followed	Individuals
Journal articles	Other researchers	Learning, building stock of knowledge, potential networking	Input into further R&D
Capacity building			
Action research—involvement of next/end user in project	Researchers/final users		Individuals
Demonstration in situ	Final users	Tours for final users	Individuals
Training program	Final users	Enhanced capacity	Individuals
Training packages	Training providers	Provision of courses incorporating content	Individuals
Regulation			
Central/local government policy	Government policy advisers, Lobby groups	Policy change	Organisation
Industry code	Organisation policy development	Publication and socialisation of the code	Individuals complying
Cooperative/firm code	Supplying organisation policy development	Internal processes for disseminating code	Firm/cooperative members
Customer requirement	Purchasing organisation policy development	Communication to suppliers of customer requirements	Supplying firms/ individuals

Adoption pathways suggest progress indicators that can be monitored to provide evidence.

Table 2 provides some examples of evidence of adoption. Only those indicators towards the bottom of Table 2 measure actual adoption; the earlier ones indicate progress towards it. The strength of the relationships between these indicators and actual adoption is important if using the progress indicators to predict adoption rates. If the project outputs are considered highly applicable, and the costs of adoption are low, then progress indicators should perform well. It is where the linkages are less well understood that greater care needs to be taken in drawing conclusions about adoption. For example, studies that have tried to test the links between changes in awareness and attitudes to actual changes in environmental practices have not found a strong relationship.[2]

3.3.3 Factors influencing adoption

The profitability of the technology (new or improved products or processes) and/or public demand for policy change are the two most significant influences on adoption rates, with the difference between returns and adoption costs having the greatest effect.[3] For this reason it is useful when mapping adoption pathways to identify additional inputs (including the operating environment) required to achieve adoption by the final user. Such information on implementation costs helps in assessing the likely extent and speed of progression along the adoption pathway.

Adoption also requires that the final user be aware of the opportunity—that the pathways described are effective, or adoption is unavoidable. ACIAR adoption studies have identified a number of factors that have influenced the uptake of project outputs. Table 3 categorises these according to the factors described above for adoption of new technology and practical approaches. There are three main categories:

- knowledge of the opportunity
- net benefits to the user
- other incentives/barriers to adoption.

3.3.4 Qualitative measures of adoption

The adoption study must assign a qualitative score that reflects the assessment of progress along the adoption pathway at the time the study is undertaken. This also

[2] See, for example, Curtis and Robertson (2003) and Rhodes et al. (2002)

Table 2. Indicators of progress toward adoption

Commercialisation	Communication	Capacity building	Regulation
Intellectual property licensed for use (with or without payment)	Publication of information	Number of participants in project	Position paper on policy change produced
Investment levels by commercial partner	Purchase or readership of publication	Survey on learning outcomes achieved	Documented discussions/ meetings held
Advertising of product/ service	Awareness of information survey	Echo measurement—number of contacts for each person trained	Formal proposal for change made
Market surveys of potential sales	Intention to adopt survey	Intention to adopt survey	Formal adoption of proposal
	Sales of associated products/services	Sales of associated products/services	Policy implemented—requests for/distribution of information
Sales of product—royalty stream as an indicator	Adoption survey	Adoption survey	Policy enforcement

[3] There is a considerable literature on factors influencing adoption. See Pannell et al. (2006) and references therein.

Table 3. Factors influencing adoption of new technology and practical approaches

Factors contributing to uptake	Factors inhibiting uptake
Knowledge of the opportunity	
Targeted workshops and communication activities	Ineffective distribution of information to farmers/lack of access to information
Workshops that increase awareness and understanding, especially those involving local 'champions'	Scientist discomfort in simplifying messages and delivering these in an educational/learning framework
Appropriate and extensive training of users and/or promoters of the new approaches	Complex policy and administration environments
Publishing results in appropriate languages and in a way that is accessible	
Long-term involvement of project 'champions'	
Benefits accruing to the adopter	
The development of market infrastructure, including public investment in transport and communications	No existing domestic market and/or poor infrastructure to support industry development
Demand by consumers for the final product	Disruption by political events
	Competition, especially from cheaper alternatives
Culturally relevant	
Compatibility with the socioeconomic context of farmers	Farmer satisfaction with their way of life and seeing no need to change
	Inadequate land tenure and reward system
Factors contributing to uptake	Factors inhibiting uptake
External incentives/barriers to adoption	
Capital cost and ability to raise sufficient funds	
	Shortage of essential facilities and/or equipment and/or the expertise to use it
	Lack of funds to 'scale up' adoption beyond those originally involved in the project
	Limited access by farmers to investment funds
Complexity and capacity to absorb, understand and apply	
Active involvement with the project from the beginning	Lack of time
Trained scientists who can continue the work and help train others	Lack of appropriate partnerships
Compulsion or prohibition	
	Government/agency secrecy about disease outbreaks—need to 'save face'
	Bureaucratic barriers to further development and implementation of project results

Table 3. (continued)

Factors contributing to uptake	Factors inhibiting uptake
Risk and uncertainty	
Government, or commercial enterprises, sharing the risk	Poor record keeping at industry level
Reputation, and credibility, of the scientists	Limited number of field trials and demonstrations to provide visible 'proof' of the effectiveness of a new approach
	Changes in personnel during the life of the project
	Time lag—where the results from implementing a change are not immediately apparent

Source: McWaters and Templeton (2004)

allows for no progress and the circumstance in which the output goes into further R&D and does not, in itself, have a final user in the community. Table 4 sets out the scoring that should be used.

This qualitative assessment has behind it some quantitative notion of what proportion of users is 'considerable'. Unless there is explicit guidance provided, this proportion may vary with who is undertaking the assessment. There can also be significant variation in the estimation of what proportion of any relevant population of potential users the assessment 'considerable' should be applied to. It must be noted that the numbers of initial and next users adopting may have no bearing on adoption by final users.

Project proposals are required to identify the expected number of years to adoption (less than 5, 5–10, more than 10). The adoption study should review these assessments and make a new assessment. Along with the adoption achievement score, this time to adoption will be collated for presentation in the adoption study overview.

3.3.5 Descriptions of outcomes

As discussed in section 2.5, outcomes are the consequences of adoption of the outputs for the final users. The changes in practice, products or policy may lead to higher yields, lower costs of production, less exposure to disease and hence lower probability of crop loss, or other immediate impacts. Table 5 lists a number of outcomes that arise regularly for ACIAR projects and identifies those that can and hence, ideally, should be measured.

In estimating outcomes be aware that trial and laboratory outcomes are rarely achieved under real conditions.

Table 4. ACIAR categories for adoption studies

Category	Description
NF	Demonstrated and considerable use of the results by the next and final users
Nf	Demonstrated and considerable use of the results by the next user, but only minimal uptake by the final users
NI	Intermediate outputs with considerable use by the next users and has led to further outputs that have a final user
Ni	Intermediate outputs with considerable use by the next users and yet to lead to further outputs that have a final user
N	Some use of the results by the next users but no uptake by the final users
O	No uptake by either next or final users

Table 5. Examples of immediate impact measures

Economic: supply shocks	**Environmental**	**Social**
Productivity improvement on-farm • Unit cost reduction/input efficiency • Fixed-cost reduction/efficiency	Pollution pressure Reduced: • chemical run-off • noxious air emissions • waste generation	Health pressures • Disease incidence • Costs of treatment
Productivity improvement off-farm • Margin activities (e.g. transport) unit cost reduction	Greenhouse gas emissions Increased: • energy efficiency • carbon capture and vegetation	Employment opportunities • Job availability • Quality of employment (security, pay and conditions)
Input production efficiency—reduction in input costs	Soil degradation Reduced: • grazing pressure • land clearing	Improved rural capacity • Market access opportunities • Diversity of resource use options • Skills base
Economic: demand shocks	**Environmental**	**Social**
Improvements in quality[a]—increased willingness to pay per unit	Water—improved river/marine/estuarine health • Ecosystem services (see economic) • Recreation/amenity use impact • Existence impacts (see biodiversity) • Fisheries (see economic)	Participation and equity
Development of complementary products—increase in associated demand for product	Biodiversity protection/improvement of natural habitat/ecosystems • Threatened species • Ecosystem services • Recreation/amenity use impact	Confidence in the future
Improvements in market access		
Risk	**Risk**	**Risk**
Changes in the probability of or exposure to the risk of shifts in factors underpinning demand or supply	Changes in the level of threats to the environment	Changes in level of threat to social conditions

a Quality can be real or perceived; for example, demonstration of health benefits raises the confidence in a product and its perceived quality. Marketing is all about raising the perceived quality of a product relative to similar products.

Replicability describes the extent to which the project outputs perform as expected when adopted by the final user. It is well documented that technologies usually fail to perform as well under a normal operating environment as they do under trial conditions. Similarly, the results of policy changes rarely replicate those predicted by models employed to convince policymakers of the need for the change. For example, one study on the performance of new varieties of grains found that only about half of the yield improvement achieved under trial conditions was gained in practice.[4] This disparity should be lower now, as trials are more likely to be conducted under real constraints facing farmers. Nevertheless, replicability should be considered in adoption studies. Better information on the likelihood of achieving the 'best case' outcomes in reality would assist in improving the estimates of 'expected outcomes', and hence the quality of ex-ante (and, in many cases, ex-post) assessments.

3.4 Identifying impacts and beneficiaries

3.4.1 Identifying the impacts

Effort should be made in adoption studies to identify the impacts that have arisen or are considered likely to arise. The main purpose is to test the presumptions on which the R&D proposal was based, to assess whether these are still valid. This is an important source of the lessons to be drawn from the adoption studies. The other feature of an adoption study is that it should consider the benefits to Australia. As discussed in section 2.6, the initial or first round impacts arise from the aggregation of the outcomes across adopters. The final impacts depend on the reactions and responses of markets, natural systems and communities to these impacts. The results mapping from outcomes to impacts can be based on well-accepted relationships and linkages that have been demonstrated in similar situations, or on the evidence available.

To identify the impact of a project requires consideration of the results over the full period when results can be observed. This is more than a time-related issue, it also requires tracing through the adjustments to the project impacts. For example, the introduction of the biological control for the banana skipper pest in Papua New Guinea (PNG) reduced the impact of the pest on production and improved food security. Bananas are grown mostly as a subsistence crop in PNG, so two flow-on effects were the release of labour for production of cash and other crops, and reduction in the incidence of malnutrition.

3.4.2 Identifying beneficiaries

Beneficiaries are those people or communities affected in a substantive way by the impacts of the R&D. The main groups of beneficiaries are:

- the final users—often the farmers
- other producers along the value chain—for example, input suppliers, traders, processors and transporters
- consumers of the product
- communities of the producers.

Consideration should also be given to those who might lose from the impacts. They may include:

- non-adopting farmers or groups of producers
- users of the resources (labour, capital and materials) whose demand increases as a result of the adoption of the research, leading to increased price or decreased availability (compared with what it would have been without the research).

3.4.3 Sources of benefit for Australia

Consideration should also be given to the benefits to Australia. These may be direct as Australian producers adopt outputs from the research or indirect as Australia benefits from the outcomes in the developing-partner country. Continuing the banana skipper example, Australian banana farmers were also major beneficiaries as the control of the pest in PNG reduced the risk to Australian production. A meta analysis of ACIAR projects identified the following as the main sources of benefits to Australia (Pearce et al. 2006):

- project-derived technology improvements
- protection from pests and diseases by reducing pests and diseases in neighbouring countries and trading partners (lower risk of transport and migration of pests and diseases into Australia)

4 See for example, Dillon and Anderson (1990)

- knowledge and capacity built that lead to further innovations of value to Australia
- increased trade—access for Australian consumers, access to inputs for Australian producers.

3.5 Validation of information and evidence

Approaches to validation include the following:

- Triangulation—using information from three sources that are expected to have different viewpoints. These may include, for example, the project manager, researchers, the implementing agency, producers and customers.
- Top-down analysis—adding up the estimated results to ensure that they are consistent with known aggregate figures.
- Comparative analysis or benchmarking—comparing the results measured to those in similar situations and questioning results that are very divergent.
- Peer review—using expert judgment to challenge the approach to estimation and the measures used.

4 Impact assessment studies

4.1 The benefit–cost approach

4.1.1 Overview of benefit–cost analysis

Benefit–cost analysis (BCA) is a well-developed approach to assessing the impact of R&D. Its main technical features are:

- quantification of inputs and impacts, and assigning of dollar values to impacts (benefits)
- the use of applied welfare economics (surplus measures) as the theoretical basis for the assessment
- measurement of these values over time
- discounting to estimate the present value of the flow of costs and benefits
- presenting the results as summary measures
  - benefit:cost ratio (BCR)—ratio of the present value of the benefits to the present value of the total investment costs (including implementation costs)
  - net benefit:investment ratio (NBIR)—ratio of the measured benefits (less implementation costs) to the measured R&D investment costs
  - internal rate of return (IRR)—the rate of return at which the investment value is equal to the value of the benefit flow.

The approaches set out in Box 3 draw on the lessons learnt from the long history of ACIAR assessments undertaken. They are not the only way to utilise BCA, but have been found to be a sensible approach that, if followed, will improve consistency, comparability and interpretation of the BCA results.

Beyond these common technical features there is a wide variety of approaches to BCA. Their conduct is as much an art as a science, and there is a considerable literature on approaches to estimating welfare effects.[5] Figure 7 sets out the results mapping with some of the issues that need to be considered in undertaking an impact assessment.

4.1.2 A common measure is used to value all impacts

Ideally, all values should be expressed in money terms (money metric). This improves comparability and allows summing of the benefits. While not all impacts are easy to value in monetary terms, efforts should be made to do so for all significant benefits and costs. The extent to which there are benefits and costs that are thought to be significant but are not included in the estimates will reduce the confidence in the estimates.

Real not nominal values must be used, taking the year of the impact assessment as the base year.

Both costs and benefits need to be reported in real values, i.e. deflated with an appropriate price deflator. What is the most appropriate deflator has been debated in the literature.[6] It is suggested that the GDP deflator should be used rather than CPI. A deflator series is given in Appendix 4. Costs and benefits should be expressed in the year that the evaluation is being undertaken, and that year reported.

5 For agricultural R&D evaluations see Alston et al. (1995).

6 The choice of price deflator should be governed by the outcomes that are being measured. Thus, if the outcomes are consumer goods, CPI is appropriate. For commodities, commodity prices are appropriate and, for general producer income, GDP deflators are used. See Pardey et al. (1992) and Hutton and Baltussen (undated) for a discussion of choices of price deflators within and across countries.

Box 3. The agreed approaches to impact assessment quantification

The following are the agreed approaches to impact assessment quantification

1. Real values must be used, taking the year in which the assessment is undertaken as the base year.
2. Results should be reported in a common currency (A$).
3. The annuity value for future benefits (and any costs) should be used in the final year of the impact assessment period.
4. Discounting is applied to provide a discounted present value up to the year in which the impact assessment is undertaken.
5. Summary statistics should be reported for a range of discount rates.
6. Ex-ante estimates used in impact assessment should have a probability assigned to get the expected value.
7. The sizes of the potential user populations should be estimated, based on the expected net benefit to the final user change in practice, product or policy.
8. In estimating rates of adoption, consider the non-pecuniary costs as well as financial costs.
9. Make public-good implementation costs explicit in the analysis, and incorporate market-based costs as part of the surplus analysis.
10. Disadoption depends on the baseline scenario. In the absence of evidence otherwise, benefits should be assumed to continue forever.
11. Consider non-market as well as market opportunity costs.
12. Use of regional multipliers should be avoided.
13. Care is needed to avoid double counting.

Common currency (A$) reported

Costs and benefits measured in foreign currency should be converted at the market exchange rate to Australian dollars prevailing at the time the cost or benefit arises. For future costs and benefits this will be the exchange rate at the time of the evaluation (annual average). This rate should be recorded. For countries with highly managed exchange rates, a purchasing power parity rate or black-market rate should be used. Appendix 4 provides a series of average exchange rates for countries in which ACIAR commonly works. The International Monetary Fund International Financial Statistics period average provides a consistent series of exchange rates.[7]

[7] A subscription is required to access the information, which is available at <ifs.apdi.net>.

4.1.3 Time period for benefit flows

The time period of the analysis can vary, but 30 years has typically been used. As many projects have a considerable gestation time, this period may be too short to reflect the returns to the project. ACIAR also wants to be able to estimate the contribution that the project has made in a particular year. This requires recognising that some benefits continue forever. The suggested approach is:

- to report the year and value of benefits ($X) once a steady state is reached
- in the following year include the present value of the future flow of benefits at the discount rate being used to estimate the BCR (estimated as $X/discount rate)

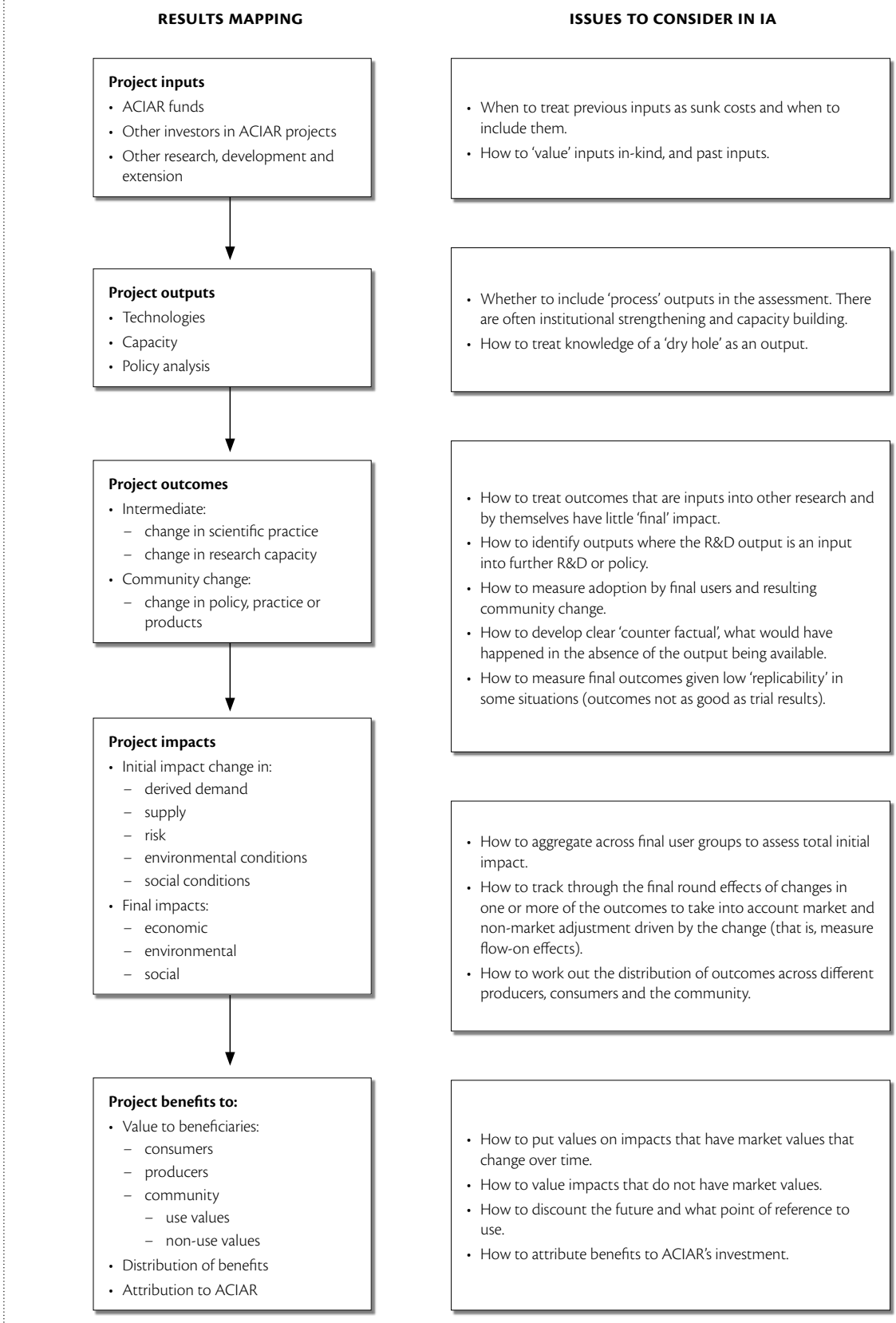

Figure 7. Tracing inputs to benefits

- include this aggregate year (year after steady state is reached) in the flow of benefits used to estimate the summary measures.

The annuity value for future benefits (and any costs) should be used in the final year of the impact assessment period.

The time period starts with the first year of the ACIAR R&D investment. Given that much R&D is long term, there may have been substantial investments made prior to this that may need to be reflected in costs. These can be incorporated by compounding back the stream of costs up to the first year of the R&D project(s) being assessed.

Discounting or compounding is applied to provide a present discounted value at the year in which the assessment takes place.

BCAs should always provide the full detailed time series of costs and benefits, so that the present value can be calculated at any point in time. This should be provided as an appendix and in a spreadsheet file to ACIAR.

4.1.4 Choice of discount rate

There has been considerable debate about what is the appropriate discount rate for BCAs. The discount rate can be interpreted as either:

- the opportunity cost of capital—the real rate of return it would be earning if it had been placed in the next-best use. This is often benchmarked as the real return on a risk-free investment (for which investment in long-term government bonds is the best proxy)

OR

- the time preference of the investor—the rate at which they are willing to forgo consumption today for a higher level of consumption tomorrow. When the investor is the government on behalf of society, a social discount rate might be used. As society is thought to live forever this discount rate is usually lower than individuals' discount rates.

It is often argued that a lower discount rate should be used for projects with an environmental and/or social impact, to reflect expectation that the values placed on these impacts in the future are generally undervalued by individuals (as they fail to take the value to future generations into account).[8] One solution to this time-inconsistency problem is to use, in the BCAs, the value of these future impacts to individuals in the future rather than a lower discount rate. This 'shadow price' could also reflect increasing scarcity or abundance of the attribute. Use of different discount rates across different benefit flows resulting from a single project unnecessarily complicates the analysis and should be avoided. Private sector projects tend to use a higher discount rate reflecting the higher personal or firm-level cost of risk associated with the return.

Ultimately, the choice of discount rate is the organisation's, and it reflects their time preference. ACIAR uses a 5% discount rate in its assessments, which is consistent with the current government practice. Summary statistics should be reported for a range of discount rates (commonly 0, 5 and 10%) so the influence of the discount rate can be assessed. The 5% results are reported in the text.

Summary statistics should be reported for a range of discount rates.

4.1.5 Treatment of forecast estimates

The results mapping is critical in identifying what needs to be measured. The R&D inputs must be measured, as must any other inputs required to deliver the outcomes. Outputs must be identified, but it is at the outcome level that quantification is required for a BCA. Figure 8 summarises the categories of measures needed to estimate the net benefit of the R&D. Each of these is addressed below.

The points in the pathway that need to be measured to estimate outcomes are:

- implementation—the cost to implement the R&D outputs
- adoption rates—the extent and timing of adoption
- replicability—the extent to which experimental results are achieved in practice.

If the BCA is being undertaken before the investment, the uncertainty about the success of the science should be included in the mapping. Similarly, if the project is

[8] See Portney and Weyant (1999)

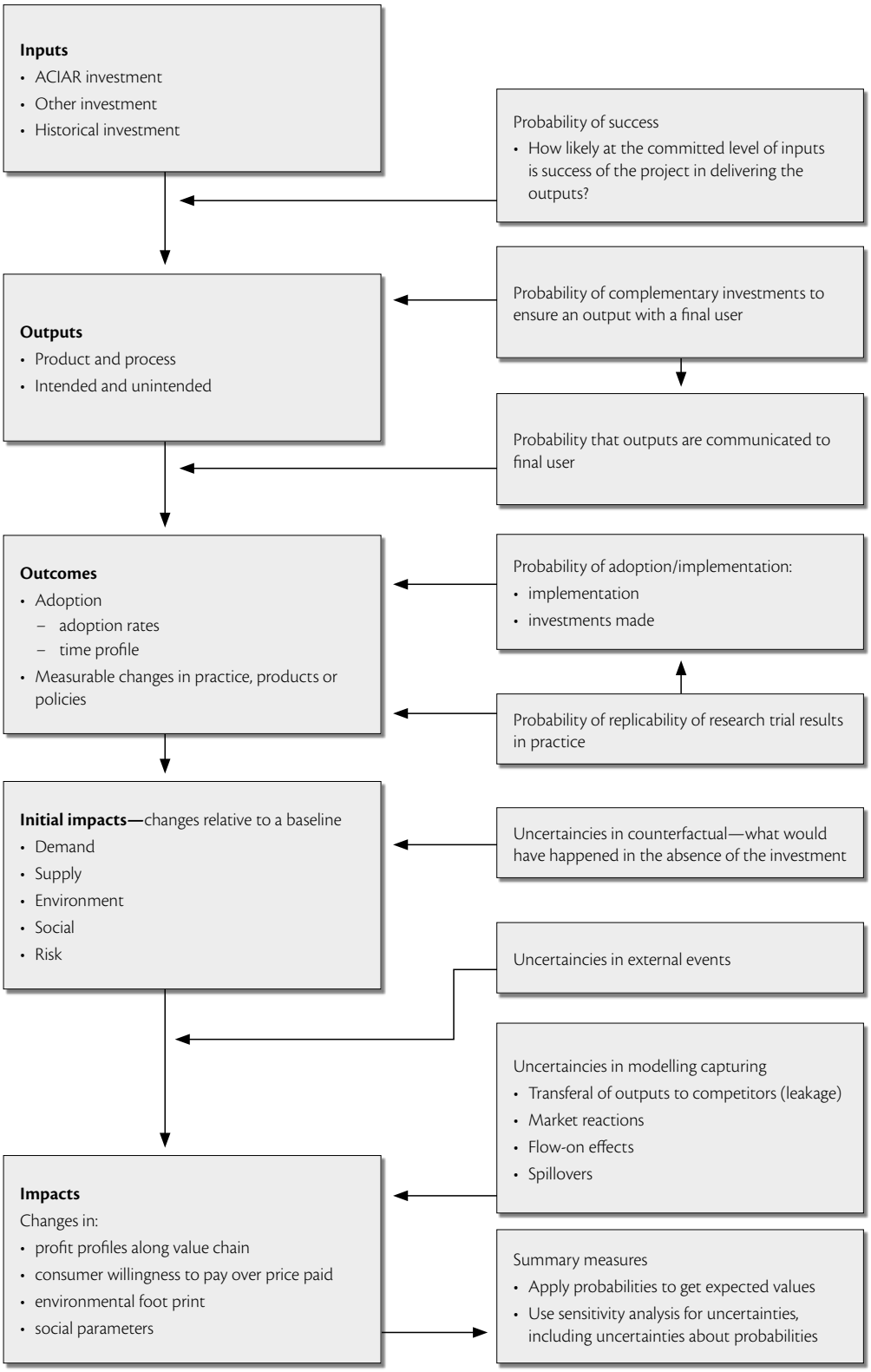

Figure 8. Forecast and uncertainty measurements required for estimating the net benefit of an investment.

completed, but adoption has yet to occur, the probability of implementation needs to be considered. And if adoption has happened, but there is a lag between adoption and achievement of outcomes, the probability of the expected outcomes occurring should also be considered.

Forecast estimates used in impact assessment should have a probability assigned to get the expected value.

4.2 Estimating costs of R&D

Projects often build on previous R&D, or may be inputs into future R&D and therefore have only intermediate outcomes. ACIAR projects that contribute to a common suite of objectives and outcomes should, for the purpose of impact assessment, be considered as a set. Failure to do so will result in understatement of the investment required to deliver the outputs and outcomes. Relevant projects are all those that contributed in a substantive way to achieving the outputs. Where there are more than a few projects contributing to the impacts being assessed, a flow chart that shows the timing and the contributions of the projects is a useful addition.

Inputs to be reported include:

- financial costs of all relevant projects, separately listing the costs of ACIAR and research partners, and any other contributions
- in-kind inputs (at agreed values) by research partner organisations
- in-kind inputs by other participants such as farmers, policymakers and public asset managers that are public good and not reflected in the market prices of the technology under examination.

The time profile and currency should be noted. Monetary values should be converted to Australian dollars in the year of the expenditure.

4.3 Estimating outcomes

4.3.1 Identifying the final user populations

Estimate the sizes of the potential user populations, based on the expected net benefit to the final user change in practice, product or policy.

The final user population is the group of users for whom the output is applicable. Applicability is limited by the crops grown, the characteristics of the production system, access to required inputs, and climatic and soil variations. Estimates of the population of final users should be based on the potential improvement in returns to the adopters relative to returns from *current and anticipated* practice. The populations to whom the project outputs are applicable are those that have sufficient improvement in expected returns to compensate them for the cost and effort of change. In assessing the potential populations and level of adoption, it may be useful to seek answers to the following questions:

- What product or production process is being replaced by producers, consumers or in the natural or social environment?
- What is the current and anticipated extent of use of the products or processes being replaced? Is this growing, static or declining?
- Do different user groups currently use the product or process being replaced differently and/or is it anticipated that they will use it differently in the future? That is, is the population uniform in current or anticipated use?
- Do the potential final user groups face different opportunities and/or incentives for adoption?

The size of the final user population sets an upper bound on adoption. This can be estimated by formal modelling of the opportunities if the markets are well understood and measured, or by drawing on farmer and expert opinion.

4.3.2 Estimating the return to the final user and the incentive for adoption

Adoption is rarely a costless process. The main costs are:

- the capital cost of implementing the change in policy, practice or product
- down time and lost production during a transition phase
- training costs, including operator time
- costs associated with the inherent uncertainty about the consequences of the change.

In estimating rates of adoption consider the non-pecuniary costs as well as the financial costs.

These costs are higher, the more:

- capital intensive the change is to implement (especially relative to the capital intensity of the current approach), such as when major pieces of capital have to be replaced
- complex the technologies and hence learning required to implement the change effectively
- culturally different the new approach is compared with previous policy, practice or product, and hence the degree of discomfort with the change
- uncertain or less demonstrated are the results of the change.

Make implementation costs explicit in the analysis.

Implementation investments are just as critical as the R&D investment to achieving benefits. They may include the costs of purchase of major new capital equipment, or the costs of implementing a new policy. They need to be explicated in the analysis.

In many cases, implementation costs should be included in the surplus analysis (as part of the shift in the supply curve, for example).

Implementation costs are not the ordinary operating costs (which must be considered when estimating benefit flows). Rather they are additional investments required prior to the generation of significant benefits. The advantage of considering implementation costs separately is that it provides insight into the costs of adoption. High implementation costs can be a barrier to adoption, in that they imply that the benefits must be considerable and relatively certain to induce this investment.

4.3.3 Estimating maximum adoption rates

While in some situations the number of individuals or communities adopting is the variable of interest, in most situations it is the area or volume of production or consumption affected by adoption that is of interest. Where only the number of users and the average levels of production or consumption are known, the overall adoption rate is estimated by multiplying the share of users by the average level. The problem of bias (say, for example, big producers are more likely to adopt, in which case this approach will underestimate production affected) can be reduced by ensuring that, in defining applicable populations, all members in the population are equally likely to adopt.

Methods to measure adoption include:

- census or surveys of the share of the applicable population that has adopted the change and the average production/consumption affected
- investigation of sales of the product being adopted, or complementary products that reveal adoption
- documentation of reported production/consumption volumes relative to modelled (expected) volumes without adoption (baseline)
- assessment of the share of a relevant population complying with a regulation (voluntary and compulsory).

4.3.4 Estimating the adoption profile

The adoption profile should measure, at a minimum:[9]

- the size of the final user populations (production/consumption as well as numbers of users)
- expected maximum adoption levels for each final user population
- time to first adoption, time to maximum adoption and the time to the point when an increasing rate of adoption begins to slow (point of inflection)

[9] See Alston et al. (1995) for a discussion of estimating adoption profiles.

- measures of historical and current adoption or progress to adoption
- errors and/or ranges on measurements.

There are some standard adoption profiles that are useful in undertaking BCAs, an S-shaped profile being the most common. Where possible, adoption studies should provide a picture of the adoption profile. Some examples are given in Figure 9.

Disadoption depends on the counterfactual, not-yet-to-be-developed technologies.

There is considerable debate over the issue of disadoption. Many assessments build in disadoption of a technology under the broad notion that it will become obsolete over time and be replaced with new and better technologies. However, this approach then attributes to the next new technology not only the improvement over the current technology, but also the improvement of the current over all of the old technologies. Figure 10 illustrates this attribution problem.

As a general principle, benefits should be assumed to continue forever. If a case for disadoption is to be made, it must be made via an explicit argument relative to the baseline, using the same tools as for the analysis (demand and supply curves, for example).

Based on considerable discussion and analysis we have concluded that there will be, in general, very few cases for which it is appropriate to assume disadoption.

4.3.5 Estimating the size of the final user populations

The final user population provides the potential scale of adoption. What usually matters is the scale of production or consumption affected rather than the number of producers or consumers. The population can be measured in a range of ways, depending on who or what is doing the adopting—the users—and on what is affected by the change. Some examples are given in Table 6.

Estimates of the population of final users should be based on the potential improvement in returns to the adopters relative to returns from *current and anticipated* practice. The populations to whom the project outputs are applicable are those that have sufficient improvement in expected returns to compensate them for the cost and effort of change. In assessing the potential populations and level of adoption, exploration of the following questions may be useful:

- What product or production process is being replaced by producers, consumers or in the natural or social environment?
- What is the current and anticipated extent of use of the products or processes being replaced? Is this growing, static or declining?
- Do different segments of the population currently use the product or process being replaced differently and/or is it anticipated that they will use it differently in the future? That is, is the population uniform in current or anticipated use
- Do the population segments face different opportunities and/or incentives for adoption?

Table 6. Measures of final user population—examples by type of user

Farmers	Consumers	Regulators	Community
Number of farmers	Number of consumers	Population impacted by the regulation	Community population
Area of production	Quantity consumed	Volume of production/ consumption affected	Area under community influence
Volume of production			Area of waterways/native vegetation etc. under community control
Volume of inputs used			

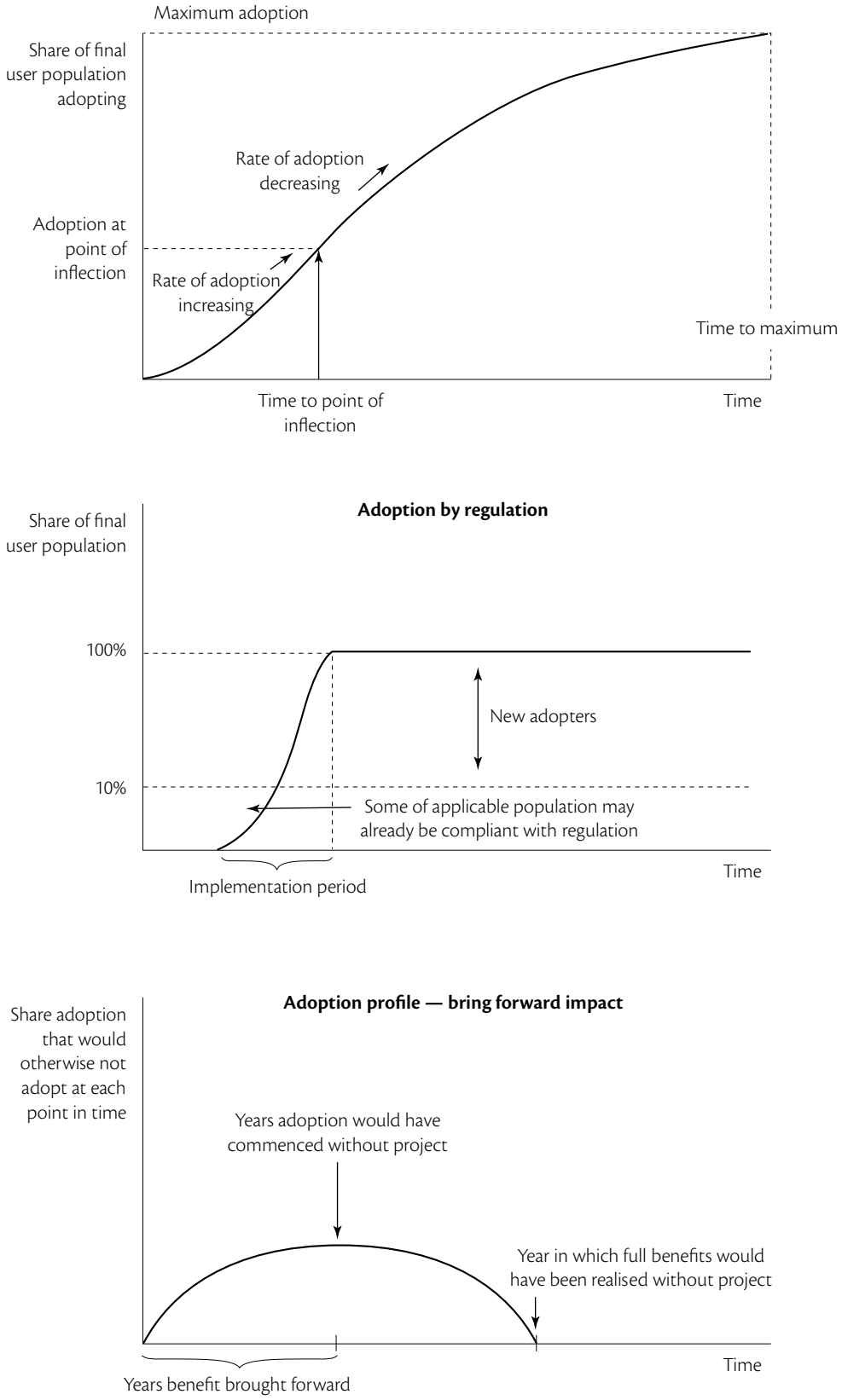

Figure 9. Adoption profiles

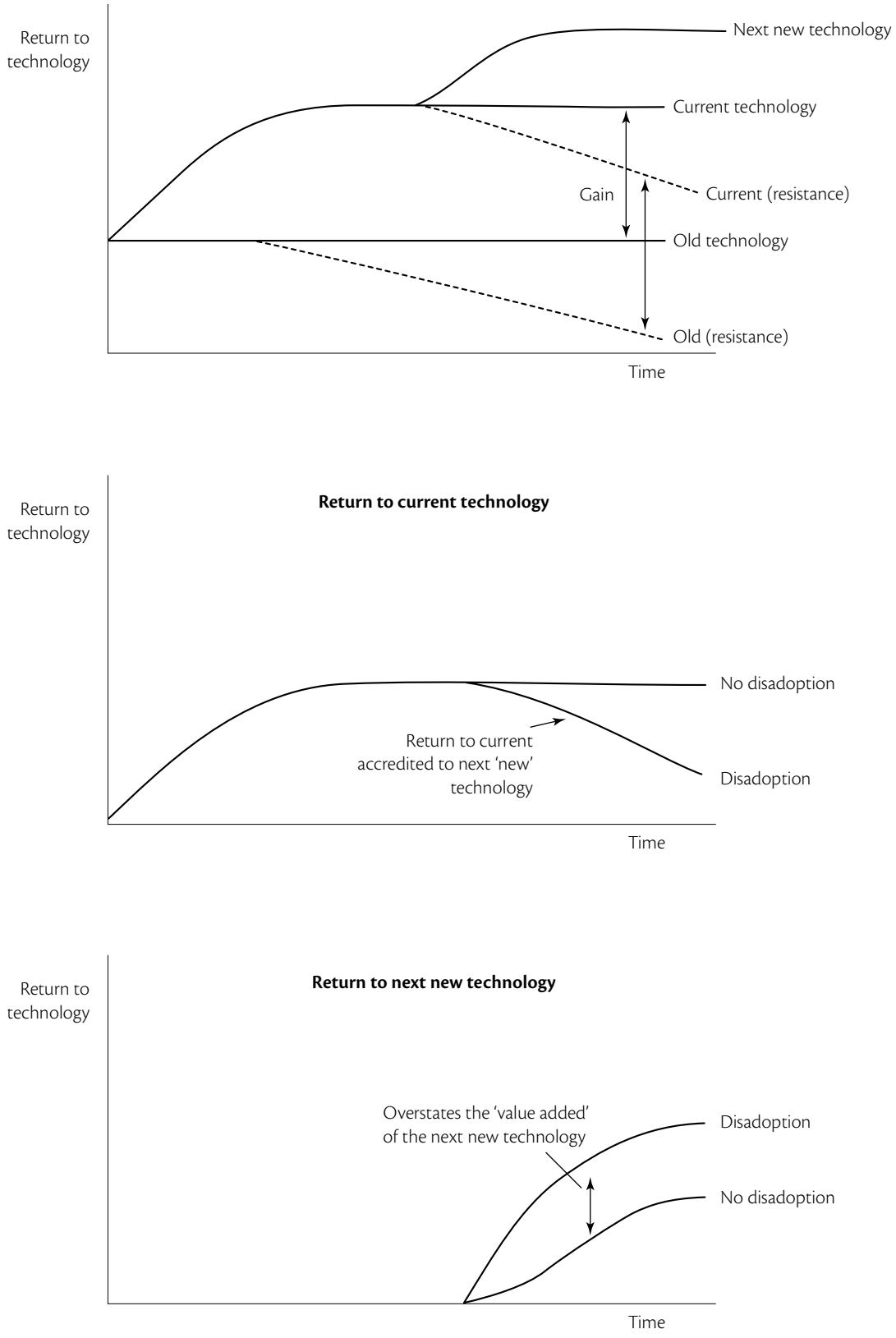

Figure 10. The case against including disadoption as standard practice in impact assessments

The size of the final user population that output is applicable to sets an upper bound on adoption. This can be estimated by formal modelling of the opportunities, if the markets are well understood and measured, or by drawing on farmer and expert opinion.

4.3.6 Validation of adoption estimates

Estimates of adoption should, as far as possible, be validated. At the outcome stage, consider:

- a reality check—does the return to final users justify the adoption rates estimated; do the final users have the capacity to adopt (financial, skills, access to resources)?
- comparative assessment—have similar rates of adoption been found before for that commodity, country or type of R&D? If the adoption estimate is well above or below previous impact assessments, why might this be the case?
- peer review—what is the view of the industry and the researchers? Do they think the estimated adoption rates and claimed changes in practice, products or policies and the immediate impacts (e.g. farm-level changes in productivity) look reasonable?

4.4 Estimating impacts

4.4.1 Measuring the baseline: the counterfactual

Measuring the baseline requires projecting the pathway over time for the result areas of interest. Methods include:

- time-series analysis (historical trends)
- modelling based on the observed changes in the exogenous drivers of change in that result area
- comparisons with similar situations that have not had the benefit of the project or equivalent type of investment, such as in similar countries, regions, communities or industries.

In estimating the baseline or counterfactual remember that gains are almost always marginal improvements rather than quantum leaps. Even new products replace something that was itself of value to users.

4.4.2 Consider opportunity cost when estimating impacts

Alternative uses of inputs should be considered in estimating impacts. If the change is more resource intensive— it uses more land, for example—then the production gain is the value-added from the changed use of the land less the value-added under the previous use of the land. Demand and supply analysis will build in the higher costs associated with an expansion in production volumes, reflecting the opportunity cost of the inputs that have to be diverted from other uses. Take, for example, a new water-management system that gives more water to urban households and less to irrigators. The gain to households (perhaps measured by their payment for the water), comes at an opportunity cost of reducing water to irrigators and, consequently, lower production levels and/or higher costs to improve water-use efficiency.

Consider non-market as well as market opportunity costs.

If, for example, the change results in less water reaching wetlands, there is also an opportunity cost for the environment if wetland health is affected. Similarly, if forest is cleared for production of crops, there is an opportunity cost in the value of lost production for communities that have harvested the forest, as well as a possible cost in terms of lost biodiversity. The analysis can become complex if, for example, the harvesting activities of the communities had become unsustainable, so that, all else being equal, this prior benefit would have declined over time.

4.4.3 Mapping to five final outcomes can help to define modelling approaches

Mapping the changes in policy, practice and products to five final outcomes is an important step in estimating the magnitude of the impacts of the R&D. It is also very useful in developing the approach to be taken in estimating the impacts. Changes in demand or supply conditions, or risk that impacts on demand or supply, need to be analysed using economic models. Externalities arising from changes to the environment or social capital can be analysed using social rather than private demand and supply functions. These are

derived from the marginal social benefit and marginal social cost functions. Willingness-to-pay approaches are required to estimate social demand functions.

In measuring initial impacts (shocks) the main considerations are:

- adoption rates and profiles for each relevant population
- for the representative consumer or producer in each relevant population
  - changes in WTP (shift demand) by consumers resulting from a change in quality, tastes or market access, or the arrival of a new product—this will often be a shift in derived demand
  - changes in the cost function (shift in supply) by producers resulting from a change in input mix, cost, outputs, timing of output
- changes in aggregate risk associated with production or consumption
- changes in environmental and/or social attributes (shift in the social cost function).

These changes are all changes from the baseline 'without the R&D output' levels. The changes should have a time profile (due to the adoption profile and the time profile of the baseline). Full details of how the impacts have been calculated should be provided so these can be reproduced at a later date.

Table 7. Mapping to five R&D final outcome categories

Final outcome	Changes to:	Examples of R&D outputs
Derived demand for the farmer's product	New products Quality and consistency of product Market access Supply chain management	Trade policy reducing barriers to trade Meeting Sanitary and Phytosanitary agreement requirements Genetic improvement of cattle Cold chain management of vegetables to market
Supply of the farmer's product	Input costs Input use efficiency Yield per unit of input Supply chain costs	Higher yielding varieties Integrated pest management systems More efficient transport methods
Risk to demand, supply and natural or social capital	Market access certainty Price certainty Certainty of access to inputs Certainty over volumes of production Certainty of regulation	More robust varieties for production (especially subsistence) Policy analysis
Environmental capital	Natural resource use (water, soil nutrients etc.) Environmental health (pollution, soil degradation, water quality)	Irrigation efficiency technology Optimised fertiliser regimes
Social capital	Human health Community cohesion Individual wellbeing (confidence, access to services) Community participation	Improved occupational health and safety

Table 7 provides some examples of the types of changes that might result from adoption of R&D outputs and the final outcome classification.

The change in private or social demand or supply is the first round effect. The size of this change depends on the size of the applicable final user populations. The appropriate metric for the final user population depends on the nature of the final outcome. In general, when supply is affected, the relevant unit is the volume of production or area of production to which the change in unit cost of supply applies. Where risk or social attributes are affected, it might be the number of producers, consumers or communities involved that matter. When it is the environment, the metric of final users might be areas of native vegetation affected.

4.4.4 Applied welfare (economic surplus) analysis should be used where possible

Economic models of markets based on consumer utility functions and producer production functions provide a useful tool for estimating the change in welfare resulting from a change in demand or supply. In general economic models these reflect private benefits, but the same welfare analysis methodology can be used to estimate changes in social benefits. The advantages of the economic surplus approach are that it reflects values above price paid (consumer surplus), prevents double counting and identifies the distribution of benefits between producers and consumers.

Partial equilibrium models are the ones most commonly used in project BCAs. They need to be tailored to the final outcomes of interest. The key parameters are:

- initial price and quantity
- price elasticity of the demand and supply functions at the initial price and quantity
- shifts in demand or supply due to the adoption of the R&D.

Disaggregation of supply or demand into different applicable populations is recommended as this allows the use of parallel shifts and recognises that total market demand and supply are aggregations of measurements from subpopulations. There is a rich literature on partial equilibrium analysis for BCAs.[10] The main point is that an economic surplus model should always be used to demonstrate what is being measured in the impact analysis, and the formulas employed provided.

Figure 11 shows two simple situations: a productivity-driven fall in cost of production, and a quality-induced shift in demand. The increase in welfare is given by the shaded area in each case. A key consideration is whether the shift in the supply or derived demand curve is parallel or pivotal. In the case of a supply shift, disaggregation of the market into the different groups of suppliers can be used to justify using a parallel shift approximation. The shift in the demand curve is more difficult to deal with as it depends on how WTP changes in response to a change in quality or other shift factor. Improvement in market access is one of the major sources of a shift in demand.

Analysis of the impacts might involve consideration of both horizontal and vertical dimensions.

Horizontal disaggregation

Most agricultural products are sold on the international market. When commodities are traded, the initial country's research can affect world prices in one or other of two ways. First, if the innovating country is a 'large country'[11] exporter (or importer) on the world market, such as in the case of Australia in terms of wool exports, a research-induced increase in domestic supplies will lower the world price for that commodity (referred to as 'price spillovers'). Second, even if the initial country is a 'small country',[12] if the new technology can be adopted by competing countries, this could lead to a change in world production of the commodity in question and to a lower the world price for that commodity (referred to as 'technology spillovers'). The technology spillovers will augment the price spillovers if the country undertaking the research is large in both trade and research. These

10 See, for example, Alston et al. (1995)

11 A country is referred to as a 'large country' (or large in trade) if it is a big enough producer or consumer of a particular commodity that a change in that country's production or consumption of the commodity will affect its world price.

12 A country is referred to as a 'small country' (or small in trade) if it is a small enough producer or consumer of a particular commodity that a change in its production or consumption of that commodity will not affect its world price.

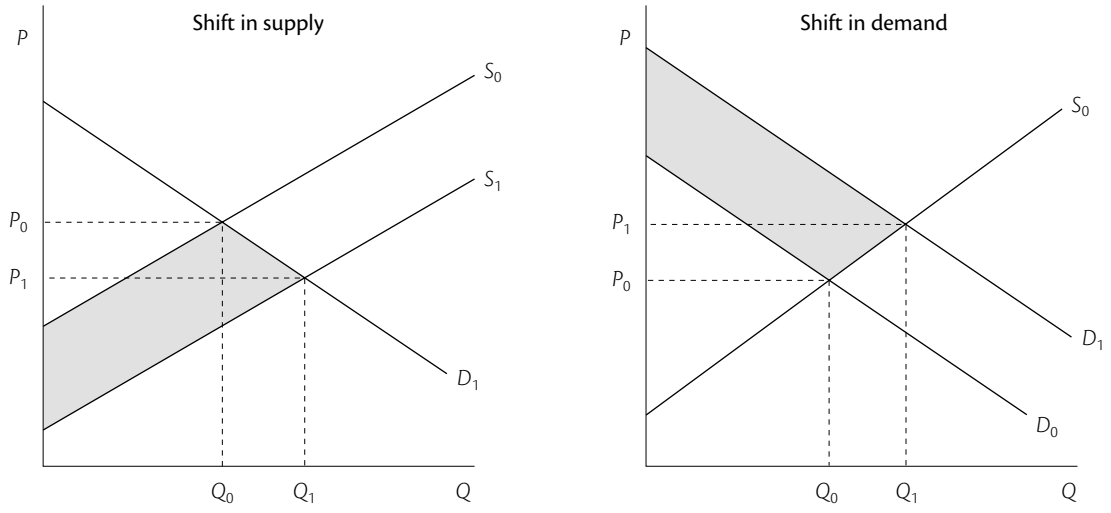

Figure 11. Mapping changes in consumer and producer surplus—a partial equilibrium approach.
Source: Centre for International Economics

research-induced changes to world prices and quantities will result in part of the gains or losses from domestic research being realised in other countries.

The literature contains several models that have been used to assess research gains for a traded good. Studies have variously allowed for price spillovers when the country is a large-country exporter or importer, for technology spillovers when the technology is transferable to other countries, or for both (Edwards and Freebairn 1982, 1984; Davis et al. 1987; Brennan et al. 1989; Voon 1992; Voon and Edwards 1992).

Modelling price and technology spillovers can be done by developing a commodity model that consists of either (a) two sets of equations, one that represents the home country and one that represents the rest of the world in aggregate (e.g. Voon 1992; Voon and Edwards 1992), (b) a set of equations that represents the home country in aggregate and a set of equations for each of the major trading partners or regions (e.g. Davis et al. 1987) or (c) a set of equations for two or more regions in the home country and a set of equations for the rest of the world in aggregate (Edwards and Freebairn 1982; Brennan et al. 1989), or (d) a set of equations that represent two or more regions in the home country and a set of equations for each of the trading partners.

This approach, shown in Figure 12, models the distribution of research benefits in the context of trade where there are price spillovers. The scenario depicts commodity equations representing the home country (country A) as a large country exporter, and all other countries (the rest of the world [ROW]) in aggregate.

Following Alston et al. (1995), Panel (a) of Figure 12 represents the supply and demand in country A, and panel (c) represents the aggregated supply and demand in the ROW. Panel (b) shows the excess (export) supply in country A ($ES_{A,0}$) calculated as the horizontal difference between domestic supply (initially $S_{A,0}$) and demand ($D_{A,0}$). While the initial excess (or import) demand from the ROW ($ED_{B,0}$) is calculated as the horizontal difference between the ROW demand ($D_{B,0}$) and supply ($S_{B,0}$). The intersection of excess supply and demand represents the international market equilibrium at a price P_0. Corresponding domestic quantities at price P_0 are shown as consumption ($C_{A,0}$), production ($Q_{A,0}$), and exports ($Q_{T,0}$). On the other hand, ROW quantities are shown as consumption ($C_{B,0}$), production ($Q_{B,0}$) and imports ($Q_{T,0}$).

Research innovation in country A causes a parallel shift of domestic supply from $S_{A,0}$ to $S_{A,1}$ leading to a shift in the excess supply from $ES_{A,0}$ to $ES_{A,1}$. Given the shifts in the supply curves, a new equilibrium price at P_1 is established

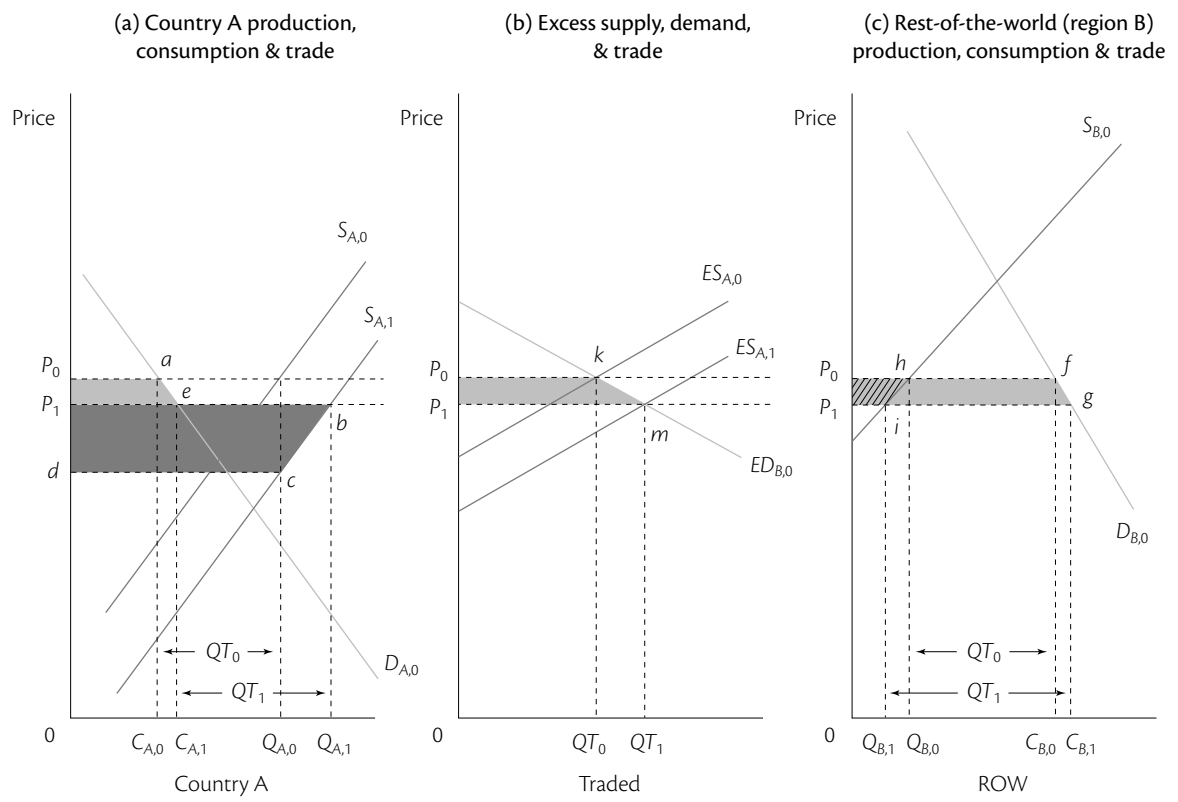

Figure 12. Horizontal market—exporter innovates

with corresponding new domestic (consumption, $C_{A,1}$, production, $Q_{A,1}$, and exports, $Q_{T,1}$) and ROW quantities (consumption, $C_{B,1}$, production, $Q_{B,1}$, and imports, $Q_{T,1}$).

The research-induced supply shift in country A causes the fall in the world price. Both consumers in country A and the ROW gain as well as the producers in country A, while the ROW producers lose.

The distribution of benefits is as follows:

- country A consumer benefits: area P_0aeP_1—measured by the change in consumer surplus
- country A producer benefits: area P_1bcd—determined by the size of the research-induced supply shift, the resulting decline in price and the initial quantity. The relevant demand elasticity is that for the total demand (i.e. domestic plus ROW).
- ROW consumer benefits: area P_0fgP_1
- ROW producer losses: area P_0hiP_1
- ROW excess demand: area P_0kmP_1 in panel (b), which equals net ROW benefit (consumer benefit less producer loss): area *fghi* in panel (c).

Therefore, a research-induced technical change in a large exporting country must benefit both countries (domestic and the ROW).

In sum, the multiple-market framework provides three important and intuitively appealing insights. First, a supply or demand shift in any one country or region can affect the price, quantity and economic surplus in every other region. Second, consumers in all affected regions will benefit, regardless of which group of producers adopts a new technology. Third, so long as the technology-induced fall in costs is greater than the technology-induced fall in price, the technology adopters will gain, while non-adopters will necessarily lose (because they cannot offset the fall in output price with the fall in costs). The general multiple-market approach

therefore provides a relatively simple way of accounting for these spillover effects across different markets *for a single product*.

Vertical disaggregation

The vertical market allows the analyst to assess the distribution of returns to research between farmers, service providers and consumers. It is particularly useful when assessing the returns to postharvest technologies.

Several assumptions underlie the vertical market relationships in multistage production systems:

- different stages of production are occurring at one time
- participants in the different stages are represented as input suppliers
- the participants' welfare is reflected in the distribution of economic surplus among inputs.

Following Alston et al. (1995), Figure 13 represents the markets for a farm product and a marketing input (which is a combination of all marketing inputs represented as one component) that are used in fixed proportions to produce a retail food item. The determinants of this market situation are the technology of production (i.e. the fixed amounts of the two factors used to produce a unit of the retail product), the supply conditions for the factors of production and the demand function for the retail product.

In Figure 13, SF_0 is the farm product supply curve and SM_0 is the marketing inputs supply curve where the units of the factor quantities are defined as per unit of the retail product. At the retail level, DR_0 is retail product demand curve. Now, given that the factors are used in fixed proportions, the retail supply and factor demand equations are derived as follows:

The retail supply function (SR_0) is the vertical sum of the farm product and marketing inputs supply curves. The farm product demand curve (DF_0) is the vertical difference between the retail product demand curve and the marketing inputs supply curve. Finally, the marketing inputs demand function (DM_0) is the vertical difference between the retail product demand curve and farm product supply curve.

In equilibrium, the retail price and quantity are PR_0 and QR_0, respectively. Similarly, the equilibrium marketing inputs price and quantity are PM_0 and QM_0 and the farm product equilibrium price and quantity are PF_0 and QF_0.

Measuring the returns to research

First, let's assume that the research is undertaken at the marketing level. The adoption of a marketing technology (for example, a new grain drying and/or storage system) will result in a parallel downward shift in the supply function for marketing inputs (from SM_0 to SM_1). As a result, the supply curve of the retail product will also shift down (by the same absolute amount per unit) from SR_0 to SR_1, while the demand for the farm product shifts up in parallel from DF_0 to DF_1. This leads to a proportional increase in quantities (to QR_1, QM_1 and QF_1), decrease in prices of the marketing input and the retail product (to PM_1 and PR_1, respectively), and an increase of the farm product price (to PF_1).

These changes cause a total welfare gain of I_0abI_1 which comprise of a change in consumer surplus ($\Delta CS = PR_0abPR_1$), and a change in producer surplus ($\Delta PS = PR_1bcd$). The change in producer surplus is equal to a change in surplus to suppliers of marketing inputs ($\Delta MS = PM_1fgh$) plus a change in surplus to suppliers of the farm product ($\Delta FS = PF_1ijPF_0$).

Equivalently, the total benefits could be measured in the market for marketing inputs, as the sum of 'producer surplus' ($\Delta MS = PM_1fgh$) and 'consumer surplus' (PM_0efPM_1—which includes ΔCS to final consumers and ΔFS to suppliers of the farm product). Total benefits and their distribution could also be measured in the market for the farm product. 'Producer surplus' (ΔFS) reflects benefits to producers of the farm product, and the 'consumer surplus' manifests benefits to final consumers (ΔCS) and suppliers of marketing inputs (ΔMS).

This set of results holds true and may be extended to more than two factors of production where, in any factor market, the 'producer surplus' refers to the surplus to suppliers of that factor while the 'consumer surplus' refers to the surpluses to both final consumers and suppliers of all other factors.

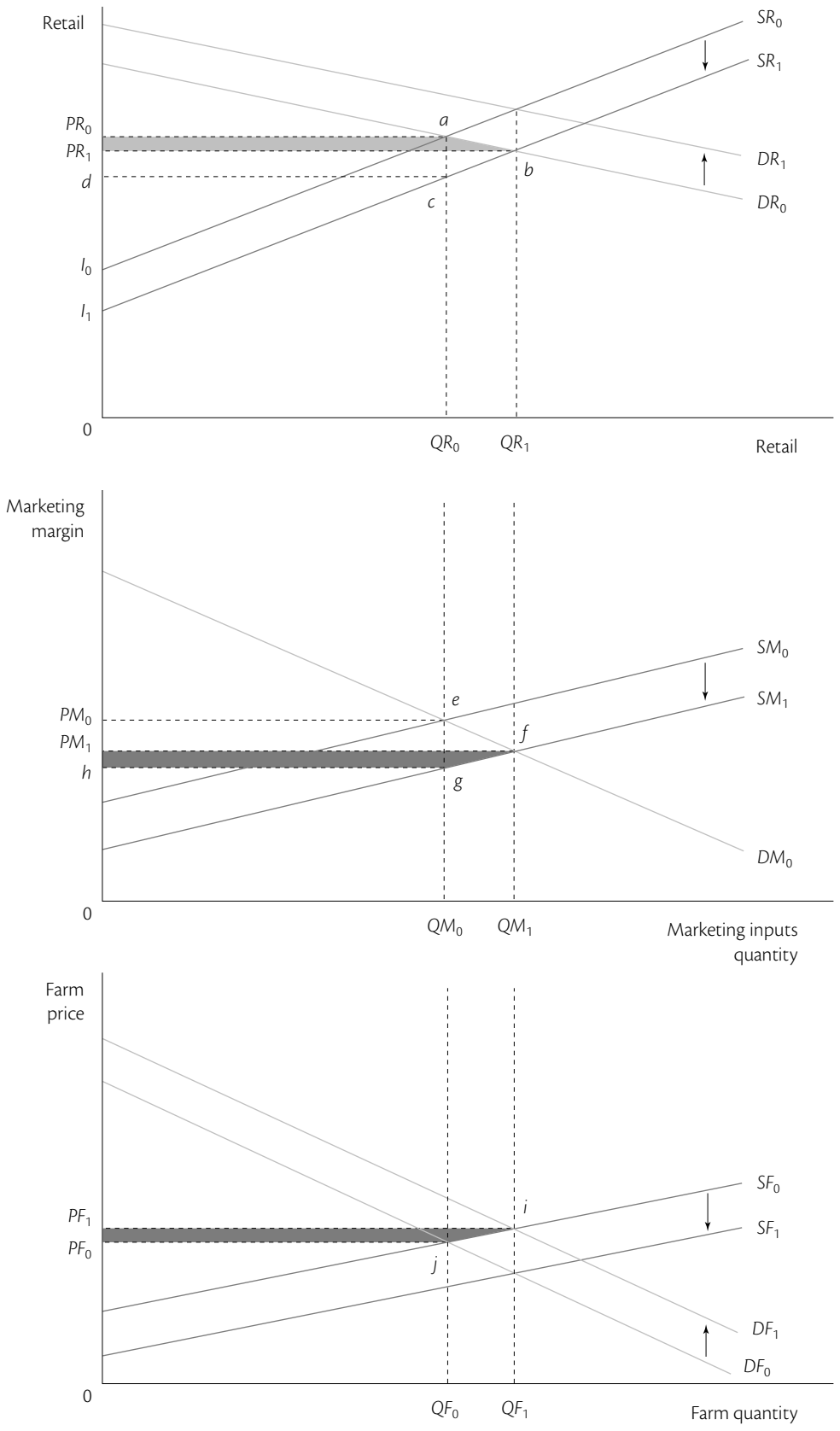

Figure 13. Vertical market

Now let's assume that the research is directed at the farm level. The adoption of a new farm technology (for example, a new, high-yielding variety) will cause the farm product supply curve to shift downward to SF_1 by the same amount per unit. In this case, the total benefit and distribution of benefits will remain the same so long as the shifts are parallel. The same applies with a shift upward of the final demand curve by the same amount per unit, to DR_1 (which could be due to promotion campaign). Alston et al. (1995) note:

> … in this setting, farmers could afford to be indifferent both about where new technology applies in the production and marketing system and about where a levy to fund research is collected; maximizing total benefits will maximize farmer benefits.

It should be noted, however, that the results of this analysis hold true only when:

- there are no market distortions
- research dollars are spent with equal efficiency at each of the market levels.

The same basic structure can be amended to identify issues such as:

- different segments of production facing different supply costs and conditions, so having different responses to changes in prices; for example, farmers with limited access to some inputs will have a different cost structure from those not facing such restrictions
- the existence of distortions in the market that mean that producers do not receive market prices; for example, price wedges due to a tariff (see Figure 14 as an example)
- where there is a divergence between the social benefit or cost and the private benefit or cost (see Figure 15). For example, when water use by farmers

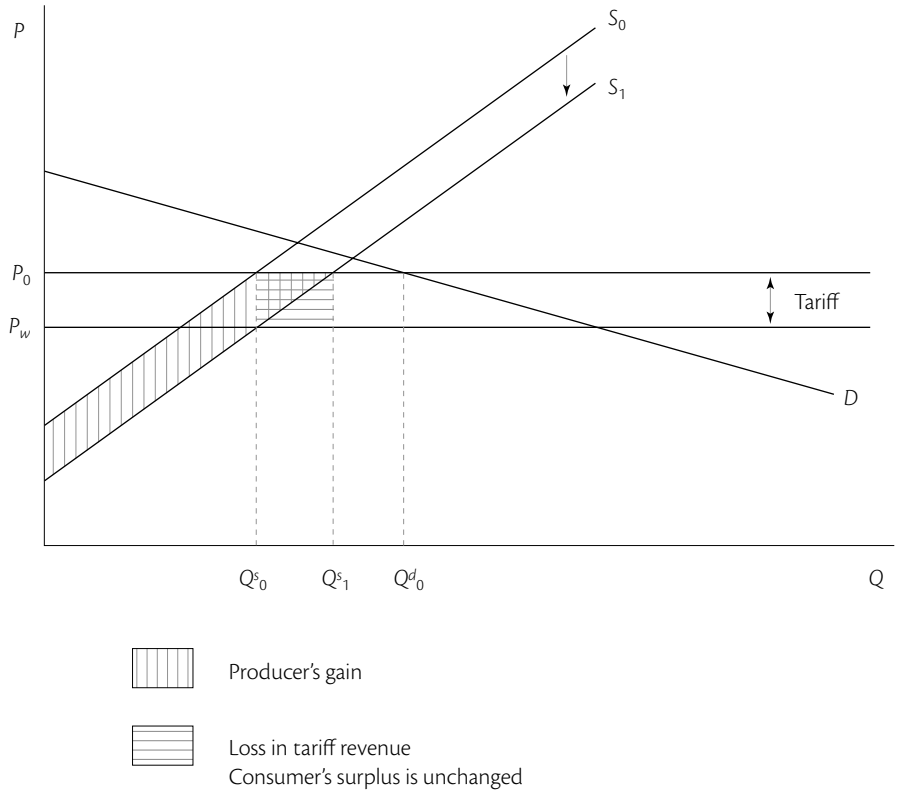

Figure 14. Example of a productivity improvement in a market with a tariff

in increasing production increases turbidity in streams and affects fish stocks, the marginal social cost (which includes loss of production from fish) is higher than the marginal private cost of the farmer's production. Treating such externalities in terms of social and private supply costs is a sensible approach, although measuring the social supply curve can be challenging.

Figure 15 illustrates how a change in the environmental costs could be modelled. Figure 15(a) shows an improvement that comes at no cost to the producer; Figure 15(b) shows the gain where the producer costs rise to reduce the environmental impact. The distributional impacts on producers, consumers and the community (the last in terms of measured difference in marginal social and private benefits and costs) can be estimated if the relative price elasticities are known. These capture the status quo in terms of the capacity to reallocate resources across industries and for consumers to reallocate consumption across goods and services. Complexities in estimating distributional impacts arise when R&D leads to a significant change in the

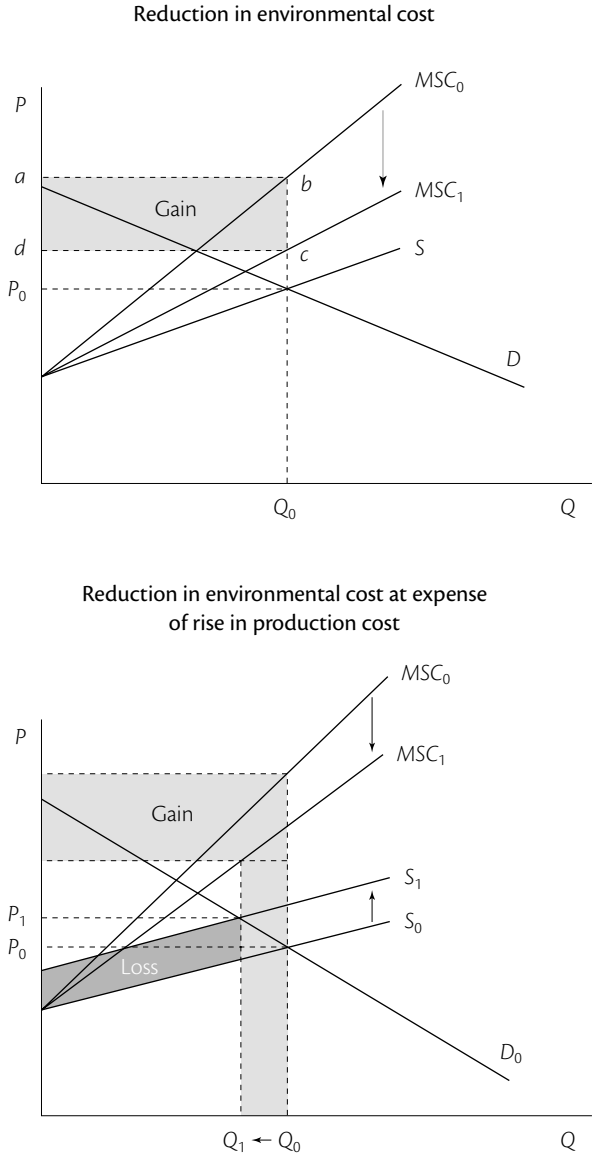

Figure 15. Mapping changes: production externalities

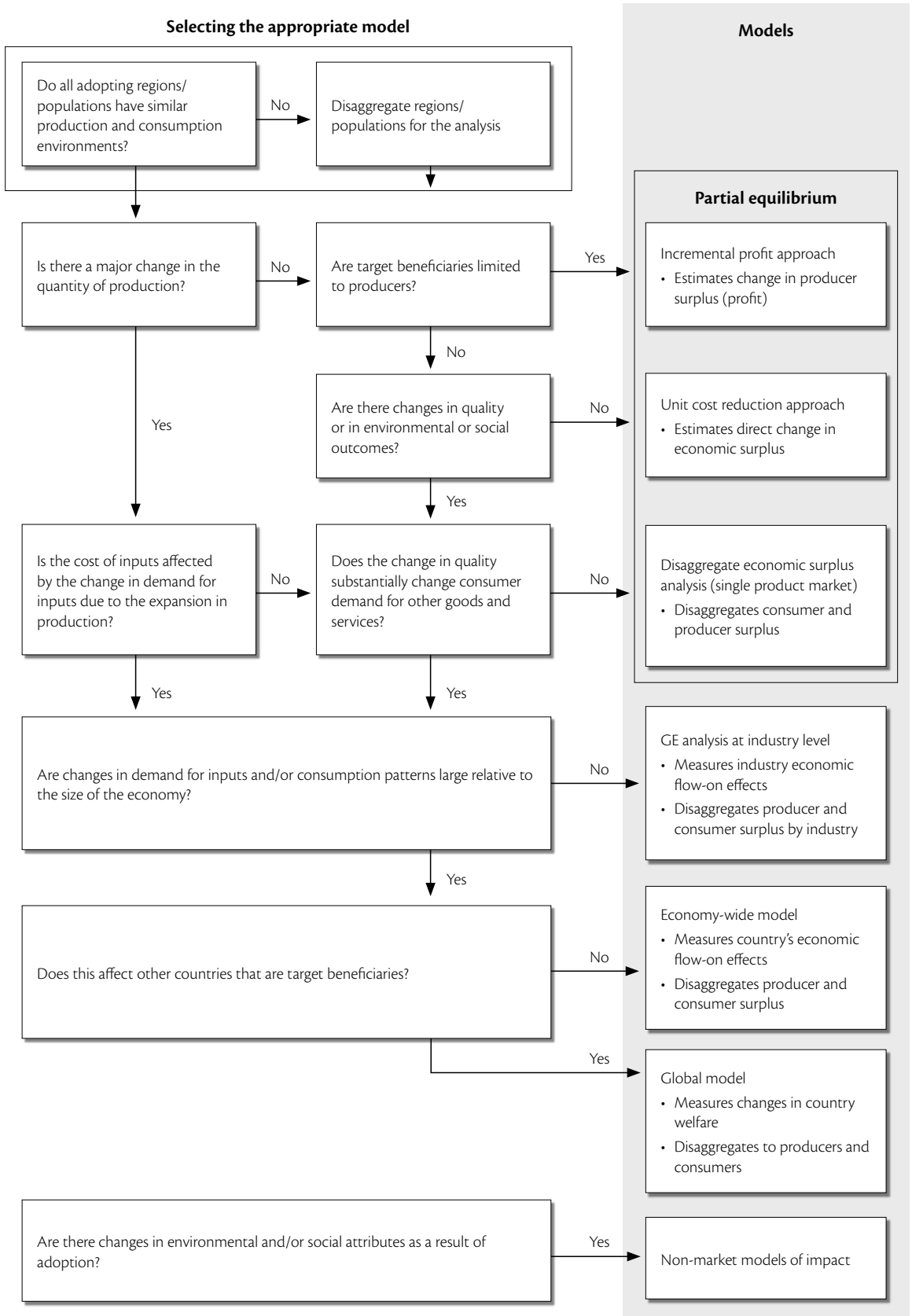

Figure 16. Impact measurement decision tree

availability of resources and in the demand patterns. Poverty analysis may complement the BCA, as it has a different focus and takes a multidimensional view.[13]

4.4.5 The degree of sophistication of the modelling should match the expected size of flow-on effects

Figure 16 provides a decision tree on the type of modelling that will be required to measure impact. It should be noted that most project assessments use only the first three models, adding the last, non-market model in selected cases. The general equilibrium approaches at industry, economy and global levels are data intensive and often are not sufficiently disaggregated for project impact assessment purposes. An exception to this general rule is when the R&D has been on policy that directly affects a number of commodities.

The level of complexity chosen should reflect the:

- need to measure the distributional impacts of the R&D, as more complex models are generally required to capture these effects
- importance of the flow-on effects—if these are small then effort in complex modelling to capture these effects may be misplaced
- level of accuracy of the data on impacts—if this is relatively uncertain, the error level will rise with the complexity of the modelling, and a simpler approach may provide a less uncertain result
- knowledge of the market parameters—if little is known about how the market will react (i.e. elasticities of demand and supply are highly uncertain), complex models will be more difficult to develop. However, they may be useful to test benefit-estimate robustness to different values of these parameters.

As a guide:

- Changes in gross margin estimates are not recommended as an approach. They are valid only where the producer is a price taker, and there is no change in land, capital and owner-labour inputs (all excluded from the gross margin analysis) associated with adoption relative to the alternative production option. The analysis also tends to be highly sensitive to price.
- For a supply shift, undertaking a thorough cost analysis to give the unit cost reduction for each applicable population of final users is the first and crucial step in a partial equilibrium approach. If the producer is a price taker then this unit cost reduction can be used directly to estimate change in producer surplus (there is no change in consumer surplus).
- Partial equilibrium analysis is the most common approach. It is particularly appropriate if there is low substitutability of the product for other products, and a competitive market for inputs (so market price reflects opportunity cost), or where changes are relatively small and effects in other markets are clearly second order.
- A general equilibrium model of the sector is required if there is considerable substitution in consumption and/or production between the product and other products in the sector. A set of partial equilibrium models can also be used to estimate changes in welfare, as long as care is taken to ensure that the sum of the partial equilibrium models is consistent with the full market.
- A general equilibrium model of the economy may be required when the changes are large and result in a substantial reallocation of resources (for example, capital and labour, water and land) in the economy. In general such models are not available for the economies and regions where ACIAR makes most of its investments. Also, the level of aggregation in these models usually makes them unsuitable for analysis of impacts at a commodity and subcommodity level.

Use of regional multipliers should be avoided.

If regional flow-on impacts are thought to be significant they should be estimated using a general equilibrium model of the economy, disaggregated at the regional level. This will reflect the reallocation of resources and consumption between regions. One region's gain is another region's loss if resources move from one to the other. Regional multipliers ignore this offset and so tend to overstate the total impact of an R&D project. They

[13] See Pearce (2002) for a discussion of poverty analysis approaches for ACIAR.

may be valid if the interest is in estimating benefits for only a target region. Care should be taken to ensure that the loss to other regions is also reported if the measure is to be used as a total impact measure.

Care is needed to avoid double counting.

Double counting can be a problem when a partial economic analysis is used and when environmental and social impacts are added. Some examples follow.

- In partial equilibrium analysis, the economic impact of the fall in consumption of other goods and services as consumption of the good in question expands is often overlooked.
- Social impacts such as increased employment can have a value independent of the increase in value-added from improved resource utilisation. However, the number of additional jobs is often taken as a measure of social value. When this is turned into a monetary value at the going wage rate, it is double counting as this value-added should already be included as part of the welfare benefits.
- An environmental impact such as higher environmental flows can sometimes be 'valued' using the market price of water, or the production forgone had the water been used for that purpose. While this price might understate the value of the environmental impacts of improved waterway health from the additional flows, adding this value as well will overstate the benefits.

A clear articulation of the benefits, and transparency in the methods used for estimation, are the best way to avoid double counting.

4.4.6 Estimating shadow prices for non-market impacts

The economic models will provide welfare estimates of changes in consumer and producer surplus. For non-market impacts the welfare changes depend on the use and non-use values associated with the impacts. These values are usually estimated as shadow prices—the price that would be paid to achieve a given level of use or existence. Shadow prices can be estimated in a number of ways. The main approaches are:

- expenditures made to access the good or service—the best known is the travel cost method
- expenditures required to redress or offset the impact—for example, expenditures on air filters to offset the impacts of poor air quality
- revealed preference, where shadow prices are revealed by market choices, or actual behaviour
  - hedonic techniques where there is a natural experiment involving market goods or services that differ only in the level of non-market good or service of interest: for example, the prices of houses with and without a view allow the value of the view to be determined
  - compensation payments accepted
- stated preference, where shadow prices are estimated from surveys
  - contingent valuation asks individuals about WTP or willingness to accept compensation for specific non-market outcomes
  - choice modelling (also known as conjoint analysis) by examining the choices individuals make across sets of attributes, estimates the trade-offs individuals make between different market and non-market attributes. Shadow prices are estimated from the individual's WTP for specific quantities. The community WTP, is the sum of the individuals' WTP.

All the methods have their weaknesses.[14] Benefit transfer refers to the use of shadow price estimates made by one of these methods as a measure of value for a non-market impact. Given that most of the shadow price estimates are time and circumstance dependent, benefit transfer is useful mainly to provide ballpark estimates of benefits derived from these non-market impacts.

4.4.7 Validation of impact estimates

Estimates and models should be validated as much as possible. At the impact stage consider:

- top-down estimates—do the implied prices and volumes fit within the observed reality? If not, check the counterfactual

[14] There is a considerable literature on all of these techniques. See Chapter 5 for references.

- comparative assessment—have similar impacts been found before for that commodity, country or type of R&D? If well above or below the findings of previous impact assessments, why might this be the case?
- peer review—what are the industry's and the researchers' views in the country? Do they think the benefits look reasonable?

4.5 Estimating net benefits and summary statistics

4.5.1 Outputs of the impact assessment analysis

The steps in an impact assessment should provide a time series of estimates (in real dollars in the year the impact assessment was undertaken) of:

- investment in RD&E (from step 1)
- implementation costs (from step 4)
- benefits to producers, net of operational costs
- benefits to consumers
- benefits accruing to the community from changes in environmental impacts (as valued by the identified communities)
- benefits accruing to the community from changes in social impacts (as valued by the identified communities).

In addition, the analysis should provide a measure of, or information on:

- the share of the total RD&E expenditure made by ACIAR projects
- the ACIAR share of funding in the ACIAR projects
- the share of benefits accruing to any different groups of consumers (such as rural consumers, urban consumers, consumers in different countries)
- the distribution of benefits across producers along the value chain, and across different groups of producers.

4.5.2 Sensitivity analysis

Uncertainty should be reported in terms of:

- fully specifying and testing the assumptions made in developing the adoption estimates
- the extent of reliance on evidence from 'average' users, and how representative these users are of the relevant population
- the likely ranges in values of parameters, including survey standard errors where available
- probability distributions for the adoption rate at specific points in time (this would be ideal, but is rarely possible).

Highly complex approaches to assessment can give the impression of accuracy where it is unwarranted. There is usually uncertainty over some if not all of the parameters used in measuring results. This uncertainty can arise from the inherent difficulty in measuring some parameters, as well as from uncertainty over the strength of the linkages. The level of uncertainty in the estimates of results should be reported. Options include the following:

- Range-of-value reporting for key parameters and for results. This can provide a likely range of best and worst case estimates of the net benefits. It is rarely appropriate to combine 'best case' or 'worst case' values to generate an overall best and worst case, as the probability that such extremes will occur together is usually close to zero. The range-of-value approach is useful to test the sensitivity to the results to specific assumptions (and measurement errors).
- Monte Carlo analysis. This generates a probability distribution for the summary statistics, based on the potential range of the values of the key parameters. It requires estimation of the probability distribution for key parameters in the analysis. It has the advantage over range-of-value reporting in that it can take into account the likely combinations of the key parameters. Using a estimating package such as @RISK, this is only slightly more resource intensive than range-of-value reporting.

Box 4. Credible measure analysis

A meta analysis of ACIAR's assessments was undertaken by Raitzer and Lindner (2005). They assessed the confidence that could be placed in the results of the ACIAR assessments that had been undertaken. *Transparency* and *analytical rigour* are viewed as indicators of credible studies.

Transparency:

- clearly derived key assumptions
  - explicitness of key assumptions
  - substantiation of key assumptions
- comprehensive attribution of data sources
  - citation of adoption data
  - citation of productivity data
  - citation of price data
  - citation of adoption-related cost data
- full explanation of data treatment
  - explanation of adoption data treatment
  - explanation of productivity data treatment
  - explanation of treatment of adoption-related cost data
  - explanation of counterfactual derivation
  - explanation of economic valuation
  - explanation of institutional attribution.

Analytical rigour:

- representative dataset utilised
  - reliability of dataset utilised
  - comprehensiveness of dataset utilised
- appropriate data treatment
  - appropriateness of data extrapolation
  - adequacy of analysis of mitigating factors
  - adequacy of disaggregation by production environment
  - adequacy of assessment of adoption-related costs
- plausible counterfactual scenario developed
  - plausibility of assumptions about substitutable innovations
  - plausibility of changes due to exogenous causes
- adequate consideration of mission-relevance of benefits
  - adequacy of analysis of mission-relevance of economic benefits
- plausible institutional attribution
  - plausibility of attribution.

Source: Raitzer and Linder (2005)

- Criterion based approaches such as credible measure analysis (see Box 4). This is a broad-based assessment approach that scans the reliability of the information as well as the process of analysis. It is a subjective assessment that is more focused on errors in analysis than on inherent uncertainties in impact.

4.6 Attribution

Attribution of credit for impacts and benefits is often a source of controversy in assessments of development assistance.[15] While organisations may like to claim full credit, it usually takes many players to achieve real on-ground change. As discussed above, implementation investments are often too diverse to ever formally cost, and many of them are sunk costs, or investments that would have been made regardless of the project. In BCAs such investments are often taken for granted but they should be costed if they are explicitly related to the implementation of the project outputs, or to translating intermediate outcomes into changes in policy, practice or products. All these additional investments are considered to be implementation costs.

4.6.1 Attribution based on responsibility versus attribution based on funding

One way to think about attribution to a project or a funder is to relate it to the extent of control or responsibility that the project or funder has over achieving the results. If a project has full control over outputs, outcomes and impacts, then the impacts can be fully attributed to it. However, projects often do not include a comprehensive approach to adoption, and can rarely ensure that the environment that influences the impact is optimal. Thus, there is an element of fortuity when adoption goes forward and the environment is supportive. The better planned a project is in ensuring adoption and a supporting environment for optimal impact, the more valid it is to attribute the impacts to the funder that designed it. Good planning also involves recognition of the often numerous contributions to achieving the outcomes. Quantifying these contributions can, however, be very difficult. Conceptually at least, recognition of these contributions suggests that attribution should be based on cost shares. This looks at the total investment, including the R&D and implementation costs, and effort to influence the environment, to achieve the impacts. Attribution of benefits to funders is then based on their share of that investment.

An alternative way to think about attribution is to consider the overall role of the specific investment in generating the impacts. While project outputs alone may be necessary for an output they are often not sufficient. At a minimum, the R&D findings have to be communicated to those who can act on the information. Additional effort may be required to adapt the finding to the user's circumstances. Greater effort still might be needed to convince the user to make a change that might increase expected returns but might also increase perceived risk. Attribution of the resulting impacts should be shared between all such other investments required.

4.6.2 Rules for attribution

Three broad cases emerge based on whether:

- the R&D outputs are sufficient in themselves to deliver the impact
- the R&D outputs are necessary but by themselves not sufficient to deliver the impact
- the impact would otherwise have been achieved over time to possibly a lesser extent without the R&D investment being made (for example, due to learning by doing).

Four options for attribution and the scenarios under which they are applicable are discussed below. The first two apply where the ACIAR investment is necessary but not sufficient—so the impact is not separable from other R&D investments. In these cases the assessment must estimate the impact of the total RD&E investment. The second two cases are where the ACIAR projects have an identifiable separate impact—often a marginal improvement—from any other R&D investments.

- Where the R&D outputs are necessary but not sufficient to have any impact a cost share approach apportions the share of the benefits (net of operational costs) to the ACIAR investment based on the ACIAR share of total expenditure required to deliver the impacts (including implementation costs but excluding operating costs).

[15] See also Alston and Pardey (2001)

- Where the project outputs have clearly been crucial to achieving outcomes, but there are also other, less crucial contributing factors, a relative importance approach apportions the share of benefits on the basis of a subjective assessment (triangulated) of the contribution (percentage) of the project to the share of outcomes achieved.
- Where the ACIAR investment allowed R&D to occur earlier than it otherwise would have, or stimulated earlier adoption, a bring forward approach is used. Changes would have come about through normal processes (farmer experimentation, learning by doing or diffuse technology transfer), but the investment brought forward the changes and hence the impact. The focus of measurement is on the time to impact without the project activities compared to the time with.
- Where the ACIAR investment resulted in better outputs or higher adoption rates the marginal gain approach is used. This aims to distinguish the contribution of the ACIAR projects that alone was sufficient to improve the outputs or adoption, and hence the impact. The focus of measurement is on the effect that the better quality or higher adoption rate has on the size of the impact.

Where the project outputs are sufficient by themselves to lead to the outcomes full attribution of benefits to the project can be made. Where the activity filled a gap that was a critical impediment to achieving the outcome, and without which the gap would not have been filled, there may be circumstances where the other investments can be regarded as sunk costs. In general, a cost share should be used in such circumstances, as the gap-filling activity alone is not sufficient.

4.6.3 Reporting attribution for projects and ACIAR funding

An impact assessment often covers a set of projects. The way to assess the contribution of the ACIAR projects where there is other investment in RD&E was considered earlier. However, for the input into ADIA, R&D investments from the different ACIAR projects, other R&D investments and implementation costs need to be reported separately.

In terms of attributing benefits to any particular ACIAR project the general rule of thumb is to use the cost share. So, if there are two ACIAR projects, one worth $300,000 and one $700,000, both necessary and only together sufficient to deliver the outputs, 30% of the benefits are attributed to the first project and 70% to the second. If ACIAR funding made up 50% of the first project and only 20% of the second project, then the return on ACIAR funds is 29% (its share of total funding provided). The use of these cost shares is important for portfolio analysis, which is discussed in Chapter 6. For an impact assessment, the important metrics are the time series of the individual ACIAR project costs and the proportions of the total cost attributable to ACIAR.

5 Special cases in impact assessment

5.1 Capacity-building projects

5.1.1 Separating capacity-building impacts

Capacity building is often embedded in larger R&D projects, and contributes to the generation of the project outputs. Capacity such as new knowledge, skills, management capabilities and even infrastructure has to be engaged to bring changes in policy, practice or products. Capacity building may be an aspect of an ACIAR investment that eventually yields significant impacts even if the technology developed by the original project failed to do so. An example of this is work on sorghum in India that sought to develop new, more productive varieties of the crop. While this output was not achieved, the knowledge transferred and biotechnology skills developed underpinned the later development by local researchers of a new hybrid variety, yielding a positive return on the ACIAR investment (see Longmore et al. 2007).

Human capacity building generates outcomes at the:

- individual level, in terms of improvements in confidence, competence, promotion and higher income
- organisational level, by improving:
  - efficiency of the organisation, leading to more or better services, improved communication or services at a lower cost;
  - innovation within the organisation, leading to new and better R&D
  - effectiveness of the organisation, leading to greater influence in shaping policy, and its effective implementation.

ACIAR projects can also build research infrastructure, which can facilitate future R&D. In making an assessment, infrastructure investments are treated in the same way as training and other human capacity building.

In general, the impact of the capacity built on the community arises through the improvements at the organisational level that flow from use of the enhanced capacity. This might be through better R&D outputs, improved communication to final users or improvements in the policy environment. The impact of the capacity built arises from the outputs generated when this capacity is utilised. This leads to two matters that require extra effort in assessing the impact of capacity-building investments:

- there are extra steps in terms of mapping from the capacity-building activity to capacity built, through capacity utilised to the outputs that lead to changes in policy, practice and products (that is, outcomes)
- attribution tends to be more difficult as, to achieving the eventual outputs, there are usually inputs additional to the enhanced knowledge and skills.

The impact of the capacity built arises from the outputs generated when the capacity is utilised.

5.1.2 Assessing the linkages between capacity built and utilised, and impacts

Figure 17 sets out an analytical pathway for impact assessment of capacity-building activities. As discussed, capacity built may influence outcomes through one or several of these pathways. A questionnaire-based survey procedure (see Appendix 3) has been developed to help trace these links. It asks the individuals involved

in the capacity-building activities (i.e. the training they received, whether formal or conducted informally such as through work exchanges) and their supervisors about:

- relevance of the training to the research they were undertaking
- quality of the training/education provided
- effectiveness of the training in building their skills, knowledge and managerial capabilities (capacity built)
- use made of the enhanced capacity in undertaking and managing their research (capacity utilised)

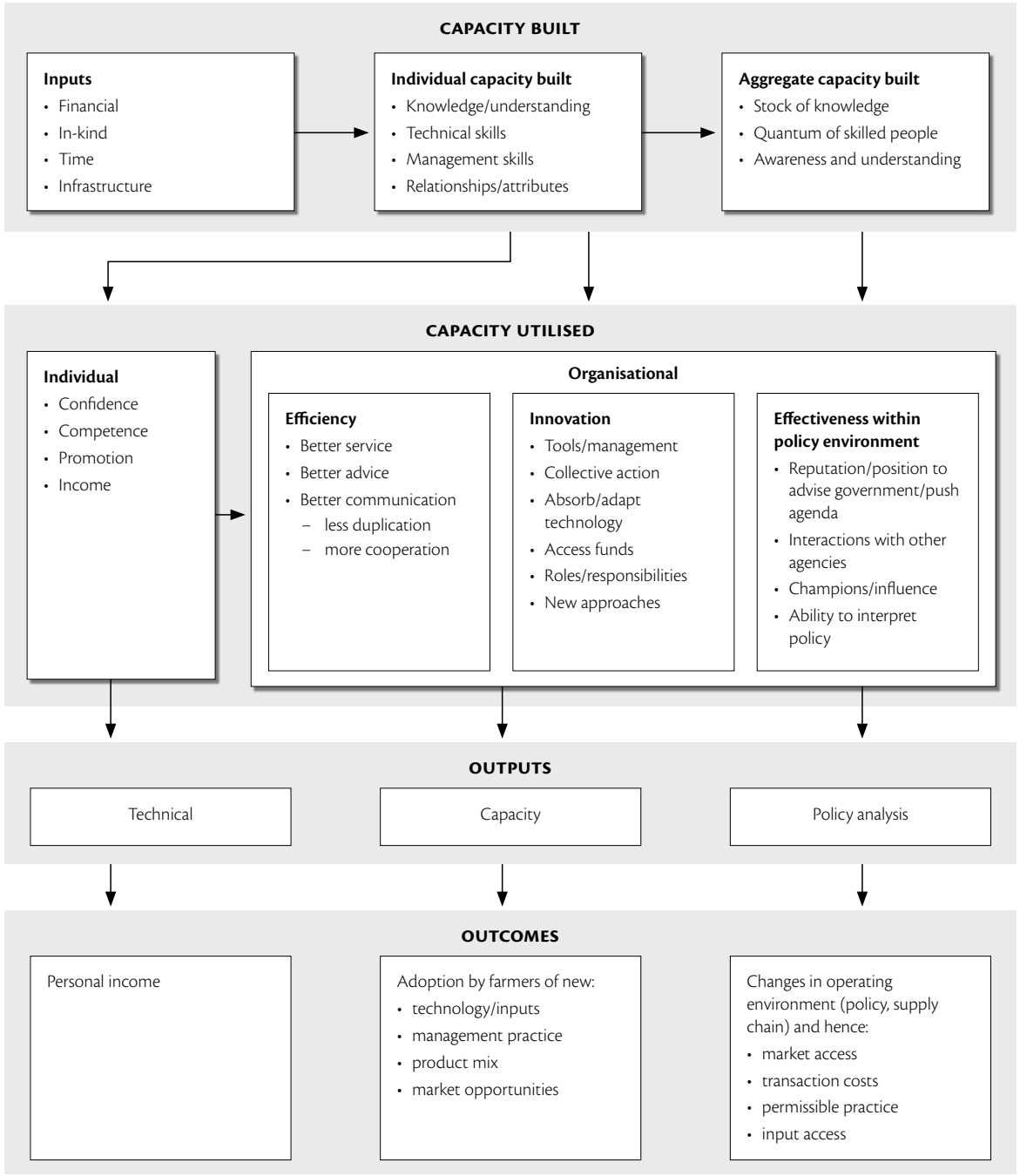

Figure 17. Analytical framework: capacity building impact assessment

- outcomes from this application for themselves in terms of their promotion and income
- outcomes from this application for the organisation in terms of improved efficiency and effectiveness
- outcomes from this application in terms of new R&D outputs that are adopted by final users.

Events in the last of these categories allow application of the usual impact assessment approach. If there are no outputs in this category then the capacity-building investment has yet to have an impact that can be attributed to it beyond the organisational and individual level. If this is the case the impact assessment should estimate only the benefits to the individuals and organisations.

Benefits accruing to individuals are usually very small relative to the community impacts if the capacity built has been utilised successfully.

The most direct impact is on the individuals whose productivity rises as a result of the training they received. This comes in terms of promotions and higher incomes, as well as intrinsic benefits that accrue to the individuals. As a general rule of thumb, workers tend to keep around half of the productivity improvement from training, the other half being captured by the firm (see Gordon and Chadwick 2007). Applying this rule suggests that capacity-building benefits are, at a minimum, twice the higher return to workers resulting from the training.

Organisational benefits can be large relative to the investment in training, but are generally small compared with innovations resulting from the individual and organisational capacity utilised.

Organisational benefits can be measured in terms of their share of the productivity improvement (with care not to double count if applying the worker rule of thumb) resulting from the training. The main organisational benefits identified to date are:

- improved efficiency in, for example, undertaking experiments—this results in a cost saving that is a lower-bound estimate of the benefit from this source
- ability to attract additional resources to continue the R&D—this results in a higher probability of outputs that will have impacts. It can also bring forward the R&D and hence the eventual impacts. The impact assessment will need to assess the impacts compared with the 'without this additional funding' as well as without the ACIAR investment. This additional funding must be taken into account in the total R&D investment and attribution based on cost share, as the capacity built was a necessary but not sufficient condition for the outputs to be achieved
- enhanced culture of innovation, and redirection of R&D and approach to activities that have greater probability of success.

The linkages can often only be assessed subjectively, so triangulation of the assessment is needed for analytical rigour. The survey procedure in Appendix 3 has a number of standard questions; questions can be added to help to assess outputs and outcomes that might have resulted. If the numbers of individuals trained is relatively large, a correlation analysis can be done to assess the strength of the links between the capacity built and capacity utilised, and capacity utilised and R&D outcomes identified. Care must be taken in using average responses as it may be the case that it is the training of a subset of researchers that has delivered major outcomes, but ex-ante it is not possible to identify which subset of individuals this might be. The reviewer needs to make judgments based on the feedback, but should validate these by seeking as many alternative viewpoints as possible.

5.1.3 Attribution to the capacity-building investments

In most situations the capacity built is necessary but not sufficient for the outputs that lead to outcomes; other investments are needed. Attribution in these cases is based on cost shares. In some cases, capacity built leads to outputs being achieved sooner, and in some cases to higher quality outputs. Where outputs are achieved sooner (or adopted sooner) the benefit is the value of bringing the impacts forward in time. Where higher quality outputs are achieved, the capacity building can be attributed with the marginal gain in impact over that which would otherwise have occurred.

In assessing the impact of capacity-building activities it is important to check if:

- learning by doing would have achieved the same capacity, but taking longer to do so, in which case the benefit is the bringing forward of the benefits.
- the addition to the stock of knowledge is sufficient to trigger progress in R&D, or if further investment in knowledge is required, in which case outcomes are still being generated. If there is progress in R&D, consideration needs to be given to whether this brought outputs forward or, indeed, whether they would have arisen without the R&D. The attribution issue depends on the choice of how to treat previous investments in the stock of knowledge and what can be considered to be a 'sunk' cost
- the activity filled a recognised gap that was hindering progress. In this case, a cost-share approach to attribution is conservative
- the activity was integrated into a broader R&D or development project.
- the activity stimulated a change in culture to a more innovative and active organisation. Where successful outcomes have been achieved, the attribution should be based on the improvement in the probability of success generated by the induced culture change
- there are diffuse effects of improvements in the overall human capital and hence the capacity for undertaking R&D in a country. This is difficult to assess in a benefit–cost analysis as average impacts of raising a country's human capital can be measured only at a macro level. At the ACIAR level of investment it is not appropriate to utilise such broader measures.

5.2 Policy analysis projects

ACIAR invests in policy research as well as technical R&D. The motivation for this is the importance of the regulatory and operating environment in adoption of technical R&D outputs and the complementarity of policy and technical outputs.[16] In general, policy relates to government policy or to that of a regulatory authority. Policy can also be applied at the community level or within an industry or firm where there is agreement to follow a set of rules governing behaviour. The approach to analysis is the same, and even with government compulsion, assessment of compliance is required.

Policy-analysis projects are similar to capacity-building projects in that there are additional steps required in assessing impact. There are usually also many different influences on policy choice, of which research is but one. Assessment usually has to rely on a subjective judgment of how influential the informing of policy decision-makers was in changing or speeding up the adoption of policy. Yet, if highly successful in embedding new thinking into an organisation, this change may not be appreciated by respondents. An additional problem for assessments is circularity, as the best tools for measuring the impact of a policy change are usually those used to argue for the change.[17]

The additional steps in an impact assessment are mapping from:

- a policy tool or information output, to communication to policymakers or influencers—this can be assessed in terms of whether they think the information affected their policy considerations
- these considerations to policy change, which can be assessed to the extent it is enshrined in law, regulations, or guidelines
- the laws and changes in regulation, to implementation and compliance, where the indicators of implementation may be observable, such as a change in tariff rates or issue of import licences, or indirect, such as a removal of local content requirements in fertiliser production, or restrictions in market access
- these changes to a response by producers or consumers, such as switching production, import of new varieties, purchase of lower cost fertilisers, or sales to higher value markets. The response will depend on the extent to which the impediment the policy addressed was a constraining factor. For example, removing an import licence requirement will have no short-term response (beyond possibly lower business costs) if the licence quota well exceeded the country's import demand.

[16] See Pearce (2005)

[17] See Pardey and Smith (2004) for a collection of papers on assessment of policy analysis.

Changes in the policy environment that improve competition, enhance property rights (including the capacity to keep the proceeds of effort) or reduce risk to farmers of production changes, stimulate investment and innovation. Like improved human capital, this indirect pathway can be difficult to trace in an impact analysis except at an aggregate macro-economic level. Figure 18 sets out some of the more direct pathways to impacts from policy R&D.

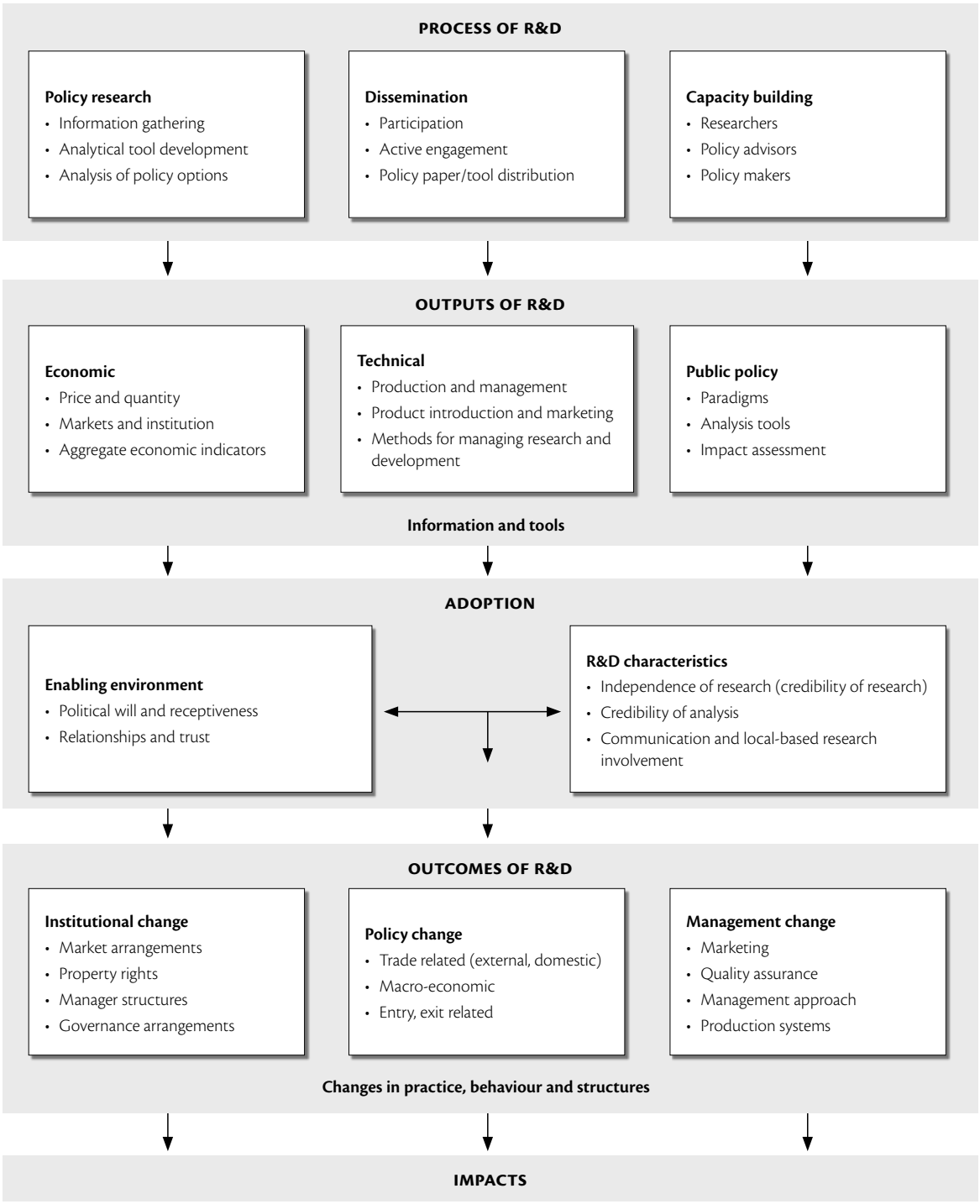

Figure 18. Pathways to impacts from policy research and development (R&D)

5.3 Environmental and social impact analysis

The approach to environmental and social impact analysis outlined in this guide integrates the impact on natural and social capital into an economic framework.[18] It does this by estimating shadow prices (or the equivalent total value) to environmental and social use and non-use impacts. Measuring all benefits and costs in terms of a common metric (money) allows explicit comparisons of impacts of the same type. Omitting an impact implicitly values it at zero. The alternative is to report impacts in metrics that do not have any natural basis for comparison. Rather than in terms of their 'value', environmental and social impacts are measured as the change in attributes of the natural or social environment arising from the changes in practice, products or policy.

Multi-criteria analysis is used to make assessments of environmental and social impacts without recourse to estimating shadow prices for the impacts. When taken separately, this approach provides useful information, and allows the actual change to be compared with a desired change. A problem arises when an index is developed based on some weighting of the different criteria. This implicitly assigns relative values to the different outcomes. If this can be done using 'community weightings' based on the individuals in a communities' aggregate WTP, the result should be the same as that provided by the economic framework. If weightings are based on 'expert opinion' then this reflects only the experts' value judgments (their implicit shadow prices for the different impacts). The approach proposed in this guide is to use WTP values on environmental and social attributes wherever available. If there is no 'community' WTP for an attribute, the change in the attribute can be reported in the analysis, but should not be included in the triple bottom line.[19]

[18] This method is preferred by most policy analysts; see OECD (2006).

[19] The lack of a 'community' value for an impact can arise when the community is split over the value of the outcome (for example, the members of the population have diverse views over whether they see the impact as a benefit or a cost), or when, on average, they do not really care. A problem arises as these preferences are not static and the community view can change when members are given more information about an issue.

5.3.1 Issues in estimating shadow prices

Reducing the triple bottom line to a single bottom line requires shadow pricing of the use and non-use values of environmental and social attributes. WTP, willingness to accept compensation (WTA) and heuristic measures can be used to place monetary values on social and environmental impacts. These measures reflect 'social norms' which, like market values, can change over time as attitudes (and relative scarcity) change. WTP and WTA estimates come from 'stated preference' techniques such as contingent valuation and choice modelling. These survey people, asking them how much they would be prepared to pay or trade-off for a set of environmental or social outcomes or attributes. Statistical analysis of these data reveals if there is sufficient consensus among survey respondents to derive an estimate of WTP. If so, the WTP data (usually household level), can be used to derive shadow prices for changes in environmental and social attributes which, in turn, can be used to estimate the marginal social cost and benefit functions for changes in demand and supply of products, or to construct markets for these social and environmental outcomes.

The main problems with WTP/WTA approaches are:

- the high cost, as they involve surveying stakeholders
- inconsistency in the values derived from WTP and WTA, and from contingent valuation and choice modelling, although this problem is increasingly being overcome with refinements in the survey methodology
- instability of the estimates over time, as values tend to be a function of household wealth and perceptions of scarcity.

Shadow prices can also be estimated from market data that reflect the outcomes of interest. Heuristic methods include travel cost (expenditure on travel reflecting the minimum value of a recreational experience), and comparative analysis (for example, the differential in wages for jobs that are similar except for a level of health risk, or prices of otherwise identical homes where one has a view and one does not). As such easy comparisons rarely arise, regression analysis can be used to estimate values from a large dataset where a number of characteristics vary. This too tends to be an expensive exercise.

5.3.2 Using benefit-transfer to estimate shadow prices

There are various compilations of values that have been estimated for environmental and health attributes.[20] Benefit transfer is a technique for using these values as a basis for estimating the shadow price of a social or environmental outcome of interest where it can be described in terms of its attributes. The key feature is how comparable the circumstances are. Thus, the country, region, relative scarcity in that context, and nature of the change are all relevant.

There is a debate about the validity of using benefit transfer to put values on social and environmental impacts, as these values tend to be situation specific. While care should be taken, it is considered better to include such indicative values than to ignore them. Leaving them out altogether may lead to the impression that they are unimportant. The valuation of these non-market benefits gives a general understanding of the trade-offs being faced when there is tension between triple bottom line impacts.

20 See <www.envirovaluation.org/index.php?cat-190> for a list of the various databases of values for benefit transfer.

6 ACIAR portfolio analysis

Desktop reviews, adoption studies and impact assessment studies provide increasingly detailed and rigorous information on the impact of ACIAR investments. This information can be used to demonstrate the overall return to ACIAR investment and how returns differ across programs, commodities, countries and the types of outputs the R&D aims to achieve. The ACIAR Database for Impact Assessments (ADIA) has been developed to provide a central repository for the impact assessment information and to facilitate meta analysis that will provide insight into the impacts of ACIAR investments.

6.1 Data collated in the ADIA

The ADIA data are input via the PIAS. The PIAS form (see Appendix 1) can be completed electronically and batch read into the ADIA, or entered directly using the ADIA interface. The PIAS records the following information (the numbers reflect those in the form):

1. Project number (1a) and related ACIAR projects and their relationship (1b)
2. Project name
3. Collaborating organisations—five can be listed separately; if more they should be entered in the fifth field
4. Project leaders—name and organisation
5. Duration of the project—the start and finish date
6. Project funding—ACIAR funding and total project funding for project 1a. Note that this may be different from the cost data in the spreadsheet as the cost data are in real terms and also include costs from the set of projects evaluated in the impact assessment
7. Countries involved in the research (excluding Australia) and an estimate of expenditure across them. List up to four individual countries; if more, use the region
8. Commodities involved—five selections allowed, use the finest detail possible from the list of commodities (List A in Appendix 1)
9. Related (non-ACIAR) projects—five can be listed separately; if more, they should be entered in the fifth field
10. Assessment information, type of assessment, assessment identifier, date, reviewer name and contact details
11. Description of the motivation for the project
12. Description of outputs, including capacity built
13. Description of differences the project has made to date (as at the time of the review)
14. Description of each output, identifying the next and final users, how the output will be used and what changes will result for final users (outcomes)
15. List of factors affecting the adoption of the outputs
16. For each of the outputs, classification of the nature of the output (16a), where in the value chain the main final user is (16b), level of adoption to date (16c), time to adoption from completion of the project (16d) (see Appendix 1, lists D–F for the classifications)

17. Description of the impacts of adoption and the results achieved by final users, including, where relevant, flow-on effects and spillovers
18. Classification of any environmental and social outcomes (see Appendix 1, lists H and I for the classifications)
19. Factors affecting benefits being achieved other than those affecting adoption outcomes
20. Classification of the overall impact of the project, and confidence in the classification
21. Lessons
22. For impact assessment only summary statistics—IRR, total net present value (NPV), PV of benefits (total), PV of benefits (Australia), costs, BCR

The PIAS form is set up so that the adoption study summary and the impact assessment summary could be downloaded directly into the relevant question categories. Alternatively, the reviewer may prefer to provide a briefer summary. Reviewers can print out the information in the database in the form that it is presented in the template. The most recent information is maintained in the ADIA; that is, an adoption study will overwrite the desktop review, and an impact assessment will overwrite the adoption study.

6.2 Options for analysis

The ADIA information can be downloaded into a spreadsheet to permit a wide range of interrogations.

6.2.1 Portfolio allocations

The ADIA includes the investment made by ACIAR in all projects. For impact assessments it includes a time series of funding by ACIAR and from other sources. Desktop reviews and adoption studies should include a time series of ACIAR project expenditure, but only impact assessments are likely to provide a time series of other investments that have contributed to the RD&E.

ACIAR project investment can be shown by:

- year of investment (subject to annual project expenditure data being available)
- ACIAR program
- countries and regions
- commodities—individual commodities and commodity groups
- any combination of the above.

6.2.2 Output and adoption information

The ADIA asks for categorisation of the outputs, the level of adoption, and years from project completion to adoption by final users. This allows some analysis of the profiles of different portfolios of ACIAR investment. For any country or commodity the ADIA can provide the:

- share of project expenditure (for projects from a specified date) going to *technology, capacity building or policy*
- share of project expenditure (for projects from a specified date) with *final users at each point in the value chain*
- share of project expenditure (for projects from a specified date) *with time to completion in each time category.*

Note that in each of these summaries the shares can sum to more than 100% as a project can have more than one type of output with different natures, final users and times to adoption. The value of this type of analysis is in comparing the profiles of R&D across programs, countries and commodities of interest. These comparisons should be interpreted with care, so the information is not generated automatically, but can be drawn out for analysis.

The adoption studies provide an assessment of level of adoption to date. By selecting adoption studies this information can be analysed to see if there are patterns in adoption 3 years out across countries, commodities and the type of R&D outputs.

6.2.3 Impact assessment summaries

The desktop and adoption studies provide preliminary estimates of impact based on a qualitative assessment. While they can be used to provide a first pass overall assessment of impact, they are useful mainly for sampling projects for the impact assessment. For impact assessments to be considered representative, projects

need to be selected randomly. In the past this has rarely been the case, in part as some projects were selected where their returns would more than compensate for the whole program investment. Other projects were selected on the basis of clear evidence of outcomes, which makes undertaking the impact assessment easier. The classifications provided in the ADIA allow for a stratified random sample to be drawn, based on overall level of investment in countries and commodities. The preliminary impact assessment (and confidence in this assessment) can be used to avoid investing in an impact assessment that will have no measured benefits to report. However, to keep the integrity of the random sample, such projects must be included when the sample is reported. This can be done by including the costs, and a zero stream of benefits in the meta analysis.

The impact assessment information provides two useful summary statistics that are unaffected by the time at which the project was completed.

- The BCR is invariant to when a project occurred, and to the year at which the discounting was applied. It is, however, sensitive to the discount rate chosen. As long as a common discount rate is chosen, and the annuity principle for ongoing benefits is applied, the BCRs are comparable. As discussed in section 4.3.2 the BCR should include all investments required including implementing investments as costs.
- The IRR is the discount rate at which the stream of discounted costs is equal to the stream of discounted benefits. The length of the time series used to estimate the IRR can affect the value. This is quite different from a market rate of return so needs to be used with care. Although rankings by IRR are not consistent with those of BCR, the IRR remains useful for providing an overview of the impact. Its major advantage over BCR is that it is independent of how costs are categorised—something to which the BCR is very sensitive.

An advantage of these summary statistics is that, as long as attribution based on cost share is appropriate, the same IRR and BCR applies to each project in a set that is assessed together. They also apply to ACIAR's funding as well as to the whole project. The ADIA can provide a chart of BCRs and/or IRRs for all projects that have had an impact assessment.

The impact assessments provide benefit and cost flows that can be used to estimate the return to ACIAR investment in several ways.

- The return on ACIAR investment from the impact assessment sample can be estimated annually by adding up the benefits across years. To do this, benefits need to be converted to the current year (they are usually in the year the impact assessment was undertaken). Subsets based on countries and commodity groups can be provided.
- A cumulative return profile can be generated for any subset of projects once returns are converted into a common currency year and discounted to the current year. This can be constructed by ranking projects by the BCR then plotting the cumulative benefits against the cumulative costs. A profile of the BCR for the sample is thus provided, highlighting whether the benefits arise from a few large projects or many small ones, and whether there is a long tail end of low-return projects. Discounting to the current year introduces a bias giving older projects both higher benefits and higher costs, but this should not overly distort the true pattern.
- Once benefit and cost flows are converted to a common currency year the costs and benefits can be summed to get an overall BCR for different samples of projects that have had an impact assessment.
- Similarly, the benefits and costs of selected subsets of projects can be combined to estimate an overall IRR for that subset. This can be compared across subsets of interest, such as countries and commodities.

7 References

Alston J.M., Norton G.W and Pardey P.G. 1995. Science under scarcity: principles and practice for agricultural research evaluation and priority setting. Cornell University Press: Ithaca.

Alston J.M. and Pardey P.G. 2001. Attribution and other problems in assessing the returns to agricultural R and D. Agricultural Economics 25, 141–152.

Brennan J.P., Godyn D.L. and Johnston B.G. 1989. An economic framework for evaluating new wheat varieties. Review of Marketing and Agricultural Economics 57(1–3), 75–92.

Curtis A. and Robertson A. 2003, Understanding landholder management of river frontages: the Goulburn Broken. Ecological Management and Restoration 4(1), 45–54.

Davis, J.S., Oram, P. and Ryan, J.G. 1987, Assessment of Agricultural Research Priorities: An International Perspective. Canberra and Washington, DC: Australian Centre for International Agricultural Research and International Food Policy Research Institute.

Dillon J. and Anderson K. 1990. The analysis of response in crop and livestock production. Pergamon Press: Oxford, UK.

Edwards G.W. and Freebairn J.W. 1982. The social benefits from an increase in productivity in part of an industry. Review of Marketing and Agricultural Economics 50(2), 193–210.

— 1984. The gains from research into tradeable commodities. American Journal of Agricultural Economics 66(1), 41–49.

Gordon J. and Chadwick K. 2007. Impact assessment of capacity building and training: assessment framework and two case studies. Impact Assessment Series Report No. 44. ACIAR: Canberra.

Longmore C., Gordon J. and Bantilan M.C. 2007. Assessment of capacity building: overcoming production constraints to sorghum in rainfed environments in India and Australia. Impact Assessment Series Report No. 48. ACIAR: Canberra.

OECD (Organisation for Economic Cooperation and Development) 2006. Cost–benefit analysis and the environment: recent developments. OECD: Paris.

McWaters V. and Templeton, D. (eds) 2004. Adoption of ACIAR project outputs: studies of projects completed in 1999–2000. ACIAR: Canberra.

Pannell D.J., Marshall G.R., Barr N., Curtis A., Vanclay F. and Wilkinson R. 2006. Understanding and promoting adoption of conservation practices by rural landholders. Australian Journal of Experimental Agriculture 46, 1407–1424.

Pardey P.G., Roseboom J. and Craig B.J. 1992. A yardstick for international comparisons: an application to national agricultural research expenditures. Economic Development and Cultural Change 40, 333–349.

Pardey P.G. and Smith A. (eds) 2004. What's economics worth: valuing policy research. Johns Hopkins Press: Baltimore, MA.

Pearce D. 2002. Measuring the poverty impact of ACIAR projects—a broad framework. Impact Assessment Series Report No. 19. ACIAR: Canberra.

Pearce D. 2005. Review of ACIAR's research on agricultural policy. Impact Assessment Series Report No. 31. ACIAR: Canberra.

Pearce D., Monck M., Chadwick K. and Corbishley J. 2006. Benefits to Australia from ACIAR-funded research. Impact Assessment Series Report No. 39. ACIAR. Canberra.

Portney P.R and Weyant J.P. 1999. Discounting and intergenerational equity. Resources for the Future: Washington DC.

Productivity Commission 2007. Public support for science and innovation. Productivity Commission: Canberra.

Raitzer D.A. and Lindner R. 2005. Review of the returns to ACIAR's bilateral R&D investments. ACIAR: Canberra.

Rhodes H.M., Leland L.S. Jr and Niven B.E. 2002. Farmers, streams, information, and money: does informing farmers about riparian management have any effect? Environmental Management 30(5), 665–677.

Voon J.P. 1992. Economic return to quality-enhancing research: the case of dark-cutting beef in Australia. Irish Journal of Agricultural Economics 31(1), 63–69.

Voon J.P. and Edwards G.W. 1992. Research payoff from quality improvements: the case of protein in Australian wheat. American Journal of Agricultural Economics 74(3), 564–572.

Walker T., Maredia M., Kelley T., La Rovere R., Templeton D., Thiele G. and Douthwaite B. 2008. Strategic guidance for ex post impact assessment of agricultural research. Report prepared for the Standing Panel on Impact Assessment, CGIAR Science Council. Science Council Secretariat: Rome, Italy.

8 Appendixes

Appendix 1. Project Impact Assessment Summary (PIAS)

A1.1 The PIAS form

Project information				
1. Project number(s)		1a. Most recent project in study / /		
		1b. Other ACIAR projects in study (if any) / / / / / / / / / /	Relationship to project in 1a. (P—immediately preceding, O—other)	
2. Project name				
3. Collaborating organisations	1			
	2			
	3			
	4			
	5			
4. Project leaders				
5. Duration of project Year last project in IAS being assessed		Start: dd/mm/yy	Finish: dd/mm/yy	Year all projects completed (IAS)
6. Project funding		ACIAR funding:	Total project funding:	Total funding (all R&D in IAS):
		$	$	$

A1.1 (continued)

7. Countries involved Share of expenditure in each country (please estimate if not known—do not include Australia)		Region	Country	Approximate share of R&D effort targeting country
8. Commodities involved		Select the five most important commodities from List A (see below). Please type name exactly as it appears in the list		
	1			
	2			
	3			
	4			
	5			
9. Are there related projects? Please list		Other related projects		
	1			
	2			
	3			
	4			
	5			
Assessment				
10. Assessment information		Assessment type	Assessment Identifier	Date	Reviewer name and contact details
11. Describe the motivation for the project—how did it come about—what problem was it designed to address? (AS section 1)					
12. Outputs: Describe the major outputs of the project (intended and unintended). Include a description of any improvement in research skills and infrastructure. (AS section 2)					
	1				
	2				
	3				
	4				

A1.1 (continued)

	1				
	2				
	3				
	4				
13. Describe the differences the project has made to date? What is the most significant change as a result of the project? (AS section 3.1 and 3.2)					
14. For each output identified in Q.12 describe how they will be used. This should include a description of the next and final users and changes that will result for the final users (outcomes) (AS section 3.3)	1				
	2				
	3				
	4				
15. What factors are affecting the adoption of the outputs (positive and negative)? (AS section 3.4)					
16. For up to four of the most important outputs please complete the following information		16a. Nature of the output	16b. Where in the value chain is the final user of the output?	16c. What is the level of adoption to date?	16d. From the completion of the project how long will it take for final adoption?
17. Describe the impact(s) of the project on the countries and communities involved and how this is expected to evolve over time (AS section 4.1)					

A1.1 (continued)

18. Do these impacts described above include any of the environmental impacts in List G (below) or the social impacts in List H (below)?			
19. What factors (other than adoption) are affecting the success or otherwise of the project in achieving significant community benefits? (AS section 4.2)			
20. Considering the impacts to date and potential impacts and the probability of adoption being achieved as described, how do you assess the overall impact of the project?	*Overall impact*		*Confidence level*
21. Lessons: in your review of the project are there any lessons that will help to improve future ACIAR investments? (AS section 5)			
22. *For full impact assessment only*: Provide the spreadsheet of results: summary sheet will present BCA results using a 5% discount rate:	IRR		
	NPV (total)	A$	
	PV benefits (total)	A$	
	PV benefits (Australia)	A$	
	PV Costs	A$	
	BCR (total)		

A1.2 Commodities

List A. Commodities

Code	Detailed commodity	Aggregated commodity
AN01	Beef	Animal
AN02	Buffalo meat	Animal
AN03	Buffalo milk	Animal
AN04	Cows milk	Animal
AN05	Honey	Animal
AN06	Horse	Animal
AN07	Other animal	Animal
AN08	Pig meat	Animal
AN09	Poultry eggs	Animal
AN10	Poultry meat	Animal
AN11	Sheep and goat meat	Animal
AN12	Turtles	Animal
AN13	Wool	Animal
FC01	Abaca	Fibre crops
FC02	Kenaf	Fibre crops
FC03	Other fibre crops	Fibre crops
FI01	Carps, barbels and other cyprinids	Fish
FI02	Clams, cockles and ark shells	Fish
FI03	Crabs	Fish
FI04	Demersal	Fish
FI05	Herrings, sardines, anchovies	Fish
FI06	Lobsters	Fish
FI07	Mackerels, snoeks, cutlass fishes	Fish
FI08	Miscellaneous diadromous	Fish
FI09	Mussels	Fish
FI10	Other fish	Fish
FI11	Oysters	Fish
FI12	Prawns, shrimps	Fish
FI13	Sharks, rays	Fish
FI14	Shells, pearls	Fish

A1.2 (continued)

Code	Detailed commodity	Aggregated commodity
FI15	Tilapias and other cichlids	Fish
FI16	Tunas, bonitos, billfishes	Fish
FO01	Charcoal	Forestry
FO02	Fuelwood—coniferous	Forestry
FO03	Fuelwood—non-coniferous	Forestry
FO04	Other forestry	Forestry
FO05	Pit-props	Forestry
FO06	Wood—coniferous saw logs and veneer logs	Forestry
FO07	Wood—non–coniferous saw logs and veneer logs	Forestry
FO08	Wood—other industrial round wood	Forestry
FO09	Wood—processed wood	Forestry
FO10	Wood—pulpwood	Forestry
FR01	Apples	Fruit
FR02	Apricots	Fruit
FR03	Avocado	Fruit
FR04	Bananas and plantains	Fruit
FR05	Breadfruit	Fruit
FR06	Custard apple	Fruit
FR07	Durian	Fruit
FR08	Grapes	Fruit
FR09	Jackfruit	Fruit
FR10	Longan	Fruit
FR11	Lychee	Fruit
FR12	Mango	Fruit
FR13	Mangosteen	Fruit
FR14	Oranges and tangerines	Fruit
FR15	Other fruit	Fruit
FR16	Passionfruit	Fruit
FR17	Pawpaw	Fruit
FR18	Peaches	Fruit
FR19	Pears	Fruit
FR20	Pineapples	Fruit
FR21	Plums	Fruit

A1.2 (continued)

Code	Detailed commodity	Aggregated commodity
FR22	Rambutan	Fruit
FR23	Rockmelon and other melons	Fruit
FR24	Water melon	Fruit
GR01	Barley	Grain
GR02	Maize	Grain
GR03	Millet	Grain
GR04	Other grain	Grain
GR05	Rice	Grain
GR06	Sorghum	Grain
GR07	Wheat	Grain
IC01	Cocoa	Industrial crops
IC02	Coconut	Industrial crops
IC03	Coffee	Industrial crops
IC04	Cotton	Industrial crops
IC05	Other industrial crops	Industrial crops
IC06	Palm oil	Industrial crops
IC07	Rubber—natural	Industrial crops
IC08	Sugar	Industrial crops
IC09	Tea	Industrial crops
IC10	Tobacco	Industrial crops
NT01	Cashew nuts	Nuts
NT02	Macadamia	Nuts
NT03	Other nuts	Nuts
OS01	Groundnuts	Oilseed
OS02	Other oilseed	Oilseed
OS03	Rapeseed (canola)	Oilseed
OS04	Sunflower	Oilseed
OT01	Hydro-electricity	Other
OT02	River transport	Other
OT03	Sericulture (silkworm production)	Other
OT04	Tourism	Other
OT05	Wildlife preservation	Other
PL01	Cowpeas	Pulses

A1.2 (continued)

Code	Detailed commodity	Aggregated commodity
PL02	General pulses	Pulses
PL03	Lentils	Pulses
PL04	Mung beans	Pulses
PL05	Other pulses	Pulses
PL06	Soybeans	Pulses
RC01	Cassava	Root crops
RC02	Kava	Root crops
RC03	Other root crops	Root crops
RC04	Sweet potato	Root crops
RC05	Taro	Root crops
RC06	Yam	Root crops
VG01	Brassicas	Vegetables
VG02	Cabbages	Vegetables
VG03	Carrots	Vegetables
VG04	Cauliflower	Vegetables
VG05	Cucumber	Vegetables
VG06	Cucurbits	Vegetables
VG07	Eggplant and green peppers	Vegetables
VG08	Lettuce	Vegetables
VG09	Other vegetables	Vegetables
VG10	Potato	Vegetables
VG11	Pumpkin	Vegetables
VG12	Tomatoes	Vegetables

A1.3 Notes on the PIAS form

When is a PIAS form used?

The PIAS is used to compile summary information for inclusion in the ACIAR Database of Impact Assessments (ADIA). This database will be used by ACIAR to provide information on the performance of the ACIAR portfolio as well as the allocation of resources over time. For this purpose it has a number of categories of information that have to be supplied in a consistent manner. These are given in drop down menus wherever possible. They include:

- countries involved
- commodities involved
- output information—type, point on the value chain of final user
- level of adoption to date (for adoption studies and impact assessments)
- time from completion of project to adoption
- nature of major environmental and social impacts
- overall assessment of impact.

Due to the large number of commodities, a list is provided in these notes. In your assessment, you are asked to strictly adhere to the list.

A PIAS is to be completed:

- as part of program desktop reviews, as the database can provide useful summary information and it is a good opportunity to populate the database. Desktop project reviews will draw on whatever information is available. If there is insufficient information to complete the section, 'insufficient information' should be noted in the text box
- as part of the summary of the adoption studies; note that the text from the summary can be copied straight into the PIAS in the relevant sections, or a summary of the summary inserted
- as part of the summary of an impact assessment, where again summary text can be copied into the relevant fields. The impact assessment must also provide a spreadsheet of the benefit–cost time series in constant Australian dollars.

Project information

Much of the information in this section will be available from the project history database that has been downloaded directly from the main ACIAR database. The reviewer will need to update the information (for example, dates and expenditure where there has been an extension).

Q1. ACIAR project number. Where projects have been jointly evaluated, a project number exists for each project. The convention has been adopted that the project that was completed most recently, or the project that has the largest budget (where projects are carried out concurrently), should be listed as the project number. All other projects included in the evaluation should be listed (in no particular order) in part B.

Q2. Full project name. This refers to the name of the project that corresponds with the project number, which is not necessarily the same as the name of the evaluation.

Q3. List the organisations involved in the research; include the acronym.

Q4. List the principal researchers/project leaders—if more than five please include the rest in the fifth field.

Q5. Duration of project including any extensions (ensure extension funding is included in ACIAR funding).

If just the year the project was started and finished is provided, the default start date is the first day of the financial year and the finish date is the last day of the financial year.

For impact assessment, if there is more than one ACIAR project, the year the last project was completed should be provided.

Q6. This is the project funding—with the ACIAR contribution and the total expenditure on the project in nominal Australian dollars (A$). For impact assessment, if there is more than one ACIAR project, the total ACIAR funding for the R&D should be provided in the third column. Note that the aim is to have the time series of expenditure for each project in the ADIA, so the present value in real dollars can be calculated as required. This funding input is included as there are still many data on project expenditure missing.

Q7. Select the region and then the country from the drop-down lists. If the project was regional and involved more than five countries, insert only the region. The default for share of expenditure in each country is equal shares unless this information is entered. For expenditure that is not specific to a country, such as general research, allocate this expenditure equally across all countries included in the evaluation.

Q8. Select up to five commodities in order of commodity focus from List A in this note. Select the most precise categorisation possible. For example, if the work is on tropical fruits but mainly on mangoes with good relevance to mangosteens and potential application to all tropical fruit, the first commodity should be 'mango', the second 'mangosteen' and the third 'tropical fruit'.

Q9. Up to five related projects can be listed using their ACIAR code. Please list in order of the most direct relationship. Related non-ACIAR projects should also be listed, including the organisation's name and acronym. The 'others' list can be used to list all other related projects that space did not allow for.

Assessment

Apart from Question 22, which is for only those reviewers undertaking a full impact assessment, this section is to be completed by all reviewers as part of their undertaking a desktop review, adoption study or impact assessment. The impact assessment will also provide a spreadsheet containing a time series in Australian dollars of the estimated real costs and benefits as at the year of the evaluation. A format for this spreadsheet is set out below.

Q10. Assessment information. This includes the date at which the review was undertaken, the name of the reviewer and their contact details (email and phone), and denotes whether the activity is a program/project review, an adoption study (AS) or an impact assessment (IA). For adoption studies please note the year of the study, for impact assessments the report number.

Q11. This describes the motivation for the project and the project objectives. It is the summary of section 1 from an AS and an IA. Project reviews will draw on the proposal and other project documentation to provide a list of objectives.

Q12. Description of the outputs of the project—these can arise from the process of undertaking the project as well as the deliverables of the project. They are to be divided into technical and policy-related outputs and capacity-building outputs. As far as possible the outputs that have different adoption pathways should be distinguished from each other. Unintended outputs should be included. This will draw on sections 2 of the AS and IA.

Q13. Describe the differences the project has made to date—that is, what adoption has there been at the time of the review. This can be copied from AS sections 3a and 3b. In IA it will be part of the discussion of evidence on outcomes and impacts. This may or may not be possible to complete for desktop reviews. If there is insufficient information to complete the section, 'insufficient information' should be noted in the text box.

Q14. Describes how the output leads to changes in the way the final user undertakes production/consumption and the consequences for the final user of adoption. It reports on the adoption pathway through which the output will come to have a community benefit over time. It should identify the next and final user for each

List B. Type of assessment

Code	Explanation
PR	*Review of project—usually part of a program assessment for development purposes*
AS	*Adoption study*
IA	*Impact Assessment*

of the outputs described in question 12. If there are more than four distinct outputs, please use the final field to include all other outputs.

Note that the final user is usually the farmers or other producers who use the technology, knowledge or capacity. In the case of policy, it is the producers, traders and consumers who respond to the changes in policy. The research organisation may also be the final user where an outcome is an improvement in the efficiency of the organisation. Note that the final user is not necessarily the major beneficiary. This draws on AS section 3c, and the section on adoption and outcomes in the IA. Project reviews should complete as much as possible.

Q15. Factors affecting adoption positively and negatively should be listed. The response should note how proactive the project has been in promoting adoption. The areas to be considered include:

- communication of the opportunity to the next and final users
- relevance of the outputs to the final users (do they gain from the adoption relative to the costs they incur?)
- cultural consistency of the required change
- policy impediments that restrict access to the resources required, or prevent the actions required
- financial and skills capacity required of users to be able to adopt
- market constraints—physical access to markets to sell excess product
- risk management issues—does adoption lower risk to consumption?

This is a summary of AS section 3d. Project reviews should complete as much as possible. The IA adoption discussion should identify these factors where they apply.

Q16. For each of up to five most important outputs complete the four drop-down choices. These are:

- Nature of the output (List C) categorises the outputs into the ACIAR categories of technologies, capacity and policy analysis/tools. Selection should be made at the subcategory level where possible.
- Point of the value chain of the final user (List D)
- Level of adoption to date (List E). Note that, if the output is intermediate—that is, does not have a final user, but has been well adopted by the next user—an Ni should be given. If the next user has gone on to use this to develop further outputs that are now being adopted an NI can be given.
- Time to adoption (List F). Note that if Ni or NI is given, the time to adoption is for the adoption of the further output.

Q17. Describes the impacts for each country involved, including Australia. The countries entered in Q7 will automatically appear in the form. The actual impact depends on the size of the change resulting from adoption of the outputs, the total value of production likely to be affected, and the flow-on effects. Note that if the impact is on the efficiency of a research organisation, then consideration should be given to the size of the budget that the efficiency improvement will apply to.

The flow-on effects arise from the market adjustments to changes in demand and supply through changes in process and quantities to restore equilibrium in the market. These are likely to be positive if there is substantial underemployment of resources in the absence of the project.

The spillover effects to:

- other industries from
  - use of platform technologies developed
  - improvement in the skills and knowledge base available to other industries/purposes
  - creation of critical mass or economies of scale improving access to resources or lowering input costs
  - reduction in risk of contagion from the industry (e.g. loss of reputation, market access etc.)
- the environment from:
  - better use of water resources such as improvement in water-use efficiency and water quality
  - revegetation or protection of vegetation and biodiversity
  - greenhouse gas abatement, improved energy balance
  - reduced chemical use, reduced risk of run-off, spray drift, contamination

List C. Output types

Major outputs	Detailed outputs
Technology	Varieties
	Production systems
	New products, new uses, uses for by-products
	Risk management
	Nutrition/irrigation
	Husbandry
	Harvest
	Postharvest handling/storage
	Distribution/transport
	Value-added/processing
	Marketing/market access
	Sustainability
	Other technology
Capacity built	Scientific knowledge
	Researcher skills, knowledge and experience
	Organisational attitudes/mindset, structure and purpose
	Research networks, partnerships
	Physical research infrastructure (laboratories etc.)
	Research tools/methodologies (databases, protocols etc.)
	Farmer, extension service skills and knowledge
	Other capacity built
Policy analysis	Economic models for policy analysis
	Biophysical models for input into decision-making
	Information collection, databases for informing decision-making
	Policy advisory papers, seminars etc.
	Legal advice on organisational structures, regulations etc.
	Other policy analysis

- the community (social) from
  - additional employment opportunities, or retention of jobs, and diversity of jobs offered
  - reduced risk to health or enhanced health
  - improved animal welfare
  - reduced community friction, enhanced community cohesion
  - Improved equity and fairness for all groups in the community, especially women and minority ethnic groups.

Q18 Asks for two main (if any) environmental (List G) or social (List H) spillovers to be identified. Please indicate whether the impact noted is positive or negative.

List D. Point on the value chain where final adoption is expected

Category	Explanation
On-farm	Adoption by the farmer—changes inputs used, products produced, production systems used
TSH	Adoption by those providing transport, storage of other handling
Processing	Adoption by processors, simple processing or complex processing, including packaging
Sales	Adoption by wholesalers or retailers of the product
Policy	Adoption by government agencies

List E. List of adoption categories

Category	Explanation
NF	Demonstrated and considerable use by next and final user
Nf	Demonstrated and considerable use by next user and minimal use by final user
NI	Considerable use by next user and has led to further outputs that have final users
Ni	Considerable use by next user but yet to lead to further outputs that have final users
N	Some use by the next user
O	No use by the next or final user

List F. Time to adoption

Category	Explanation
0–1	Years to substantial impact at the community level
1–5	
5–10	
10+	

List G. Environmental impacts

Category	Explanation
Water	Lower water use, improved water-use efficiency, improved water quality (marine and inland)
Chemicals	Reduced/less-hazardous chemical use, chemical containment, reduced risk of run-off
Vegetation	Revegetation of degraded areas, protection of biodiversity/habitat, maintenance of natural vegetation
GHG	Contribution to reducing greenhouse gases, reduced carbon emissions, improved energy use efficiency
Negative	Flag any negative impacts on the environment—these should be explained in the text

List H. Social impacts

Category	Explanation
Social benefits from increased employment opportunities	Creation and/or maintenance of employment opportunities, especially where labour is underemployed (rural areas), that lead to indirect social benefits that would not otherwise be captured by an economic measure of increased wages.
Health	Reduced risks to human health from injury, diet, exposure to dangerous chemicals/pathogens, improvement in availability of healthier diet
Animal welfare	Improved animal husbandry practices
Community cohesion	Greater capacity to absorb/integrate/coexist different cultures and approaches, resolution of points of tension in communities
Equity	Improvements in equity and fairness of allocation of resources, responsibilities and participation in decision-making

Q19. Asks for factors other than those affecting adoption that might enhance or reduce the impact of the project.

Q20. Asks for an overall assessment of the impact, taking into account the adoption rates, time to adoption, value of production directly affected and flow-on and spillover effects. This should take into account the impacts on all beneficiaries (including those negatively affected). The question also asks for an assessment of the level of confidence in the impact assessment. It will be high if the quality of evidence is good and all significant impacts are included, and low if the quality of evidence is poor and/or all significant impacts are not taken into account.

Q21. Description of lessons that add to the understanding of what kinds of R&D areas and approaches will be successful in the countries and for the commodities considered in the project.

Q22. These are the IA results that are generated from the spreadsheet of BCA results provided. The values should be reported in Australian dollars in real value terms at the year of the evaluation. The base year for the estimates is to be inserted. The spreadsheet should include in the R&D expenditure column only those costs related to the project. The benefits column should include only those attributed to the ACIAR project. This will usually be based on a cost share of total benefits if there is more than one ACIAR project in an IA. The total investment cost is the same share of total R&D and implementation costs as the share applied to the benefits. The spreadsheet should follow the structure below.

Total investment cost is the cost used in calculating the BCR. It takes into account any non-project expenditure that was required for adoption to occur. It would include extension costs, and implementation costs, but not operating costs. Year N is the year in which the benefit flows reach steady state in real dollars (or zero if there is disadoption or, for other reasons, the impacts fall to zero).

Spreadsheet structure

Project code	**Base year**			
	R&D expenditure	**Total investment cost**	**Total benefits**	**Australian benefits**
Year 1				
Year 2 etc.				
Year N				

Appendix 2. Adoption study report templates

A2.1 Format for the summary adoption study report

Project title:

Table A2.1. Project information summary

Project information	
Project number	
Project name	
Collaborating institutions	
Project leaders	
Duration of project	
Funding	
Countries involved	
Commodities involved	
Related projects	

Note that this table can be generated automatically from the PIAS form Q1–Q9.

1. Motivation for the project and what it aimed to achieve

This presents a summary of section 1 of the report. It should set out what was the problem or opportunity that motivated the research. For example, a region may have been suffering an infestation of a pest that was affecting productivity and for which there were no affordable solutions, or a new variety developed in Australia offered an opportunity for ameliorating land degradation in a country. It should also briefly explain how the research agencies came to work together. It should set out what the project aimed to achieve in terms of outcomes. It should not be a cut and paste from the proposal.

This summary is to be inserted into PIAS 11.

2. What the research project produced

This presents a summary of section 2 of the report. It should list the major outputs of the project and classify them according to whether they are technical, policy or capacity-building outputs. It should note which outputs were intended and which were serendipitous. If capacity developed was a major issue this should be addressed in

a separate paragraph drawing on section 2.2 of the full report. This should be what the project has delivered in terms of outputs; for example, identification of higher-yielding varieties for a location, development of mapping tools for locating dams, or a tailored training package for extension officers to use. It is not about the inputs, such as research methods used, workshops conducted or trainings held. It should quantify the outputs where it makes sense to do so; for example, a variety with a 20% higher yield, a mapping tool applicable to a region of X km^2, a training package for crops that currently make up X% of the region's production.

This summary is to be inserted into PIAS 12.

3. Adoption—how the project outputs are being used

This presents a summary of section 3 of the report. It should distinguish between capacity utilisation and adoption of technical and policy outputs. It should clearly state whether the outputs are in a form that can be adopted by the final user, or whether they are intermediate outputs. The adoption discussion should follow the order of presentation of the outputs in the previous section and state the current level of adoption and what is expected in the future. For example the variety may require field testing (next user) before propagation by the seed company (next user) and purchase by the farmer (final user). The mapping tool may have been applied by a catchment management group (next user) and dams placed by landowners according to their advice (final user). The extent of adoption should be quantified where possible by providing information on the scale of actual adopters relative to the scale of potential adopters. For example, while a technology may be used in only 1 of a possible 10 plantations, this plantation may produce 50% of the region's supply. Factors affecting adoption positively and negatively should be noted.

This summary is to be inserted into PIAS Q14.

4. Impact—the difference the project has or is expected to make

This is a summary of section 4 of the report. It should describe how the project *has* contributed to improvements or changes in the local communities. It should identify whether these changes have improved income, reduced income risk, improved health or other social aspects, or improved environmental health. It should also note any negative impacts. Any factors that have enhanced or detracted from the impact of the project should be noted. In a separate paragraph, further expected impacts should be described, including the likely timing and whether these are contingent on any other events and what those are.

This summary is to be inserted into PIAS Q17.

A2.2 Format for the detailed adoption study report

1. Motivation for the project and what it aimed to achieve

This section should set out the history of the project, the problem or opportunity it set out to respond to, and what it hoped to achieve.

It will form the basis of the summary for input into PIAS Q11.

1.1 The motivation

What was the problem or opportunity the project targeted? That is, why did the project happen?

1.2 The objectives of the project

What were the objectives of the project? Note that these should relate to the problem or opportunity set out above.

1.3 History of the project

How was the project initiated, what other projects (ACIAR or otherwise) did it follow or was designed to feed into?

Who were the agencies involved and how was contact established?

What were the funding contributions from ACIAR and other agencies? Include expenditure on extension and other follow-up work. Where possible provide actual funding information.

2. Outputs—what the research project produced

This section sets out the outputs of the project, both intended and unintended. It is not a description of the research undertaken, rather it is what the research produced. It should cover technical and policy outputs and capacity built by the project.

It will form the basis of the summary for input into PIAS Q12.

2.1 Technical and policy outputs

This should describe the output and *how it differs* from what was available prior to the research, or from other research that might have been going on.

Technical outputs could include:

- varieties with higher yields, pest resistance, climate suitability
- production systems with lower inputs, improved water-use efficiency, maintaining soil health, reduced variability in volume or quality
- new uses for by-products, enhancement of joint production systems
- improved quality, lower chemical residues
- value-adding postharvest, cool chain management, postharvest handling procedures.
- new research methodologies, databases, trial information collection systems
- new research tools, e.g. diagnostic tests.

Policy outputs could include:

- models of industries or economies that can be used to assess policy options
- biophysical models that can be used to predict physical impacts of resource-use decisions

- policy advisory papers, seminars, workshops conducted
- laws, regulations, institutional structures, or input into these outputs.

2.2 Capacity developed by the project

The capacity developed by the project should be discussed separately from technical and policy outputs. While technical and policy outputs may be inputs into further research or development work, capacity outputs are usually intermediate outputs. What is their impact depends on their utilisation in delivering technical and policy outputs. The report should identify where capacity building was a primary objective of the project or where the capacity developed was a by-product of the research project. The capacity built should be assessed relative to the level of capacity before the start of the project; this is the change that can be directly attributed to the project's activities. The categories to consider are:

- development of the stock of knowledge that is available to the researchers within the organisation and/or the wider research community
- development of skills and knowledge of the researchers, extension agents, farmers and others, in the partner countries and in Australia. This should include any networks or linkages of researchers formed
- investment in physical research infrastructure, including germplasm and seedbanks
- development of research tools such as methodologies, databases, specialised equipment
- organisational capacity to undertake research efficiently and effectively and attract research funding, and organisational linkages formed.

3. Adoption—how the project outputs are being used

This section should describe how the outputs set out in the previous section are being used and how this has flown through to final users, or is expected to do so. The *final user is the group whose use has an impact on the community*. This might be a farmer, processor, or transport provider, or a government agency changing regulations. It is rarely the consumer—although consumers are often major beneficiaries. The final user is rarely another researcher or research organisation, although these are often next users. A research organisation may be a final user where the use leads to major improvements in the efficiency of the organisation *and* this was the purpose of the output. In this case the impact is the savings made by the organisation arising from the improvement in efficiency. If no adoption has occurred and none is expected for any of the outputs described above this should be noted. The reasons for this are discussed in a later section. The discussion should clearly state what has happened to date, as well as making an assessment of future adoption.

This section will form the basis of the summary for input into PIAS Q13 to Q16.

3.1 Capacity utilisation—how the capacity built is being used

This section will describe how the knowledge, skills and infrastructure built are being used. It will note where these are leading to new technical and policy outputs that, in turn, will be/have been adopted and have impacts.

3.2 Adoption to date

This section forms the basis of the assessment of the extent of adoption to date. It should cover the period from the start of the project until the date of the adoption study. Where the project outputs were intermediate, in that they did not in themselves have a final user, this should be made clear. If they have led to outputs that have been adopted, the analysis should be applied to these indirect, but strongly linked outputs.

For each output the report should describe the initial user, then each user along the pathway to the final user. It should explain how each initial and next user group became aware of the outputs, the factors that influenced their adoption and the tools used, such as workshops, seminars, information sheets, manuals, demonstration sites etc. This should distinguish between communication and dissemination activities undertaken as part of the project and those that were achieved by other means. Where other agencies were involved in promoting adoption they should be listed and the link between their work and the project described.

Where possible adoption rates should be quantified; for example, the share of farmers the output is applicable to who are using the output and the share of production this represents. If no adoption has occurred this should be stated with the reasons why.

Table A2.2 provides the classification of the extent of adoption at the time of the adoption study.

3.3 Adoption in the future

This will briefly discuss whether adoption is expected to progress, and identify what it might be contingent on. This could be an external event, such as a rise in price or end of a drought, or one that can be influenced by those involved, such as farmer education and training. The information should be sufficient to make an assessment of the likely time to adoption by the final user.

3.4 Factors affecting adoption

This will discuss the features of the project that have supported good adoption, or what has hampered adoption at initial, next or final user levels.

4. Impact—what difference has/will the project make?

This section will describe the consequences of adoption and the beneficiaries. It should identify whether impact is a result of only some or all of the outputs, and whether there are very different impacts from different outputs.

This section is to be summarised for PIAS Q17–Q20. PIAS Q20 asks for an overall assessment of impact.

4.1 Community impacts—the beneficiaries of the project

This section should describe both actual and anticipated impacts:

- Who is affected as a result of adoption by the final users: which communities—farmers, consumers, landless labourers etc. in what regions in a country, and/or which countries—benefit from adoption, or are negatively affected by it? It should note whether all are likely to be affected in the same way or whether there are different impacts on different groups. These impacts could be economic and social (affecting the health, safety or other social benefit).
- Are there any environmental impacts of the adoption of the research outputs?
- What is the likely magnitude of the impact for each group—does it substantially improve profitability, food/income security, health status, the built environment, the natural environment? The potential impact on poverty should be discussed.

Table A2.2. Level of adoption

Category	Explanation
NF	Demonstrated and considerable use by next and final user
Nf	Demonstrated and considerable use by next user and minimal use by final user
NI	Intermediate output with considerable use by next user and has led to further outputs that have final user
Ni	Intermediate output with considerable use by next user but yet to lead to further outputs that have final users
N	Some use by the next user
O	No uptake by next or final user

4.2 Factors affecting the magnitude of the impact

This section should describe the factors that have enhanced or reduced the impact on any of the groups identified in the previous section. It should complement, not repeat, the discussion in section 3.4. It should explain any factors that account for good adoption but little impact. An example is a new timber product that was well adopted by processing firms but, due to the Asian financial crisis, had yet to be widely used by consumers.

4.3 Benefits for Australia

This section should describe the impact, if any, for Australia.

5. Lessons

Discuss any lessons for ACIAR that have been highlighted during the adoption study. These could include:

- prospects for research on the commodity/farming system—are there areas that are not fruitful or particularly fruitful?
- are there any avenues that are particularly effective for engaging with the country? This should include the agencies that work well in the country, and go beyond consideration of research partners.
- other lessons.

This section provides the basis for PIAS Q21.

6. Contacts

Provide a list of people you have communicated with during this adoption study. Include their name, position, organisation (where appropriate), contact details (where available) and their involvement in the adoption process.

For example;

Dr Jeff Davis,
Position/Organisation: Manager, Policy Linkages & Impact Assessment, ACIAR
Address: GPO Box 1571, Canberra ACT 2601
Ph: +61 2 6217 0522
Fax: +61 2 6217 0501
Email: davis@aciar.gov.au
Involvement: Initial user—a coordinator of the training workshops

Attachment—project-related photos

Please send with the reports 4–8 photos of interesting aspects of the project. Include a Microsoft® Word document clearly identifying the pictures and providing 2–3 line captions for each.

Appendix 3. Assessment of capacity building

The survey would be expected to contain the following questions adapted from tracer surveys previously undertaken by the Crawford Fund and ACIAR.

The questions relate to the training and learning-by-doing activities that formed part of the ACIAR project. Please select the response that most reflects your view of the statement.

Table A3.1. Survey questions—initial

Relevance						
	Please select most appropriate					
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not applicable
a. The topics of the activities were directly related to my field of work at the time						
Quality of training/education provided						
	Please select most appropriate					
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Not applicable
a. The trainers/mentors were knowledgeable and provided information of a good quality						
b. I found participating in the activities difficult due to my level of English						
c. I found the activities well structured and content well focused						

Table A3.1. (continued)

Capacity built						
	Please select most appropriate					
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Not applicable
a. I increased my capacity to conduct high quality research						
b. I acquired new or improved laboratory or other technical skills						
c. I acquired new skills for managing research projects efficiently and effectively						
d. I better understand issues and principles in my field and resources I can access to assist in my research						
e. I acquired new ways to approach work problems						
f. I learned new or improved ways of communicating with networks within my field						
Capacity utilised						
	Please select most appropriate					
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Not applicable
a. I was able to apply the knowledge/skills gained to my work						
b. I continue to use the knowledge/skills gained						
c. I increased my professional collaboration with organisations both nationally and internationally						
d. I have trained others in the skills I learned						
e. I was able to secure additional resources to expand or enhance my research						
f. The networks made during the project have enabled me to produce better research outputs						
g. The technologies/knowledge/skills gained from the project enabled me to perform better at work						

Table A3.1. (continued)

Outcomes—personal						
	Please select most appropriate					
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not applicable
a. I was offered a promotion as a result of my training						
b. I have pursued work opportunities in the field of the workshop						
c. As a result of what I learned and have applied, I gain greater satisfaction from my work						
Outcomes—organisational						
	Please select most appropriate					
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Not applicable
a. The organisation has increased its efficiency in undertaking R&D						
b. The project added to the quality of research our organisation produces						
c. The project has promoted a more innovative culture in the organisation						
d. The improved capacity of the organisation has allowed it to attract more funding for R&D						

These are examples of the types of questions that would be asked as part of the study. Further questions would also need to be formulated once more is known about the research outcomes, including project-specific questions. Examples of such questions are shown below:

Table A3.2. Survey questions—supplementary

Outcomes—research						
	Please select most appropriate					
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Not applicable
a. As a result of the knowledge and skills gained, research projects are completed much sooner than before						
b. As a result of the knowledge and skills gained, research outputs are better tailored to the needs of the users						
c. As a result of the knowledge and skills gained, the organisation is producing new and exciting research						
d. *Question on contribution to specific R&D outputs*						
e. *Question on contribution to specific R&D outputs*						

Impacts

Questions to be tailored to the expected impact on final users.

Appendix 4. Impact Assessment Series report information

Impact Assessment Series report template

- Research undertaken:
  - agencies and countries involved
  - dates undertaken
  - previous research that this work has built on
  - total expenditure on the research
- Outputs of the research
  - new technology, new knowledge, capacity built
  - adoption pathway, additional investments required for implementation
- Outcomes resulting
  - evidence on adoption—who are the adopters (applicable populations)?—adoption profile
  - changes in practice, policy or products and their consequences for yields, costs of production, prices received, income security
  - box giving assumptions/measures used for modelling the welfare changes
  - environmental consequences (if any)
- Impact assessment
  - approach to estimating welfare changes (demand/supply diagram)
  - benefit flows (economic, environmental, social)
  - net benefits and summary measures (benefit:cost ratio, rate of return), confidence in estimates
  - distributional implications (poverty impact)
- Lessons
  - reasons why things worked particularly well or poorly
  - ways to improve in impact assessment methods
  - rules of thumb/benchmarks supported or contradicted

One-page summary mapping

Spreadsheet of time series of costs and benefits estimated

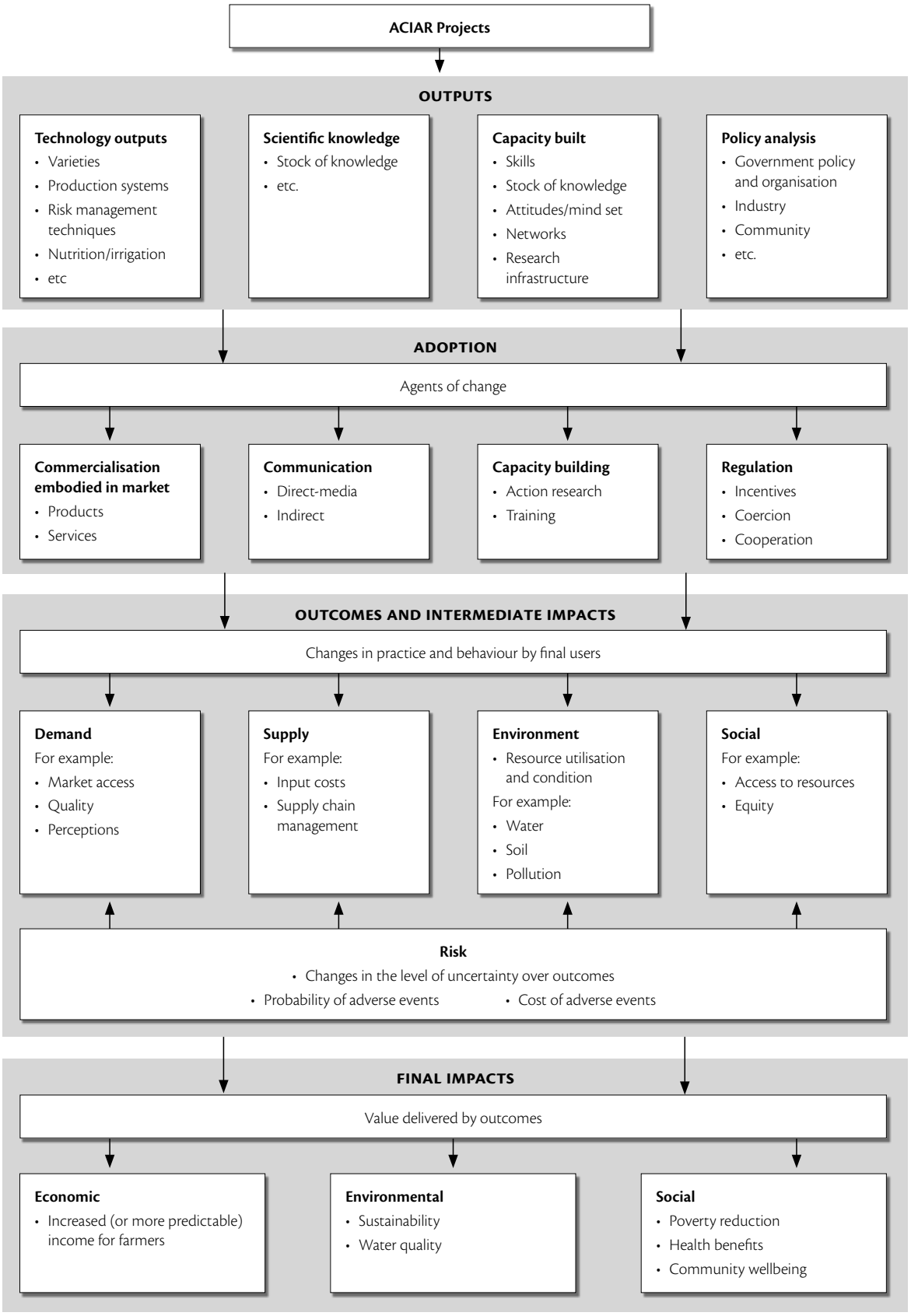

Figure A4.1. ACIAR projects pathways to benefits: generic example

Table A4.1. Exchange rates

		1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
China: Exchange Rates	$A/Yuan	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572
Cambodia: Exchange Rates	$A/Riels	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2
China: Exchange Rates	$A/Yuan	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572
Fiji: Exchange Rates	$A/$Fiji	0.888	0.888	0.888	0.888	0.888	0.888	0.888	0.888	0.888	0.888
India: Exchange Rates	$A/Rupees	5.333	5.333	5.333	5.333	5.333	5.333	5.333	5.333	5.333	7.122
Indonesia: Exchange Rates	$A/Rupiah										
Lao: Exchange Rates	$A/Kip	39.2	51.8	89.6	89.6	89.6	89.6	89.6	268.8	268.8	268.8
Malaysia: Exchange Rates	$A/Ringgit	3.4286	3.4286	3.4286	3.4286	3.4286	3.4286	3.4286	3.4286	3.4286	3.4286
Nepal: Exchange Rates	$A/Rupees	7.0152	7.3932	8.0002	8.4	8.5333	8.5333	8.5333	8.5333	8.5333	8.5313
Papua New Guinea: Exchange Rates	$A//Kina	1	1	1	1	1	1	1	1	1	1
Philippines: $A/Exchange Rates	$A/Pesos	2.24	2.24	2.24	2.2568	2.2624	4.1752	4.3797	4.3792	4.3783	4.368
Thailand: Exchange Rates	$A/Baht	23.2401	23.5108	23.7105	23.7236	23.5854	23.3857	23.3297	23.296	23.296	23.296
Tonga: Exchange Rates	$A/Pa'anga	1	1	1	1	1	1	1	1	1	1
Vanuatu: Exchange Rates	$A/Vatu	72.4556	85.62307	100.5368	100.5368	100.5368	100.5368	100.5368	100.5368	100.5368	100.5368
Vietnam: Exchange Rates	$A/Dong										
New Zealand: Exchange Rates	$A/$NZD	1.25	1.25	1.25	1.25	1.24858	1.24147	1.24147	1.24147	1.24147	1.24147

Table A4.1. (continued)

		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
China: Exchange Rates	$A/Yuan	2.7572	2.7572	2.7572	2.7572	2.7923	2.6769	2.826	2.8244	2.4337	2.3794
Cambodia: Exchange Rates	$A/Riels	39.2	39.2	48.77	62.16	86.56	193.49	349.22			
China: Exchange Rates	$A/Yuan	2.7572	2.7572	2.7572	2.7572	2.7923	2.6769	2.826	2.8244	2.4337	2.3794
Fiji: Exchange Rates	$A/$Fiji	0.9026	0.9753	0.9753	0.9753	0.9738	0.9839	1.1292	1.1599	1.0759	1.0987
India: Exchange Rates	$A/Rupees	8.4	8.4	8.4	8.4	8.497	9.056	11.015	11.662	10.957	10.98
Indonesia: Exchange Rates	$A/Rupiah	167.53	331.85	365.12	406.37	444.79	494.82	590.42	597.37	543.74	508.44
Lao: Exchange Rates	$A/Kip	268.8	268.8	268.8	268.8	272.22	608.22	853.62	863.67	949.15	531.31
Malaysia: Exchange Rates	$A/Ringgit	3.4286	3.4286	3.4286	3.4286	3.4616	3.3619	3.4687	3.4667	3.1313	3.1142
Nepal: Exchange Rates	$A/Rupees	8.9983	11.34	11.34	11.34	11.4841	12.0725	14.9452	15.2006	14.3949	15.3145
Papua New Guinea: Exchange Rates	$A//Kina	1	1	1	1	0.999	1.00466	1	1	1	1.03191
Philippines: $A/Exchange Rates	$A/Pesos	4.368	4.368	4.368	6.6129	7.295	7.9588	9.6113	9.7632	9.4882	9.1159
Thailand: Exchange Rates	$A/Baht	23.296	23.296	23.296	23.296	23.5921	24.8007	29.327	29.3289	26.7013	24.9933
Tonga: Exchange Rates	$A/Pa'anga	1	1	1	1	0.99855	0.97672	1	0.99892	1.00006	1.00036
Vanuatu: Exchange Rates	$A/Vatu	100.5368	100.5368	105.7728	113.1032	114.1933	97.30799	102.3248	112.111	90.69345	94.54851
Vietnam: Exchange Rates	$A/Dong										
New Zealand: Exchange Rates	$A/$NZD	1.22135	1	1	1	1.00157	1.00241	0.95651	0.97349	0.92581	0.81392

Table A4.1. (continued)

		1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
China: Exchange Rates	$A/Yuan	2.0374	1.9272	1.7384	1.7069	1.9582	1.9216	1.7822	2.0323	2.0562	2.3074
Cambodia: Exchange Rates	$A/Riels										
China: Exchange Rates	$A/Yuan	2.0374	1.9272	1.7384	1.7069	1.9582	1.9216	1.7822	2.0323	2.0562	2.3074
Fiji: Exchange Rates	$A/$Fiji	1.0173	0.9691	0.9342	0.9314	0.9819	0.9472	0.9169	0.9507	0.8084	0.7589
India: Exchange Rates	$A/Rupees	9.69	9.377	9.084	8.956	9.947	9.609	9.111	9.974	8.672	8.454
Indonesia: Exchange Rates	$A/Rupiah	460.25	505.98	696.5	714.44	726.06	672.25	817.57	901.41	777.86	856.1
Lao: Exchange Rates	$A/Kip	221.81	381.96	411.34	11.4	24.81	35.61	31.58	30.79	38.29	63.73
Malaysia: Exchange Rates	$A/Ringgit	2.7291	2.6508	2.4465	2.4796	2.6478	2.3744	2.0942	2.0603	1.7405	1.7307
Nepal: Exchange Rates	$A/Rupees	13.863	13.8625	13.4153	13.6742	14.1759	13.472	13.1248	14.4496	12.7863	14.2364
Papua New Guinea: Exchange Rates	$A//Kina	1.13964	1.23304	1.25699	1.30897	1.29384	1.33415	1.32838	1.27212	1.42996	1.53942
Philippines: $A/Exchange Rates	$A/Pesos	8.2098	8.4318	8.2476	8.5613	9.0775	8.677	10.022	14.5999	13.0428	13.6746
Thailand: Exchange Rates	$A/Baht	22.6245	23.2786	22.8272	23.3346	25.0703	23.4001	20.7548	20.7737	19.037	17.6482
Tonga: Exchange Rates	$A/Pa'anga	1.00005	1.00007	1.00006	1.00007	1.00007	1.00003	1.0002	1.00014	1.00047	1.00023
Vanuatu: Exchange Rates	$A/Vatu	88.05837	83.47179	76.8701	77.83206	100.868	97.75478	89.64204	87.24079	74.24837	71.1574
Vietnam: Exchange Rates	$A/Dong							0.91	0.9	5.8	15.26
New Zealand: Exchange Rates	$A/$NZD	0.87535	0.90649	0.91492	0.85546	0.75664	0.73958	0.74133	0.65535	0.71369	0.78199

Table A4.1. (continued)

		1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
China: Exchange Rates	$A/Yuan	2.6087	2.9189	2.9837	3.7365	4.1475	4.0531	3.9184	6.3047	6.1928	6.5095
Cambodia: Exchange Rates	$A/Riels				334.09	560.08	919.45	1832.81	1863.15	1818.35	2055.22
China: Exchange Rates	$A/Yuan	2.6087	2.9189	2.9837	3.7365	4.1475	4.0531	3.9184	6.3047	6.1928	6.5095
Fiji: Exchange Rates	$A/$Fiji	0.8724	1.1208	1.1741	1.1564	1.1495	1.1046	1.0485	1.0706	1.0429	1.0985
India: Exchange Rates	$A/Rupees	9.083	10.946	12.84	13.679	17.728	19.057	20.741	22.955	24.052	27.739
Indonesia: Exchange Rates	$A/Rupiah	1152.16	1322.9	1402.28	1440	1519.53	1492.23	1419.28	1581.41	1667.38	1834.15
Lao: Exchange Rates	$A/Kip	132.22	315.23	466.58	552.9	547	526.52	487.13	525.11	597.05	721.09
Malaysia: Exchange Rates	$A/Ringgit	1.7656	2.0557	2.1473	2.1132	2.1425	1.8734	1.7509	1.9189	1.8574	1.9696
Nepal: Exchange Rates	$A/Rupees	15.2904	18.3153	21.5145	22.9494	29.0437	31.4093	33.0643	36.1458	38.4855	44.3825
Papua New Guinea: Exchange Rates	$A//Kina	1.57161	1.47416	1.47605	1.34017	1.34833	1.41115	1.50353	1.36288	1.05685	0.9694
Philippines: $A/Exchange Rates	$A/Pesos	14.4152	16.5493	17.2195	19.005	21.4066	18.7698	18.4311	19.3065	19.0655	20.5261
Thailand: Exchange Rates	$A/Baht	18.0267	19.8361	20.3623	19.9867	19.8796	18.6778	17.2204	18.3988	18.4766	19.8428
Tonga: Exchange Rates	$A/Pa'anga	1.00014	1	0.99957	1.00008	1.00976	0.99009	0.94115	0.96539	0.94237	0.96432
Vanuatu: Exchange Rates	$A/Vatu	76.96729	81.92768	91.78618	91.42316	87.00214	83.31927	82.67015	85.12278	83.1356	87.4505
Vietnam: Exchange Rates	$A/Dong	54.94	488.81	3490.91	5076.48	7825.02	8243.53	7235.82	8024.28	8184.75	8638.16
New Zealand: Exchange Rates	$A/$NZD	0.84468	0.83996	0.75585	0.7642	0.74347	0.73236	0.79572	0.81125	0.88574	0.87838

Table A4.1. (continued)

		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
China: Exchange Rates	$A/Yuan	6.1683	5.2108	5.3422	4.821	4.2845	4.5019	5.3957	6.0965	6.2599	6.0059
Cambodia: Exchange Rates	$A/Riels	2182.79	2354.4	2457.45	2235.4	2027.19	2127.96	2591.15	2958	3125.53	3091.2
China: Exchange Rates	$A/Yuan	6.1683	5.2108	5.3422	4.821	4.2845	4.5019	5.3957	6.0965	6.2599	6.0059
Fiji: Exchange Rates	$A/$Fiji	1.0728	1.2491	1.271	1.2361	1.1779	1.1882	1.2319	1.2752	1.2914	
India: Exchange Rates	$A/Rupees	26.989	25.933	27.787	26.13	24.422	26.439	30.329	33.368	33.68	34.133
Indonesia: Exchange Rates	$A/Rupiah	2139.91	6275.07	5065.32	4879.91	5306.95	5055.96	5583.72	6578.04	7410.51	6899.76
Lao: Exchange Rates	$A/Kip	925.7	2061.21	4595.07	4582.13	4631.09	5475.42	6887.34	7792.9	8136.88	
Malaysia: Exchange Rates	$A/Ringgit	2.0784	2.469	2.4523	2.2129	1.967	2.0668	2.4772	2.799	2.8928	2.7629
Nepal: Exchange Rates	$A/Rupees	43.1062	41.4688	44.0386	41.3291	38.7936	42.3657	49.5666	54.2603	54.5056	54.8107
Papua New Guinea: Exchange Rates	$A//Kina	0.93699	0.77093	0.61096	0.62324	0.57273	0.47413	0.43242	0.42211	0.42218	0.43442
Philippines: $A/Exchange Rates	$A/Pesos	21.7943	25.7116	25.2229	25.6197	26.3933	28.0719	35.3598	41.2785	42.0764	38.6477
Thailand: Exchange Rates	$A/Baht	23.1085	26.0772	24.4027	23.2787	22.9917	23.3586	26.9909	29.6054	30.7116	28.5253
Tonga: Exchange Rates	$A/Pa'anga	0.93874	0.93691	1.03191	1.01979	1.09858	1.194	1.39687	1.45172	1.48373	
Vanuatu: Exchange Rates	$A/Vatu	86.10418	80.17828	83.29526	79.97434	75.20895	75.64252	79.40505	82.2681	83.42897	83.75704
Vietnam: Exchange Rates	$A/Dong	8683.53	8341.09	8998.06	8245.81	7622.03	8311.84	10113.77	11570.75	12113.34	12050.01
New Zealand: Exchange Rates	$A/$NZD	0.89105	0.85243	0.82074	0.78478	0.81276	0.85278	0.8945	0.90172	0.92211	0.86218

Table A4.2. Price deflator

Year	Deflator
1990	67.48
1991	68.82
1992	69.97
1993	70.80
1994	71.34
1995	72.65
1996	74.16
1997	75.12
1998	75.52
1999	75.91
2000	79.06
2001	82.19
2002	84.29
2003	86.96
2004	89.88
2005	93.94
2006	97.53

Note: Australia GDP Deflator 2006–07 = 100 Index IMF

IMPACT ASSESSMENT SERIES

No.	Author(s) and year of publication	Title	ACIAR project numbers
1	Centre for International Economics (1998)	Control of Newcastle disease in village chickens	8334, 8717 and 93/222
2	George, P.S. (1998)	Increased efficiency of straw utilisation by cattle and buffalo	8203, 8601 and 8817
3	Centre for International Economics (1998)	Establishment of a protected area in Vanuatu	9020
4	Watson, A.S. (1998)	Raw wool production and marketing in China	8811
5	Collins, D.J. and Collins, B.A. (1998)	Fruit fly in Malaysia and Thailand 1985–1993	8343 and 8919
6	Ryan, J.G. (1998)	Pigeon pea improvement	8201 and 8567
7	Centre for International Economics (1998)	Reducing fish losses due to epizootic ulcerative syndrome—an ex ante evaluation	9130
8	McKenney, D.W. (1998)	Australian tree species selection in China	8457 and 8848
9	ACIL Consulting (1998)	Sulfur test KCL–40 and growth of the Australian canola industry	8328 and 8804
10	AACM International (1998)	Conservation tillage and controlled traffic	9209
11	Chudleigh, P. (1998)	Post-harvest R&D concerning tropical fruits	8356 and 8844
12	Waterhouse, D., Dillon, B. and Vincent, D. (1999)	Biological control of the banana skipper in Papua New Guinea	8802-C
13	Chudleigh, P. (1999)	Breeding and quality analysis of rapeseed	CS1/1984/069 and CS1/1988/039
14	McLeod, R., Isvilanonda, S. and Wattanutchariya, S. (1999)	Improved drying of high moisture grains	PHT/1983/008, PHT/1986/008 and PHT/1990/008
15	Chudleigh, P. (1999)	Use and management of grain protectants in China and Australia	PHT/1990/035
16	McLeod, R. (2001)	Control of footrot in small ruminants of Nepal	AS2/1991/017 and AS2/1996/021
17	Tisdell, C. and Wilson, C. (2001)	Breeding and feeding pigs in Australia and Vietnam AS2/1994/023	
18	Vincent, D. and Quirke, D. (2002)	Controlling *Phalaris minor* in the Indian rice–wheat belt	CS1/1996/013
19	Pearce, D. (2002)	Measuring the poverty impact of ACIAR projects—a broad framework	
20	Warner, R. and Bauer, M. (2002)	*Mama Lus Frut* scheme: an assessment of poverty reduction	ASEM/1999/084
21	McLeod, R. (2003)	Improved methods in diagnosis, epidemiology, and information management of foot-and-mouth disease in Southeast Asia	AS1/1983/067, AS1/1988/035, AS1/1992/004 and AS1/1994/038
22	Bauer, M., Pearce, D. and Vincent, D. (2003)	Saving a staple crop: impact of biological control of the banana skipper on poverty reduction in Papua New Guinea	CS2/1988/002-C
23	McLeod, R. (2003)	Improved methods for the diagnosis and control of bluetongue in small ruminants in Asia and the epidemiology and control of bovine ephemeral fever in China	AS1/1984/055, AS2/1990/011 and AS2/1993/001
24	Palis, F.G., Sumalde, Z.M. and Hossain, M. (2004)	Assessment of the rodent control projects in Vietnam funded by ACIAR and AUSAID: adoption and impact	AS1/1998/036

IMPACT ASSESSMENT SERIES <CONTINUED>

No.	Author(s) and year of publication	Title	ACIAR project numbers
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26	Mullen, J.D. (2004)	Impact assessment of ACIAR-funded projects on grain-market reform in China	ANRE1/1992/028 and ADP/1997/021
27	van Bueren, M. (2004)	Acacia hybrids in Vietnam	FST/1986/030
28	Harris, D. (2004)	Water and nitrogen management in wheat–maize production on the North China Plain	LWR1/1996/164
29	Lindner, R. (2004)	Impact assessment of research on the biology and management of coconut crabs on Vanuatu	FIS/1983/081
30	van Bueren, M. (2004)	Eucalypt tree improvement in China	FST/1990/044, FST/1994/025, FST/1984/057, FST/1988/048, FST/1987/036, FST/1996/125 and FST/1997/077
31	Pearce, D. (2005)	Review of ACIAR's research on agricultural policy	
32	Tingsong Jiang and Pearce, D. (2005)	Shelf-life extension of leafy vegetables—evaluating the impacts	PHT/1994/016
33	Vere, D. (2005)	Research into conservation tillage for dryland cropping in Australia and China	LWR2/1992/009, LWR2/1996/143
34	Pearce, D. (2005)	Identifying the sex pheromone of the sugarcane borer moth	CS2/1991/680
35	Raitzer, D.A. and Lindner, R. (2005)	Review of the returns to ACIAR's bilateral R&D investments	
36	Lindner, R. (2005)	Impacts of mud crab hatchery technology in Vietnam	FIS/1992/017 and FIS/1999/076
37	McLeod, R. (2005)	Management of fruit flies in the Pacific	CS2/1989/020, CS2/1994/003, CS2/1994/115 and CS2/1996/225
38	ACIAR (2006)	Future directions for ACIAR's animal health research	
39	Pearce, D., Monck, M., Chadwick, K. and Corbishley, J. (2006)	Benefits to Australia from ACIAR-funded research	FST/1993/016, PHT/1990/051, CS1/1990/012, CS1/1994/968, AS2/1990/028, AS2/1994/017, AS2/1994/018 and AS2/1999/060
40	Corbishley, J. and Pearce, D. (2006)	Zero tillage for weed control in India: the contribution to poverty alleviation	CS1/1996/013
41	ACIAR (2006)	ACIAR and public funding of R&D. Submission to Productivity Commission study on public support for science and innovation	
42	Pearce, D. and Monck, M. (2006)	Benefits to Australia of selected CABI products	
43	Harris, D.N. (2006)	Water management in public irrigation schemes in Vietnam	LWR2/1994/004 and LWR1/1998/034
44	Gordon, J. and Chadwick, K. (2007)	Impact assessment of capacity building and training: assessment framework and two case studies	CS1/1982/001, CS1/1985/067, LWR2/1994/004 and LWR2/1998/034
45	Turnbull, J.W. (2007)	Development of sustainable forestry plantations in China: a review	
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No.	Author(s) and year of publication	Title	ACIAR project numbers
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48	Longmore, C., Gordon, J., and Bantilan, M.C. (2007)	Assessment of capacity building: overcoming production constraints to sorghum in rainfed environments in India and Australia	CS1/1994/968
49	Fisher, H. and Gordon, J. (2007)	Minimising impacts of fungal disease of eucalypts in South-East Asia	FST/1994/041
50	Monck, M. and Pearce, D. (2007)	Improved trade in mangoes from the Philippines, Thailand and Australia	PHT/1990/051 and CS1/1990/012
51	Corbishley, J. and Pearce, D. (2007)	Growing trees on salt-affected land	FST/1993/016
52	Fisher H. and Gordon J. (2008)	Breeding and feeding pigs in Vietnam: assessment of capacity building and an update on impacts	AS2/1994/023
53	Monck M. and Pearce D. (2008)	The impact of increasing efficiency and productivity of ruminants in India by the use of protected-nutrient technology	AH/1997/115
54	Monck M. and Pearce D. (2008)	Impact of improved management of white grubs in peanut-cropping systems	CS2/1994/050
55	Martin G. (2008)	ACIAR fisheries projects in Indonesia: review and impact assessment	FIS/1997/022, FIS/1997/125, FIS/2000/061, FIS/2001/079, FIS/2002/074, FIS/2002/076, FIS/2005/169 and FIS/2006/144
56	Lindner, B. and McLeod, P. (2008)	A review and impact assessment of ACIAR's fruit-fly research partnerships – 1984 to 2007	CS2/1983/043, CS2/1989/019, CS2/1989/020, CS2/1994/003, CS2/1994/115, CS2/1996/225, CS2/1997/101, CS2/1998/005, CS2/2003/036, CP/2007/002, CP/2007/187, PHT/1990/051, PHT/1994/133, PHT/1993/87, CP/1997/079, CP/2001/027 and CP/2002/086
57	Montes N.D., Zapata Jr N.R., Alo A.M.P. and Mullen J.D. (2008)	Management of internal parasites in goats in the Philippines	AS1/1997/133
58	Davis J., Gordon J., Pearce D. and Templeton D. (2008)	Guidelines for assessing the impacts of ACIAR's research activities	

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