

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

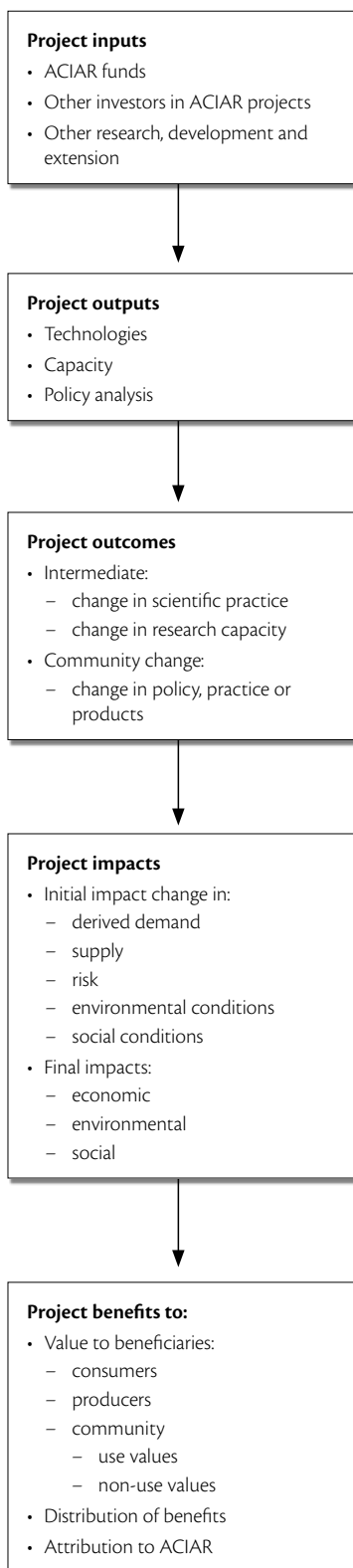
⁷ A subscription is required to access the information, which is available at <ifs.apdi.net>.

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)

RESULTS MAPPING



ISSUES TO CONSIDER IN IA

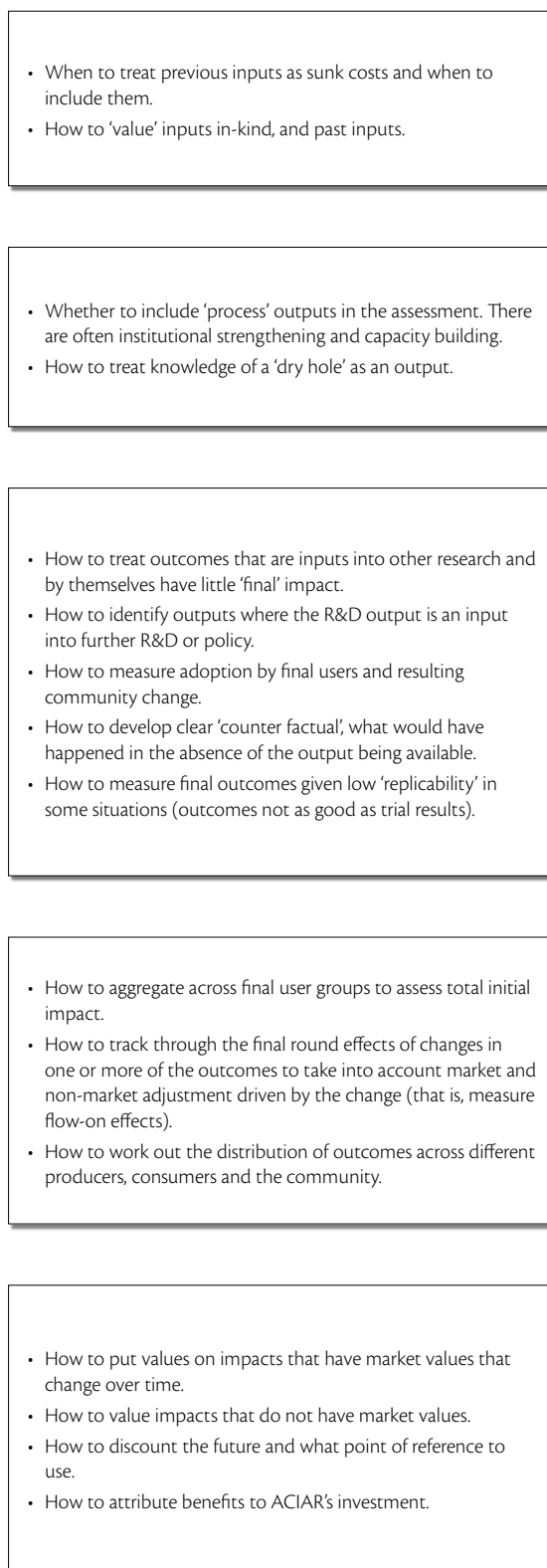


Figure 7. Tracing inputs to benefits

- 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)

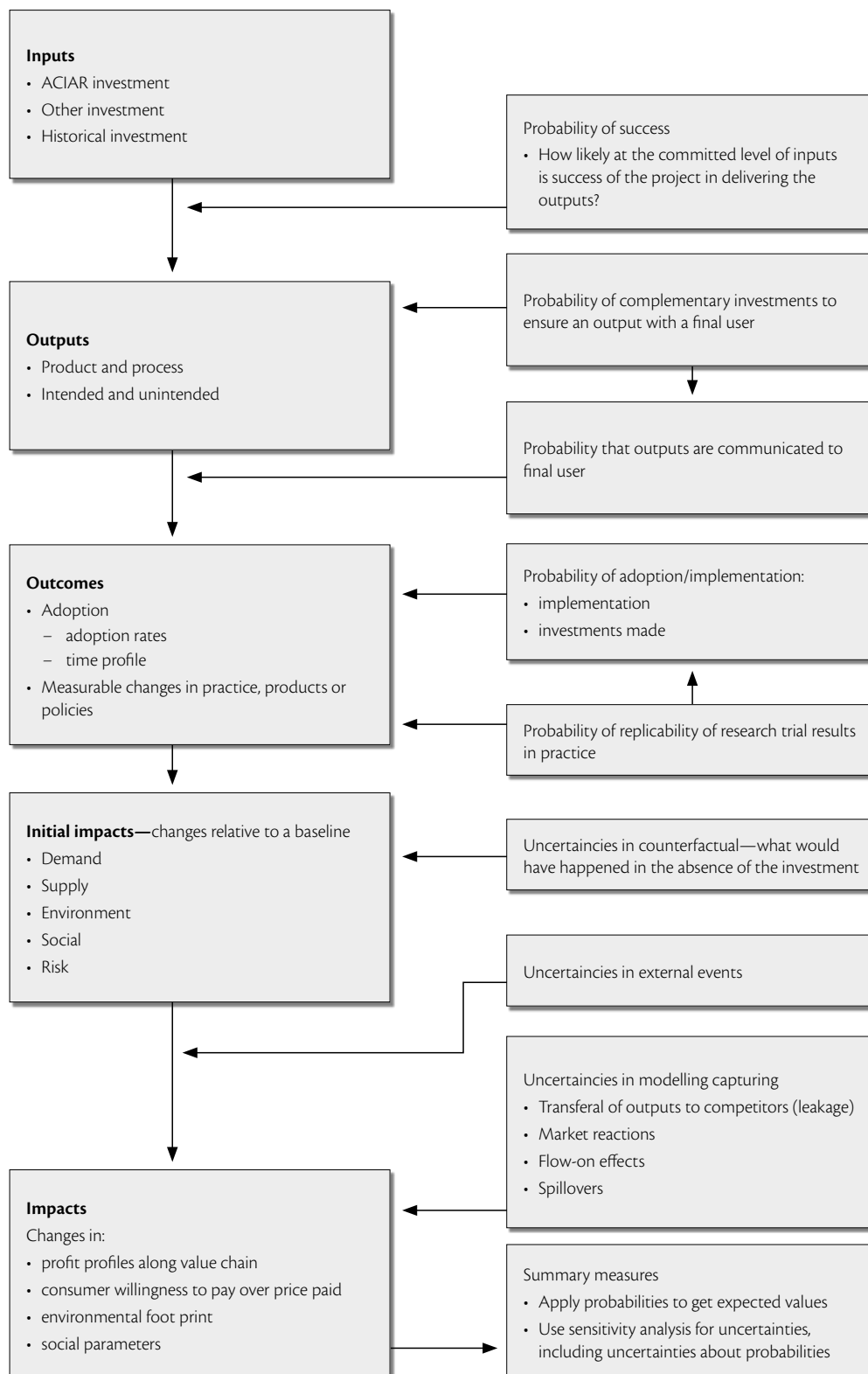


Figure 8. Forecast and uncertainty measurements required for estimating the net benefit of an investment.

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			

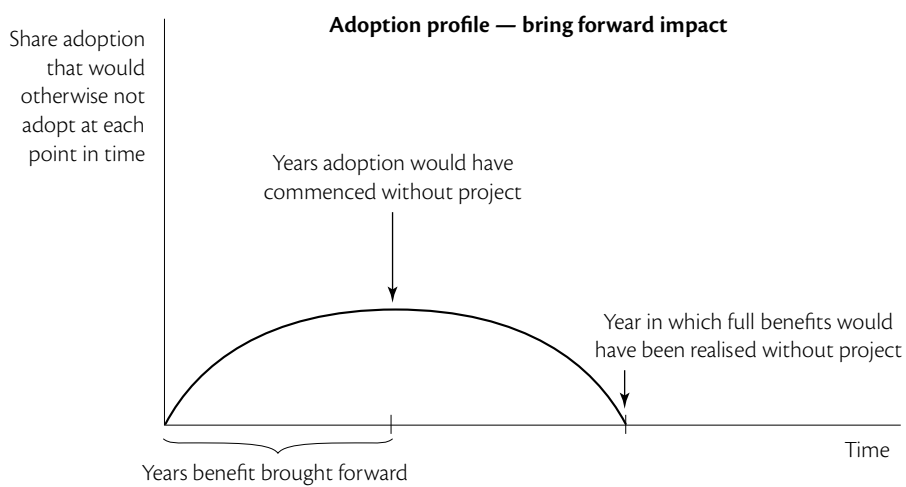
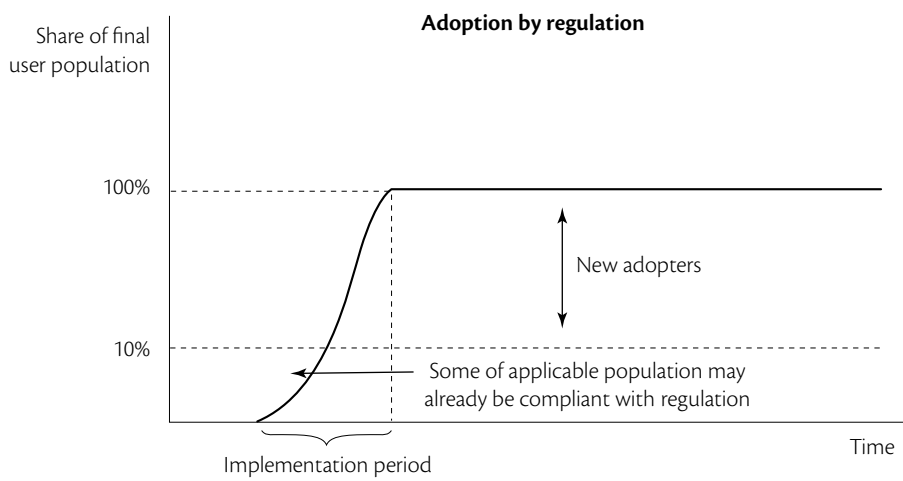
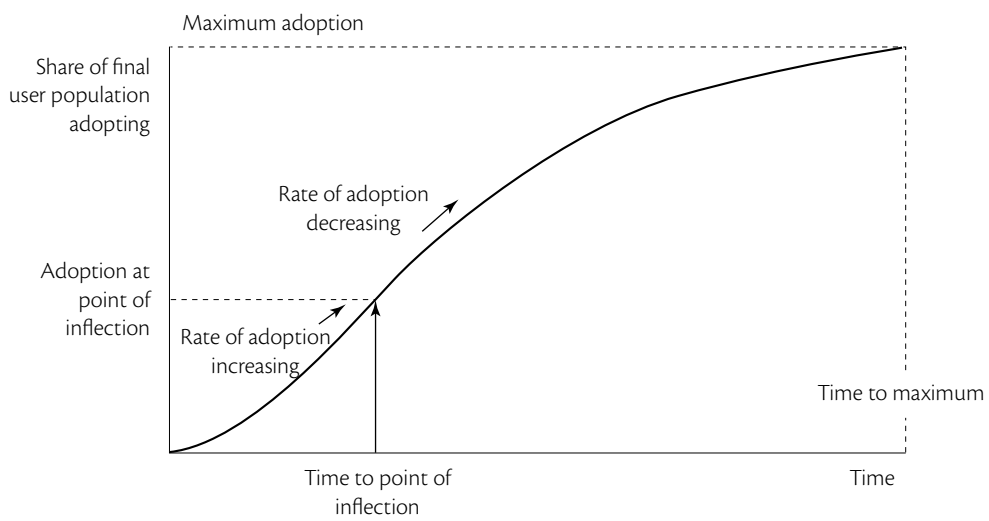


Figure 9. Adoption profiles

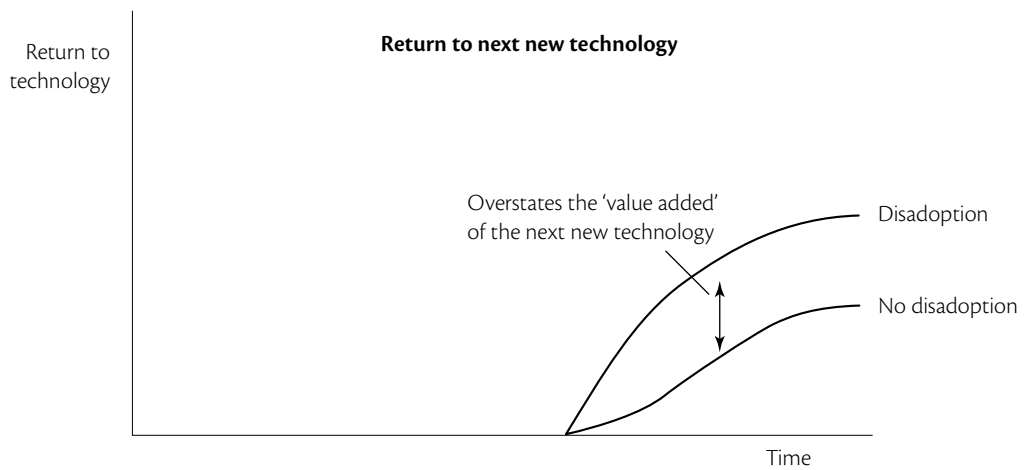
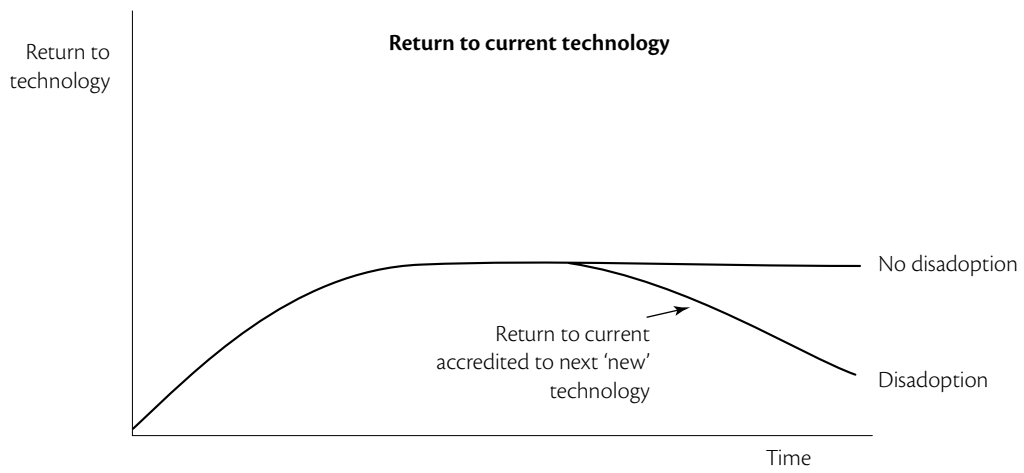
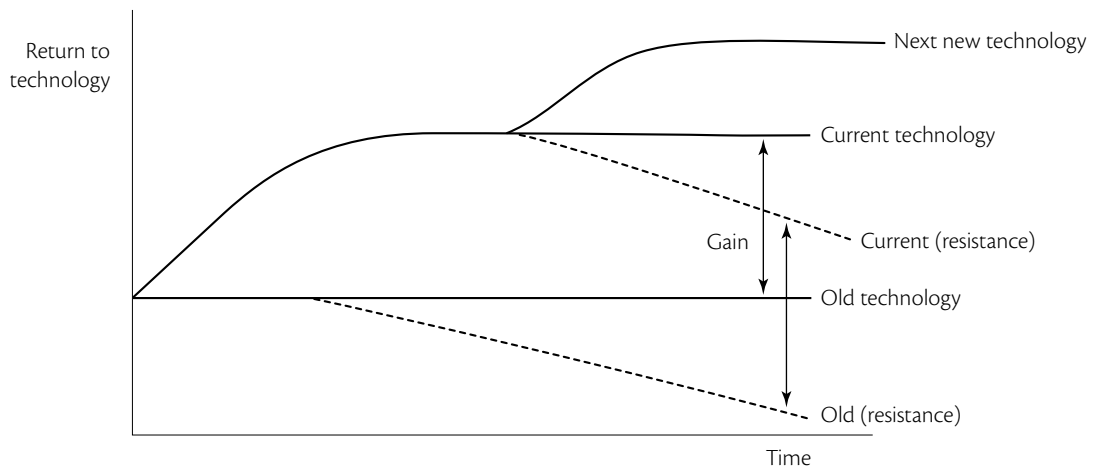


Figure 10. The case against including disadoption as standard practice in impact assessments

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

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

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

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.

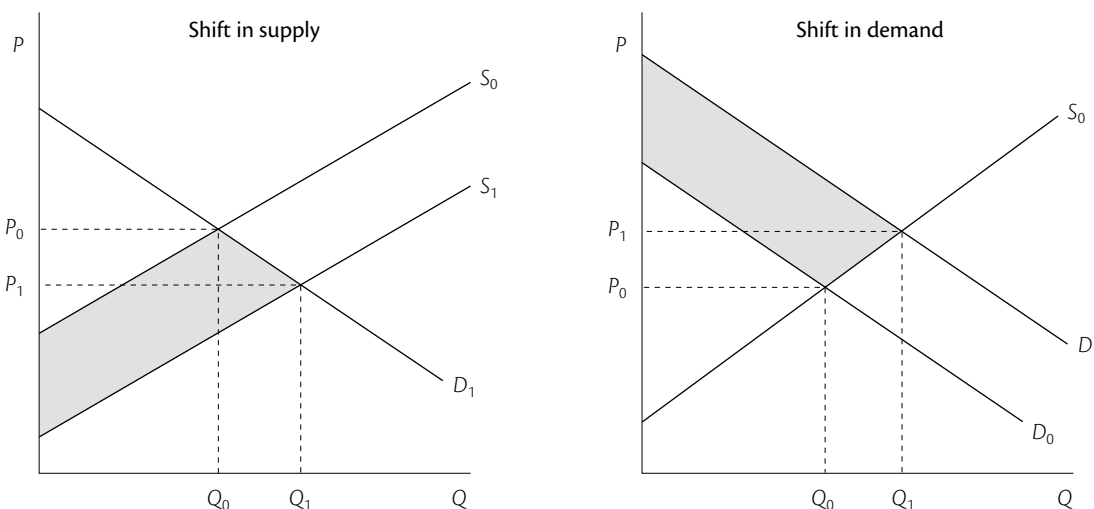


Figure 11. Mapping changes in consumer and producer surplus—a partial equilibrium approach.
Source: Centre for International Economics

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

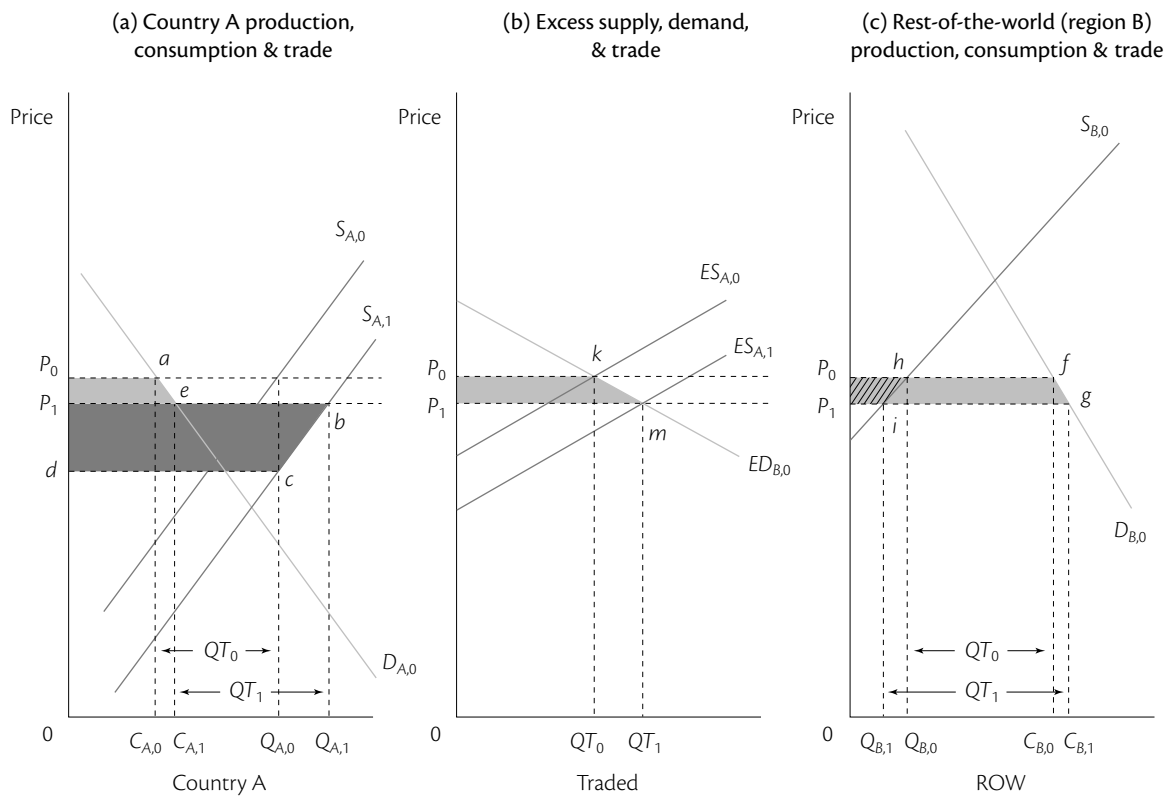


Figure 12. Horizontal market—exporter innovates

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.

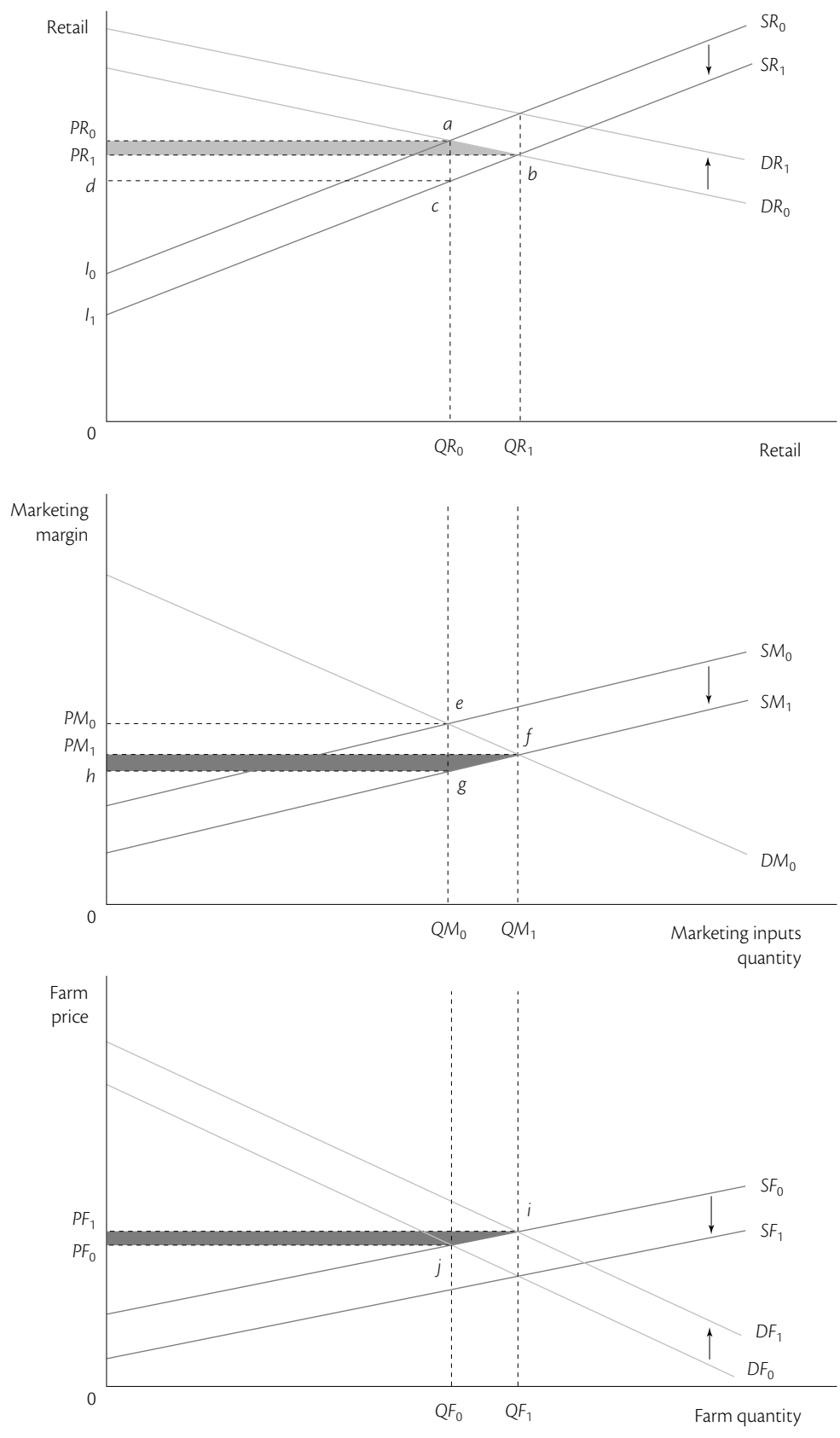


Figure 13. Vertical market

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.

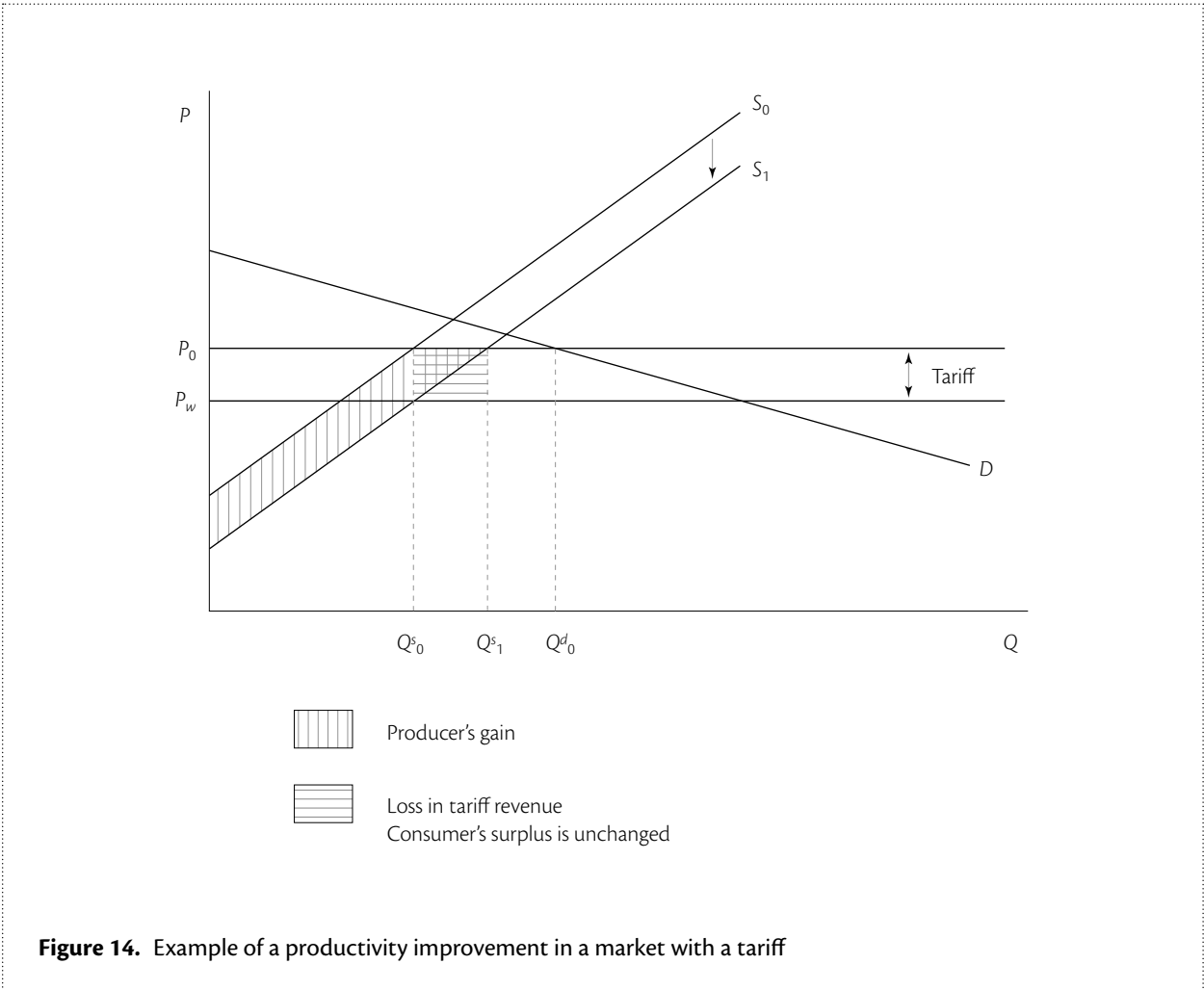
It should be noted, however, that the results of this analysis hold true only when:

- 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



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

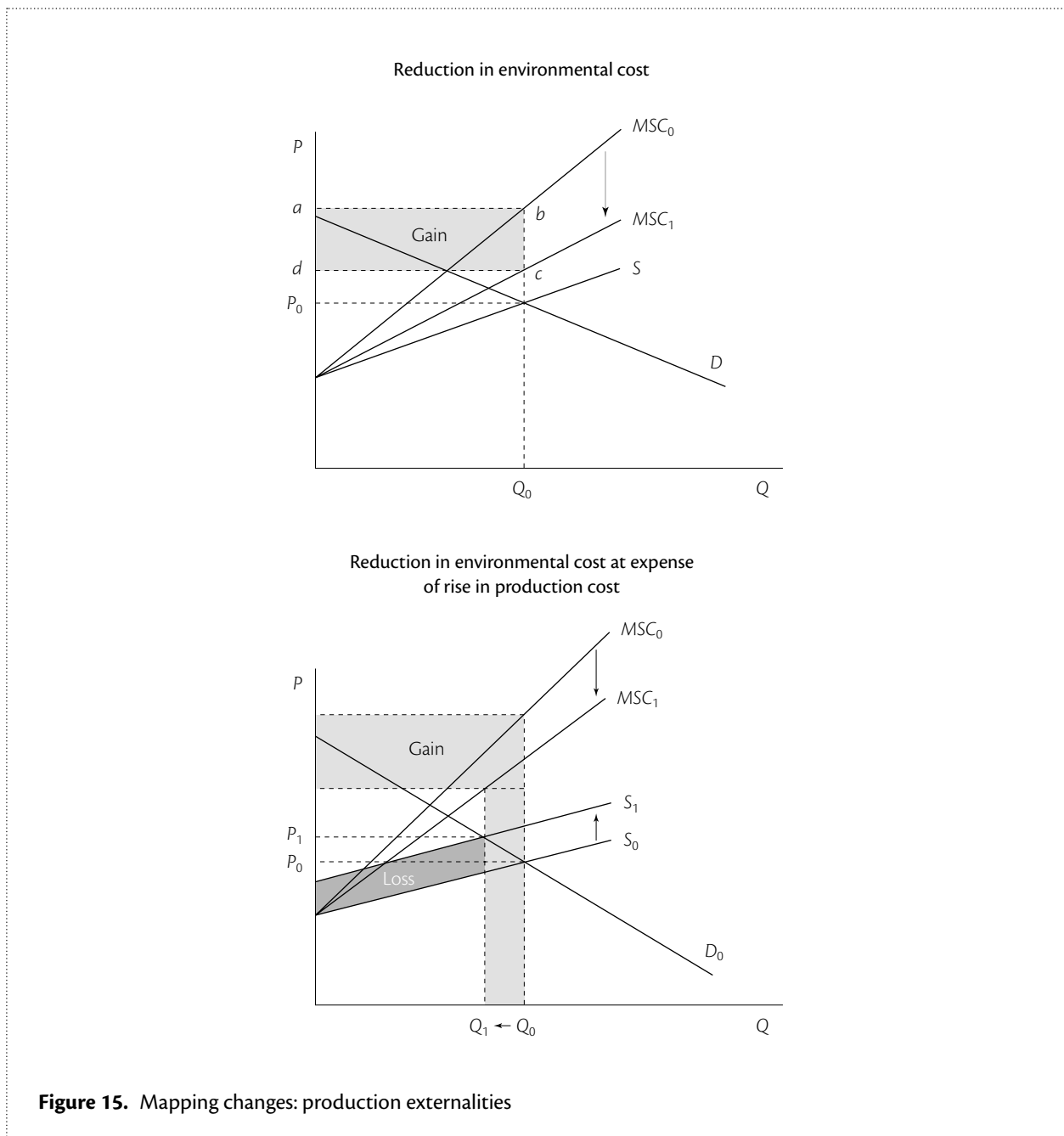


Figure 15. Mapping changes: production externalities

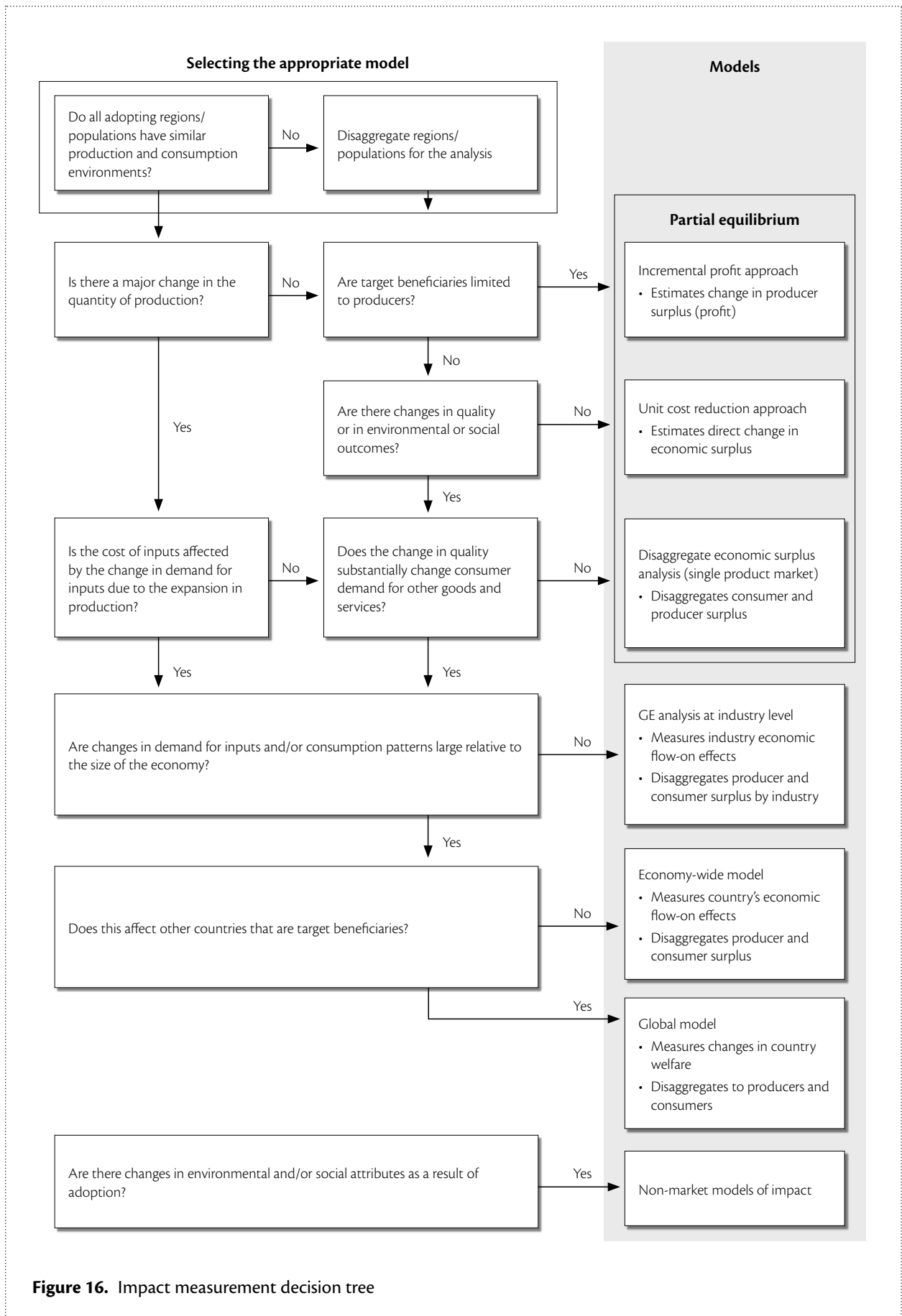


Figure 16. Impact measurement decision tree

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 an 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)

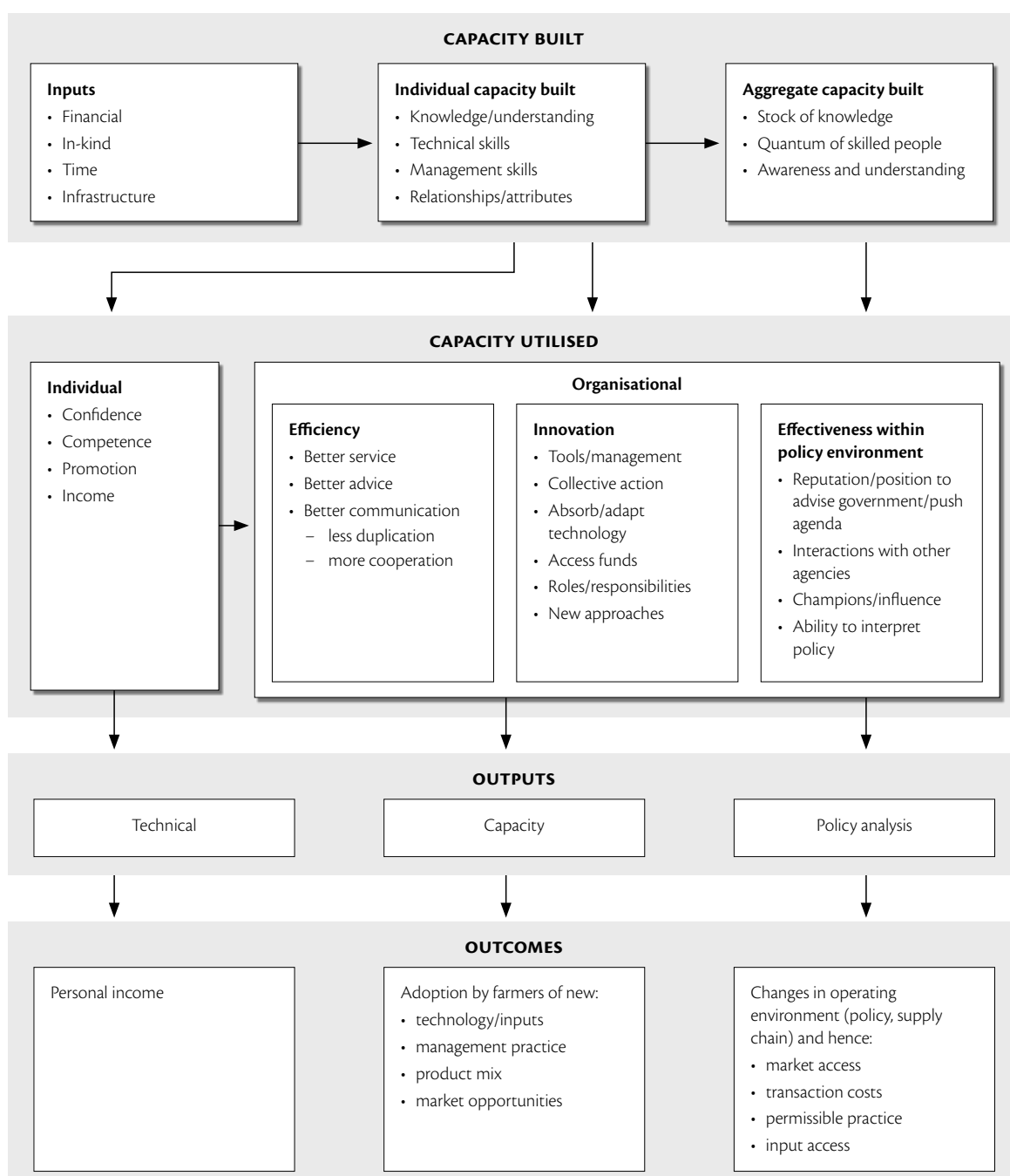


Figure 17. Analytical framework: capacity building impact assessment

- 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.

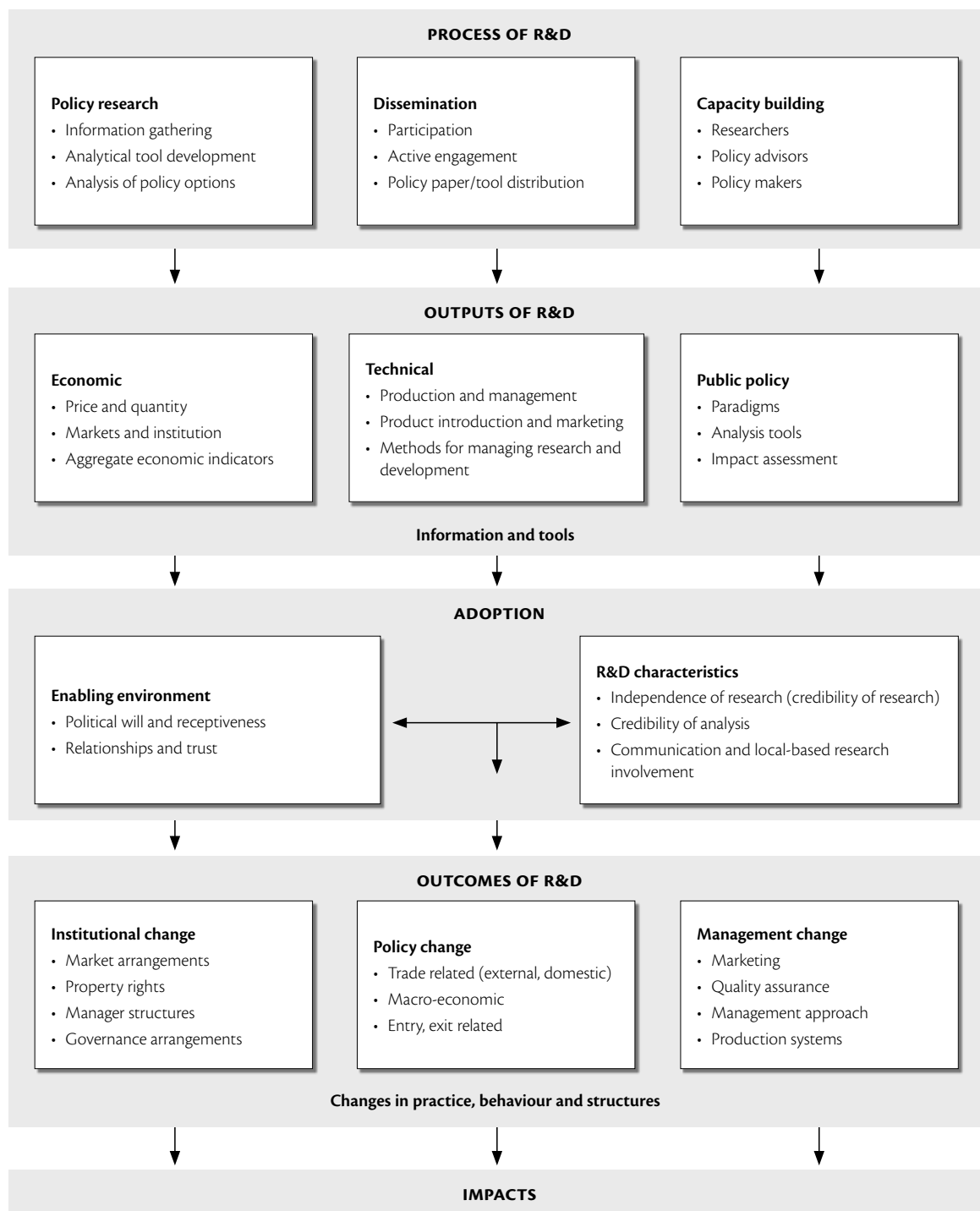


Figure 18. Pathways to impacts from policy research and development (R&D)

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.

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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				
<p>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)</p>					
<p>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)</p>	1				
	2				
	3				
	4				
<p>15. What factors are affecting the adoption of the outputs (positive and negative)? (AS section 3.4)</p>					
<p>16. For up to four of the most important outputs please complete the following information</p>	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?	
<p>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)</p>					

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?	<i>Overall impact</i>	<i>Confidence level</i>
21. Lessons: in your review of the project are there any lessons that will help to improve future ACIAR investments? (AS section 5)		
22. <i>For full impact assessment only:</i> 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	Carp, 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	<i>Review of project—usually part of a program assessment for development purposes</i>
AS	<i>Adoption study</i>
IA	<i>Impact Assessment</i>

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
Capacity built	Sustainability
	Other technology
	Scientific knowledge
	Researcher skills, knowledge and experience
	Organisational attitudes/mindset, structure and purpose
	Research networks, partnerships
	Physical research infrastructure (laboratories etc.)
Policy analysis	Research tools/methodologies (databases, protocols etc.)
	Farmer, extension service skills and knowledge
	Other capacity built
	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 km², 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@aciarc.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						
	<i>Please select most appropriate</i>					
	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						
	<i>Please select most appropriate</i>					
	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						
	<i>Please select most appropriate</i>					
	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						
	<i>Please select most appropriate</i>					
	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						
	<i>Please select most appropriate</i>					
	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						
	<i>Please select most appropriate</i>					
	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						
	<i>Please select most appropriate</i>					
	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. <i>Question on contribution to specific R&D outputs</i>						
e. <i>Question on contribution to specific R&D outputs</i>						

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

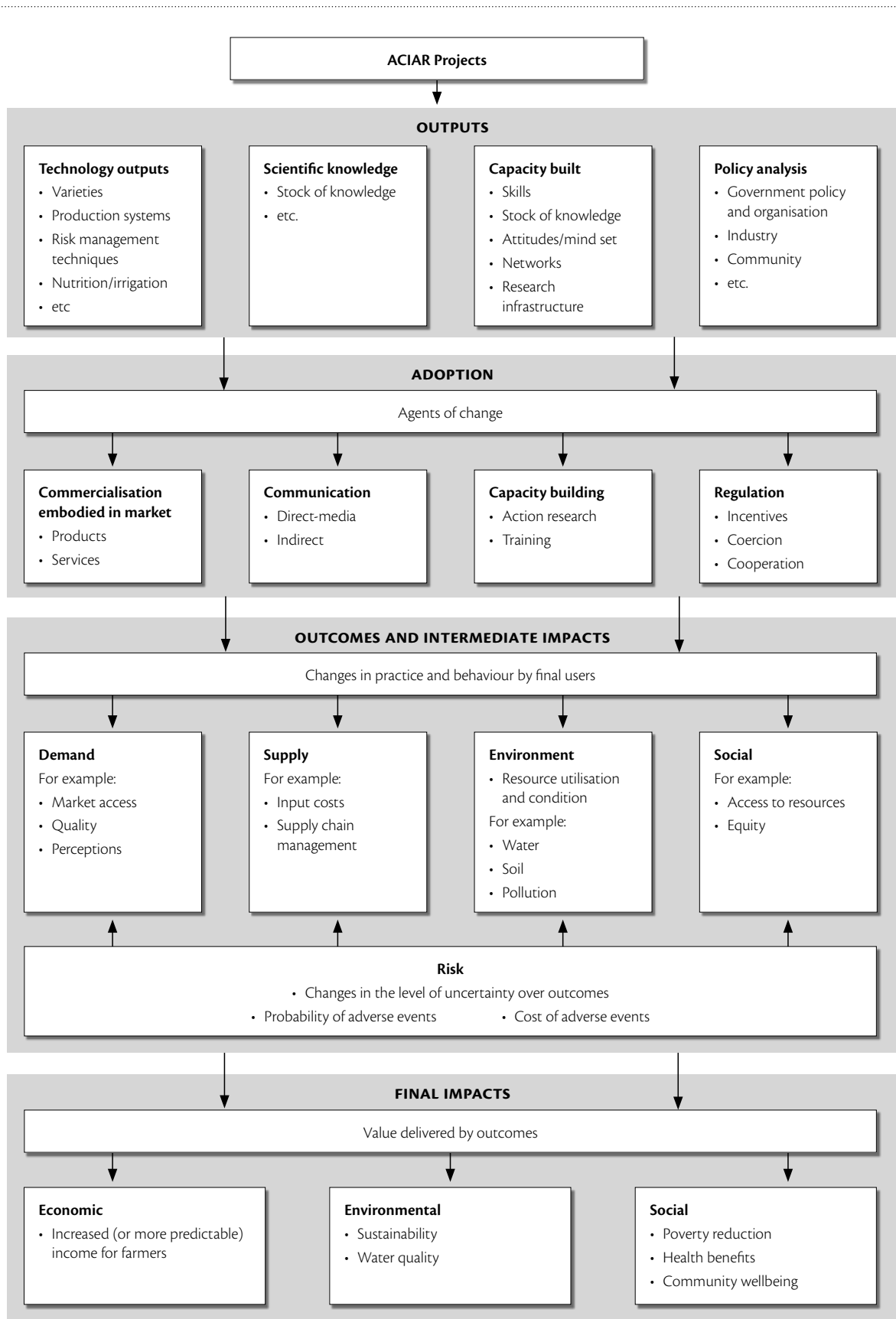


Figure A4.1. ACIAR projects pathways to benefits: generic example

Table A4.1. Exchange rates

		1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
China: Exchange Rates	\$/Yuan	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572
Cambodia: Exchange Rates	\$/Riels	392	392	392	392	392	392	392	392	392	392
China: Exchange Rates	\$/Yuan	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572	2.7572
Fiji: Exchange Rates	\$/Fiji	0.888	0.888	0.888	0.888	0.888	0.888	0.888	0.888	0.888	0.888
India: Exchange Rates	\$/Rupees	5.333	5.333	5.333	5.333	5.333	5.333	5.333	5.333	5.333	7.122
Indonesia: Exchange Rates	\$/Rupiah										
Lao: Exchange Rates	\$/Kip	392	518	896	896	896	896	896	268.8	268.8	268.8
Malaysia: Exchange Rates	\$/Ringgit	3.4286	3.4286	3.4286	3.4286	3.4286	3.4286	3.4286	3.4286	3.4286	3.4286
Nepal: Exchange Rates	\$/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	\$/Kina	1	1	1	1	1	1	1	1	1	1
Philippines: \$/Exchange Rates	\$/Pesos	2.24	2.24	2.24	2.2568	2.2624	4.1752	4.3797	4.3792	4.3783	4.368
Thailand: Exchange Rates	\$/Baht	23.2401	23.5108	23.7105	23.7236	23.5854	23.3857	23.3297	23.296	23.296	23.296
Tonga: Exchange Rates	\$/Pa'anga	1	1	1	1	1	1	1	1	1	1
Vanuatu: Exchange Rates	\$/Vatu	72.4556	85.62307	100.5368	100.5368	100.5368	100.5368	100.5368	100.5368	100.5368	100.5368
Vietnam: Exchange Rates	\$/Dong										
New Zealand: Exchange Rates	\$/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	392	392	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/Paanga	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/Paanga 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	\$/Yuan	2.6087	2.9189	2.9837	3.7365	4.1475	4.0531	3.9184	6.3047	6.1928	6.5095
Cambodia: Exchange Rates	\$/Riels				334.09	560.08	919.45	1832.81	1863.15	1818.35	2055.22
China: Exchange Rates	\$/Yuan	2.6087	2.9189	2.9837	3.7365	4.1475	4.0531	3.9184	6.3047	6.1928	6.5095
Fiji: Exchange Rates	\$/Fiji	0.8724	1.1208	1.1741	1.1564	1.1495	1.1046	1.0485	1.0706	1.0429	1.0985
India: Exchange Rates	\$/Rupees	9.083	10.946	12.84	13.679	17.728	19.057	20.741	22.955	24.052	27.739
Indonesia: Exchange Rates	\$/Rupiah	1152.16	1322.9	1402.28	1440	1519.53	1492.23	1419.28	1581.41	1667.38	1834.15
Lao: Exchange Rates	\$/Kip	132.22	315.23	466.58	552.9	547	526.52	487.13	525.11	597.05	721.09
Malaysia: Exchange Rates	\$/Ringgit	1.7656	2.0557	2.1473	2.1132	2.1425	1.8734	1.7509	1.9189	1.8574	1.9696
Nepal: Exchange Rates	\$/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	\$/Kina	1.57161	1.47416	1.47605	1.34017	1.34833	1.41115	1.50353	1.36288	1.05685	0.9694
Philippines: \$/Exchange Rates	\$/Pesos	14.4152	16.5493	17.2195	19.005	21.4066	18.7698	18.4311	19.3065	19.0655	20.5261
Thailand: Exchange Rates	\$/Baht	18.0267	19.8361	20.3623	19.9867	19.8796	18.6778	17.2204	18.3988	18.4766	19.8428
Tonga: Exchange Rates	\$/Paanga	1.00014	1	0.99957	1.00008	1.00976	0.99009	0.94115	0.96539	0.94237	0.96432
Vanuatu: Exchange Rates	\$/Vatu	76.96729	81.92768	91.78618	91.42316	87.00214	83.31927	82.67015	85.12278	83.1356	87.4505
Vietnam: Exchange Rates	\$/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	\$/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	\$/Yuan	6.1683	5.2108	5.3422	4.821	4.2845	4.5019	5.3957	6.0965	6.2599	6.0059
Cambodia: Exchange Rates	\$/Riels	2182.79	2354.4	2457.45	2235.4	2027.19	2127.96	2591.15	2958	3125.53	3091.2
China: Exchange Rates	\$/Yuan	6.1683	5.2108	5.3422	4.821	4.2845	4.5019	5.3957	6.0965	6.2599	6.0059
Fiji: Exchange Rates	\$/Fiji	1.0728	1.2491	1.271	1.2361	1.1779	1.1882	1.2319	1.2752	1.2914	
India: Exchange Rates	\$/Rupees	26.989	25.933	27.787	26.13	24.422	26.439	30.329	33.368	33.68	34.133
Indonesia: Exchange Rates	\$/Rupiah	2139.91	6275.07	5065.32	4879.91	5306.95	5055.96	5583.72	6578.04	7410.51	6899.76
Lao: Exchange Rates	\$/Kip	925.7	2061.21	4595.07	4582.13	4631.09	5475.42	6887.34	7792.9	8136.88	
Malaysia: Exchange Rates	\$/Ringgit	2.0784	2.469	2.4523	2.2129	1.967	2.0668	2.4772	2.799	2.8928	2.7629
Nepal: Exchange Rates	\$/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	\$/Kina	0.93699	0.77093	0.61096	0.62324	0.57273	0.47413	0.43242	0.42211	0.42218	0.43442
Philippines: \$/Exchange Rates	\$/Pesos	21.7943	25.7116	25.2229	25.6197	26.3933	28.0719	35.3598	41.2785	42.0764	38.6477
Thailand: Exchange Rates	\$/Baht	23.1085	26.0772	24.4027	23.2787	22.9917	23.3586	26.9909	29.6054	30.7116	28.5253
Tonga: Exchange Rates	\$/Pa'anga	0.93874	0.93691	1.03191	1.01979	1.09858	1.194	1.39687	1.45172	1.48373	
Vanuatu: Exchange Rates	\$/Vatu	86.10418	80.17828	83.29526	79.97434	75.20895	75.64252	79.40505	82.2681	83.42897	83.75704
Vietnam: Exchange Rates	\$/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	\$/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

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No.	Author(s) and year of publication	Title	ACIAR project numbers
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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 <i>Phalaris minor</i> 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)	<i>Mama Lus Frut</i> 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

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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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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
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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
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