Impact assessment of capacity building and training: assessment framework and two case studies

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The ATSE Crawford Fund

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

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Foreword

Capacity building and training have long been recognised as an important component of most research-for-development activities. Right from its establishment in 1982, ACIAR placed considerable emphasis on this area, and quickly found that, to ensure longer-term sustainability and impact of the outcomes of the research projects it funded, it was important that all those involved in the projects improved their skills and understanding of all aspects of the research undertaken. In similar recognition of the importance of capacity building, the Australian Academy of Technological Sciences and Engineering (ATSE) established the Crawford Fund in 1987, in part to promote and facilitate training that complemented research activities, in particular those funded by ACIAR.

Impact-assessment studies of the value of agricultural research have been undertaken for many years, and they have established a substantial body of evidence of the very high rates of return from the investment. Despite a widespread recognition that capacity building is crucial for ensuring that effective development-research outcomes are generated and sustained, there have nevertheless been very few attempts to better understand how improved capacity building leads to enhanced research outcomes, or to quantitatively measure the value of this activity. Many of the research impact assessments that have been conducted have implicitly included the benefits from capacity building in the estimates of overall benefits, but even in these cases it is not clear if the studies have taken account of the full impacts of the improved capacity of the research group members.

While the need to quantitatively estimate the benefits of capacity building has sometimes been recognised, very few people have tried to do this. Most have felt that issues such as attribution of benefits and the abstract nature of capacity building make the task of quantifying impacts in monetary terms too difficult. ACIAR and the ATSE Crawford Fund believe that such quantification is highly desirable, both to complement the research impact assessments and, in particular, to give a clearer indication of the potential returns of capacity building relative to those from more readily measurable technical outcomes. Such information would, moreover, help guide decisions about the right levels of resources to devote to capacity building in development-research activities.

Both our organisations felt that it was time to undertake a detailed assessment of the options for more-rigorously estimating the returns to capacity building and training. We therefore commissioned the Centre for International Economics (CIE) to undertake a thorough review of the literature and of the methods that might be adapted for this task. CIE was asked to draw on the results of this review to suggest a framework for analysing the benefits of capacity building and training and, through two case studies, to illustrate how the framework could be implemented.

The results of this review and analysis are described in this report. We are very pleased with the outcome and believe the CIE has taken a significant step forward in providing a framework for quantifying the returns to this important aspect of research. We congratulate Jenny Gordon and her CIE team. We also sincerely thank the steering committee established to provide feedback and ideas to the CIE group. We plan to apply the framework to further case studies during the coming year.

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Contents

Tables

Figures

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

Abbreviations

ACIAR	Australian Centre for International Agricultural Research
AusAID	Australian Agency for International Development
BCA	benefit–cost analysis
BCR	benefit–cost ratio
CGIAR	Consultative Group for International Agricultural Research
CIE	Centre for International Economics
CIMMYT	International Maize and Wheat Improvement Center
CT	conservation tillage
DANIDA	Danish Agency for International Development
EDG	Effective Development Group
ESDPP	extra-short-duration pigeonpea
FAO	Food and Agriculture Organization of the United Nations
FDI	foreign direct investment
GIS	geographical information system(s)
ha	hectare(s)
HPP	hybrid pigeonpea
IAS	Impact Assessment Series (ACIAR)
ICAR	Indian Council for Agricultural Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IGP	Indian Gangetic Plain
IMSOP	irrigation main system operation [model]
IRR	internal rate of return
M&E	monitoring and evaluation
MNE	multinational enterprise
NPV	net present value
OECD	Organisation for Economic Cooperation and Development
R&D	research and development
SDPP	short-duration pigeonpea
TFP	total factor productivity
UQ	University of Queensland
USAID	United States Agency for International Development

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All errors and omissions remain the responsibility of the authors.

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Executive summary

There is wide recognition that capacity building and training are prerequisites to economic and social development (World Bank 2006a), and the development community is estimated to spend US$15 billion per year on capacity development (World Bank 2006b). Nevertheless, most evaluations of capacity building stop well short of attributing benefits to training, mainly going only so far as to claim that the capacity building made a significant contribution to achieving project objectives.

This study was motivated by the lack of evidence to support the strongly held convictions that improving human capacity is inherently valuable and absolutely necessary for the achievement of development objectives.

ACIAR and the Crawford Fund capacity building

The Crawford Fund provides formal and informal training for researchers, agricultural department staff and farmers in developing countries. The Australian Centre for International Agricultural Research (ACIAR) incorporates formal training and learning-by-doing in most of its agricultural research projects, as well as supporting a scholarship program for research scientists.

Pathways from capacity building to impacts

Capacity-building activities contribute to improved economic, environmental and social outcomes through four main pathways.

- Individual human capital raises the productivity and hence the earning capacity of the individual, reflected in higher lifetime income.
- The efficiency of the organisation as it captures part of the returns from the individual improvement in productivity, and due to the echo effect improving the productivity of other workers via complementarity—for example, extension of their learning and adding to the local stock of knowledge. This is reflected in improved levels and/or reduced cost of services or outputs delivered by the organisation to customers.
- Innovation in the organisation as the culture and mindset changes, new and better ways of doing things are introduced and new products and services are developed. This is reflected in the changes in the services or outputs the organisation delivers to customers.
- Effectiveness of the organisation within the policy environment, improving targeting to areas of need, attracting more resources and engaging more effectively on policy, due to the networks and enhanced perceptions of the views of the organisation, as well as its competency. This is reflected in the contribution the organisation makes to the enabling environment for adoption of the organisation's outputs and enhances the value-added of the organisation.

These 'changes in practice or behaviour' reflect capacity used by the individual and the organisation they work for. The potential to utilise capacity depends in part on the capacity that has been built by the training activities. This depends, in turn, on the relevance and quality of the training or other capacity-building activity provided, as well as the degree to which the organisation uses the skills, knowledge, networks and other capacity developed by the activities.

The ultimate beneficiaries, apart from individuals who may receive both financial and intrinsic benefits from the training, are the customers of the organisations. For agricultural research and development (R&D) these customers are primarily the farmers and communities in which they live. Thus, impact is ultimately derived through the delivery of lower-cost and/or better-quality goods and services. Impact can also come through a better enabling environment that enhances farmers' access to resources and markets and allows them to reap the rewards of their own labour.

A framework for evaluating capacity-building activities

The methodology outlined here was developed following an extensive review of the literature on capacity-building evaluation and the impact of educational training. This review found that most evaluation approaches do not measure impact, citing attribution as a key challenge.

The framework described aims to elucidate and substantiate the linkages between the training provided and the intended or observed benefits, thus facilitating the attribution of benefits to specific capacity-building investments.

Mapping to impact

Three types of capacity-building situations are identified, with different implications for the evaluation approach.

- Gap filling—where the activity fills a gap that enables progress to be made towards a broader set of outputs and outcomes. In this case the capacity built may be sufficient to result in a change in practice or behaviour at the organisational level (as set out above).
- Integrated—where the training activities are identified as a component in a broader set of technical or other investments. In this case, the capacity-building activity is usually necessary but not by itself sufficient for the desired change in practice or behaviour.
- Diffuse—where the training activity adds to the stock of human resources but cannot be linked directly with specific change in practice or behaviour. In this case, it is the quantum of capacity built that leads, over time, to changes rather than any one contribution to this capacity.

Measuring impact and benefit

The value of the capacity building depends on the value of the impact resulting from the change in practice and behaviour of organisations. In the case of agricultural R&D, these changes are often:

- new varieties of plants or breeds of animal with specific genetic characteristics that endow them with greater range, higher yields or disease resistance
- better management practices that are more sustainable, resilient, improve yields or lower costs of production
- lower costs of production, transport and marketing due to improvements in the business, regulatory or policy environment resulting from better informed decision-making
- improved food safety or other quality assurances that reduce consumption risks to households, attract premiums or facilitate market access
- more-effective supply-chain management, such as cold-chain integrity, reduced time to market and wider distribution options.

In estimating the impact, the adoption profile and the transferability of trial results to practice must be known. These will depend on the relevance of the outputs to farmers in different regions (or, for policy changes, the regulators) and implementation costs, as well as the farmers' awareness of the option and their capacity to exercise it. The estimation of the benefits arising from these impacts follows normal benefit–cost rules.

Attribution

Once the benefits are estimated, the issue is the share of the benefits that can be attributed to the capacity-building activity. Three broad scenarios have emerged, based on whether the capacity built is sufficient, or necessary but not sufficient, or would have otherwise been achieved over time (or an alternative that would achieve the change in practice or behaviour found). The framework outlines five approaches to attribution and the scenarios under which they are applicable.

Where capacity building is necessary but not sufficient:

1. The cost-share approach apportions the share of the benefits (net of implementation costs) to capacity building based on the share of the expenditure going to the capacity-building activities.

2. The relative-importance approach apportions the share of benefits on the basis of a subjective assessment (triangulated) of the contribution (percentage) of the capacity-building activity to the outputs achieved. This can be used if the training would have been sufficient to get some but not all of the outputs, with an assessment made of how much. It can also be used when the training is necessary but not sufficient, but a strong case must be made as to why the training components were worth more than the other components.

Where capacity building is neither necessary nor sufficient, but improves outcomes:

3. The bring-forward approach is used where the changes would have come about through normal processes, but the investment in capacity building brought forward the changes and hence the impact. The focus of measurement is on the time to impact without the capacity-building activities, compared to the time with.

4. The marginal-gain approach is similar to the bring-forward approach, but applies when the investment in capacity building raised the quality of the changes and hence the magnitude of the impact. The focus of measurement is on the effect that higher quality has on the size of the impact.

Where capacity building alone, given the context, is sufficient:

5. Normal impact assessment should be undertaken, with full attribution to the capacity-building activity. Where this activity filled a gap that was critical to achieving the outcome, and without the activity would not otherwise have been filled, the other investments can be regarded as sunk costs.

The returns to capacity building tend to be highest where training or other capacity building is critical to achieving a change. However, care must be taken not to ignore other investments when it has always been recognised that the capacity-building activity is needed. The impact of a capacity-building activity is the same no matter who funds it. Thus, the argument that someone else would have funded it does not devalue the impact of the activity. It does, however, require caution in treating other investments as sunk costs.

Rules of thumb

Several rules of thumb about the return on training also emerged:

- a worker's lifetime income is higher, on average, by around 10% for each additional year spent in formal education
- the firm captures around half of the benefits of their investment in specific training for their workers, the workers capturing the other half, and the individuals trained around a third
- improvements in human capital explain around 30% of the increase in total factor productivity
- 50% of increases in (agricultural) productivity are due to interstate or international R&D spillovers.

Case-study results

The method was applied to two case studies that demonstrated the value of the capacity-building activities in an integrated context, with the following findings.

- A 3-year postdoctoral fellowship, funded by ACIAR as an integral component of their pigeonpea improvement projects and undertaken in Australia by a plant scientist from ICRISAT, India, resulted in estimated benefits of A$70 million at an estimated cost of A$2.5 million. This evaluation was based on the relative importance of the training activity to achieving the project impacts and expert opinion about the number of years the ACIAR projects brought forward the adoption of improved pigeonpea genotypes.
- A 3-week intensive geographic information systems (GIS) capacity-building exercise, funded by a Crawford Fund award and undertaken in Australia by a Vietnamese GIS specialist, provided estimated benefits of A$82,837 at an estimated cost of A$6,723. This evaluation was based on the cost-share approach because the GIS training was regarded as a vital ingredient in achieving the project impacts of more efficient water usage in irrigation systems. The trainee's enhanced GIS skills enabled the creation of site-specific water management models that played a crucial role in demonstrating to the irrigation companies the benefits of adopting improved operational rules for water management.

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1 Introduction

Capacity building is an integral part of development assistance. It seeks to build the understanding, skills and knowledge base of individuals and institutions in developing countries. The Australian Centre for International Agricultural Research (ACIAR) incorporates formal training and learning-by-doing in most of its agricultural research projects, as well as supporting a scholarship program for research scientists. The Crawford Fund provides formal and informal training for researchers, agricultural department staff and farmers in developing countries. These investments in capacity building are made because of the conviction that building the capacity of individuals, and consequently adding to the local stock of knowledge, is an essential element in improving the productivity of agriculture in the partner countries.

While capacity-building investments are judged as essential, there is little hard evidence to demonstrate how important these investments are. Evaluation of capacity-building activities generally stops at assessing the capacity built (such as skills gained), and only occasionally goes on to measure capacity utilised. While measurement of the impact of capacity building is important for justifying the investment, it is more important for assessing how much to invest in 'human capital' relative to other investments in development assistance.

The complementarity of human capital—defined as the understanding, skills and stock of knowledge applicable to the particular environments of the workers and decision-makers—with investments in research, technology, physical capital and institutional infrastructure, make evaluation of just the capacity-building investment difficult. But knowledge of the relative return on 'people investment' is critical for maximising the return on development assistance provided. To this end, ACIAR and the Crawford Fund have commissioned this study to develop a methodology for evaluating capacity-building investments. This report sets out a framework for evaluating capacity-building investments, and guidelines and tools for use in evaluation. The central tenet of the framework is mapping the pathways from the capacity built to the benefits gained. The guidelines provide methods and measures for evaluating changes along the dominant pathways, and for presenting the results to provide evidence on the return to the capacity-building investment.

The report is structured as follows:

- Part I provides a review of the literature on how investment in individual capacity brings returns for individuals, the organisations they work for and the economy. It reviews the approaches taken to evaluation of capacity-building activities, including evaluations undertaken by ACIAR.
- Part II presents the guidelines for evaluation of capacity-building activities. It develops the evaluation framework, which has an analytical core, a process for implementing the framework and sets of tools for use in the evaluation.
- Part III applies the framework in two case studies:
  - pigeonpea training for International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) scientists as part of a set of ACIAR projects
  - Crawford Fund GIS training that was an input into irrigation-scheme management (an ACIAR project) in Vietnam.

The authors hope that the evaluation framework will be a living document, with the analytical framework updated as new pathways emerge. This framework aims to reflect all possible pathways through which capacity building leads to benefits. It is hoped that, over time, rules of thumb will develop about which pathways are dominant in which context, and the likely magnitude of the causal links between the training investment, capacity built, capacity utilised, impacts and benefits.

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Part I
Literature review

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2 Theory and evidence

Pathways from improved individual capacity to economic growth

Capacity building encompasses training and all other forms of learning that enhance the knowledge, understanding and competencies (skills) of individuals. This chapter examines the theoretical underpinning of the benefits of capacity building. Three main pathways from human capital to economic benefit have been identified in the literature. These are through improved:

- labour productivity of the individuals undertaking training, and the flow-on effects of the training to other individuals
- capital productivity arising from the complementarity between human capital and physical capital as more-capable workers can better adapt to and utilise equipment, machinery and the latest technology. These higher returns to capital also encourage greater investment in capital and enable inward technology transfers
- total factor productivity arising from better management, intra and inter-firm synergies and, over time, higher rates of innovation and improvements in the enabling environment.

The first pathway is the best documented as it is the easiest to track in terms of returns to workers in higher lifetime incomes. Firms also capture some of the value of higher labour productivity. Similarly, workers can capture some of the value of higher capital productivity in higher wages. However, estimating the impact of human capital on capital productivity is more difficult as new capital typically embodies new technology, and so attribution to the human capital driver of capital productivity is complex. The final pathway—through total factor productivity—has many routes. It is thought to be the most important pathway, but is the hardest to track empirically.

The cumulative impact of building-up the stock of human capital, like the stock of knowledge and that of physical capital, is also important in development. The impact is potentially even greater, in that human capital is better able to alter the 'enabling environment'. This refers to the prevailing political and economic environment, and to aspects of 'good governance', the latter requiring 'good institutions' such as, for example, the rule of law and the protection of property rights. These institutions encourage investment in human and physical capital and make possible more-effective decision-making and more-efficient policy implementation. Capacity building of individuals contributes directly and indirectly to 'institutional strengthening'. This, in turn, supports economic growth in a virtuous cycle.

Figure 1 depicts the different pathways through which improved individual capacity has the potential to value-add to the individual, firm and national economic wellbeing. This chapter summarises the empirical work that has been undertaken in trying to measure the impact through each of these pathways. It also presents estimates of the overall impact of human capital investment on economic growth.

Higher education levels and participation in training also augment the social wellbeing of individuals in ways that economic growth measures fail to pick up, because some impacts cannot be bought and sold via a market. These non-market impacts include health, 'child quality', lower fertility rates, more-efficient consumer choices and lower crime rates. Recent work that attempts to provide quantitative estimates of these impacts is also discussed.

To round off this examination of the literature on the impacts of capacity building, we provide a brief overview of the evidence supporting the positive impact of capacity-building activities on agricultural productivity, and the contribution made to economic growth by increases in agricultural productivity and R&D.

Evidence on increased productivity of labour

Standard economic theory concludes that, in perfect markets, factors of production are employed up to the point where the price of the last unit used is equal to the value of the additional output produced as a result of hiring that unit. This implies that workers' wages are determined by the value of their marginal product. Wage increases over time for workers performing the same function are justified only if worker productivity increases. The main sources of productivity improvement are on-the-job and formal training.

Returns to individuals

Education and training have long been seen as an important pathway to improving wages.

A number of economists have recognised the contribution made to individual productivity by education of various sorts. The following section provides an overview of empirical studies in this area.

Drawing on work by Mincer (1958) on education and personal income distribution, returns to the person undertaking the training are conventionally measured in terms of observed income increments associated with a further year of education. Most studies assume that the return to schooling is independent of the level of schooling and that the only costs of schooling are foregone earnings. Mincer, however, observed a strong correlation between the time spent in education and personal income. This supported his contention that individuals make a rational choice to postpone current potential earnings in order to enhance their skills and therefore maximise life-long income. This implies that occupations requiring more training attract higher salaries.

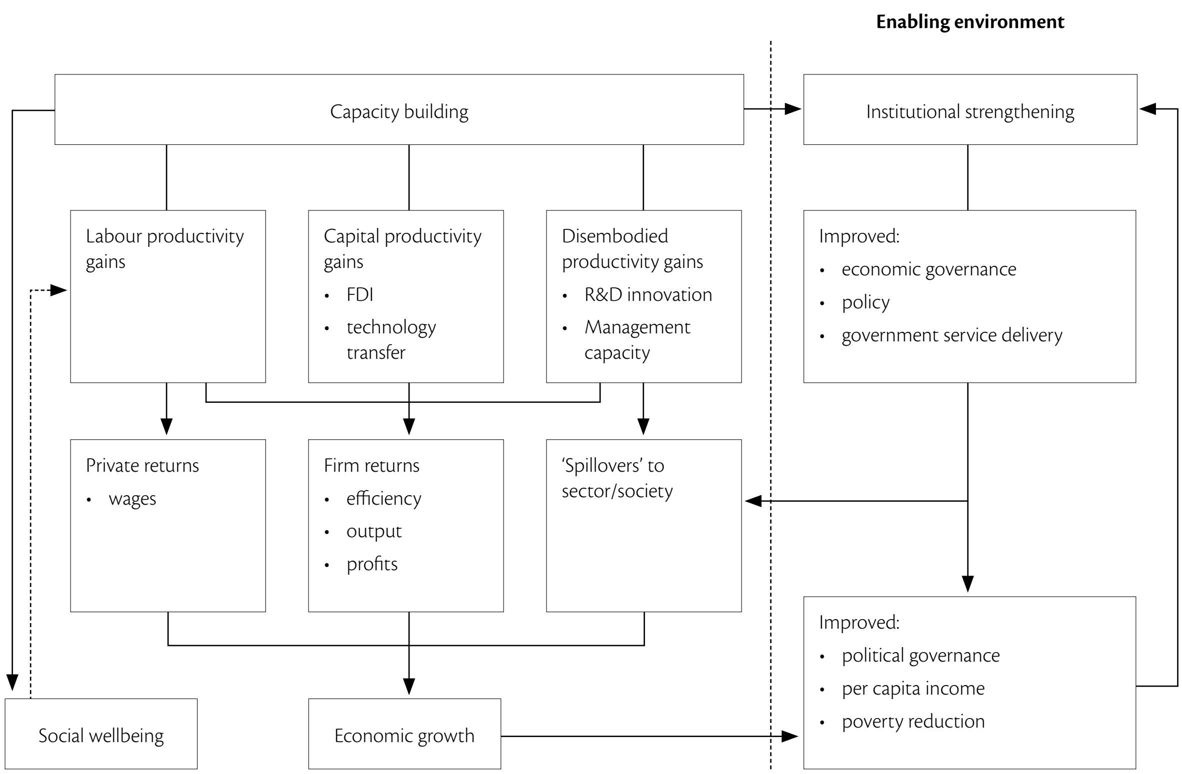

Figure 1. Overview of the benefits of capacity building

Becker (1962) observed that most investments in human capital, regardless of their particular form (school, university, vocational training, on-the-job training etc.), raise earnings at older ages and lower them at younger ages. He therefore argued that human capacity should be measured in terms of the sum of all activities that build capacity, and that the amount invested in human capacity and its rate of return can be estimated on the basis of earnings information alone. An important implication of this paper was that some people may earn more than others with similar ability, simply because they invest more in themselves.

Numerous studies have estimated the returns of education to the individual. Summaries of a few of them follow.

- Griliches and Mason (1972) used variables including scores on a mental ability test, indicators of parental status, region of residence while growing up, and school years completed before, during and after military service. In this way, they inquired into the separate effects of parental background, intelligence and schooling on a sample of 1964 US military veterans. They estimated that an additional year of schooling would add about 4.6% to income in their sample. They noted, however, that the results could not be taken as representative of all males due to the selectivity inherent in being a veteran and given the nature of their sample of relatively young males (under 35 years).
- Angrist and Krueger (1991) estimated that the additional year of schooling undertaken by US students compelled by law to attend school until age 17, earned wages 7.5% higher than students in other states where the legal school-leaving age was 16.
- Ashenfelter and Krueger (1994) used a sample of identical twins with different schooling levels to determine the returns, in terms of increased wages, to an additional year of schooling. They estimated that the return to each year of schooling was 12–16% higher wage rates. This is nearly double estimates in the earlier literature and is the result of an adjustment made to take into consideration measurement error that they found led to an underestimation of the returns to schooling.
- Using data from a 1988 survey of Chinese individuals, Johnson and Chow (1997) estimated that rates of return to schooling in China were 4.02% in rural areas and 3.29% in urban areas. The return to schooling for females was significantly higher than that for males in urban areas. Also, the returns to members of the Communist Party in urban areas were significantly lower than those to non-members. One reason for the relatively low estimates, compared with similar estimates in other countries, could be that the monetary return received by Chinese wage earners excludes 'off-market' transactions that result from seniority or relationships that additionally benefit workers.
- Ashenfelter and Rouse (1998) developed a model of optimal schooling using a sample of 700 identical twins. They estimated that the average hourly wage for this group is higher by 9% for each additional year of schooling. In addition, they found slightly higher returns to schooling for less-able individuals, a finding contrary to earlier studies. These results imply that individuals with more ability attain more schooling because they face lower marginal costs of schooling, not due to higher marginal benefits.

Psacharopoulos and Patrinos (2004) provide the most recent international cross-country evidence on individual returns to education. They estimated that the average rate of return to an additional year of schooling across 98 countries was approximately 10% (see Figure 2). Average returns to schooling are highest in sub-Saharan Africa, Latin America and the Caribbean region. Returns are lower in the OECD countries, while the non-OECD European, Middle Eastern and North African group of countries has the lowest average returns.

This estimated private return to schooling of 10% is also supported by a recent study (Leigh and Ryan 2005) using Australian data. This study compared three different approaches: instrumenting schooling using month of birth; instrumenting schooling using changes in compulsory schooling laws; and comparing outcomes for twins.

The returns gained by individuals from investing in their own professional development in terms of increased wages omit potential benefits to the employer (producer surplus) resulting from the increased human capital of employees.

Returns to firms from labour productivity

The returns to firms from higher labour productivity originate from two sources. The first source is the capacity of the firm to capture the surplus generated by workers (that is, paying workers less than their average product). In a competitive market for labour, this capacity is limited, as firms compete for more productive workers, which drives up wages. The second source of returns to firms arises from capturing the productivity gains from the transfer of knowledge, contribution to the local stock of knowledge, skills and attitudes to other workers, and other sources of human capital 'spillovers' within the firm.

Although Marshall (1890) recognised that social interactions among workers create learning opportunities that enhance productivity, until recently there had been few empirical investigations into the magnitude of these human capital spillovers.

Ballot et al. (2002) investigated the effects of training and R&D on wages and productivity at the firm level in France and Sweden. They estimated that returns to training for the individual were 13.1% in France and 6.1% in Sweden, whereas the estimated returns to the firm (productivity) for investments in training were 17.3% in France and 7.3% in Sweden. French workers obtain 30% of the returns to training and Swedish workers about 35%. The firm therefore obtains the larger returns to investments in training, although the gains to workers are also substantial. An additional finding of note is that training has a larger positive impact on productivity if the firm accumulates R&D capital and, conversely, R&D has a larger impact on productivity if the firm accumulates human capital.

Deardon et al. (2005) investigated the impact of training on labour productivity in British industries between 1983 and 1996 for training, productivity and wages. The study found that a 1 percentage point increase (from the average of 10–11%) in the proportion of workers trained in an industry was associated with an increase in value added per worker of about 0.6%. The associated increase in wages was about 0.3%, implying that the standard approach of using wages (individual return only) as a measure of productivity underestimates the return to training by a factor of half.

Returns to individuals from work-related training can therefore be seen as a lower-bound measure of the value of productivity increases. The results of the latter study (Deardon et al. 2005) also suggest that industry-level analysis captures spillover effects attributable to training activities that are missed in firm-level studies.

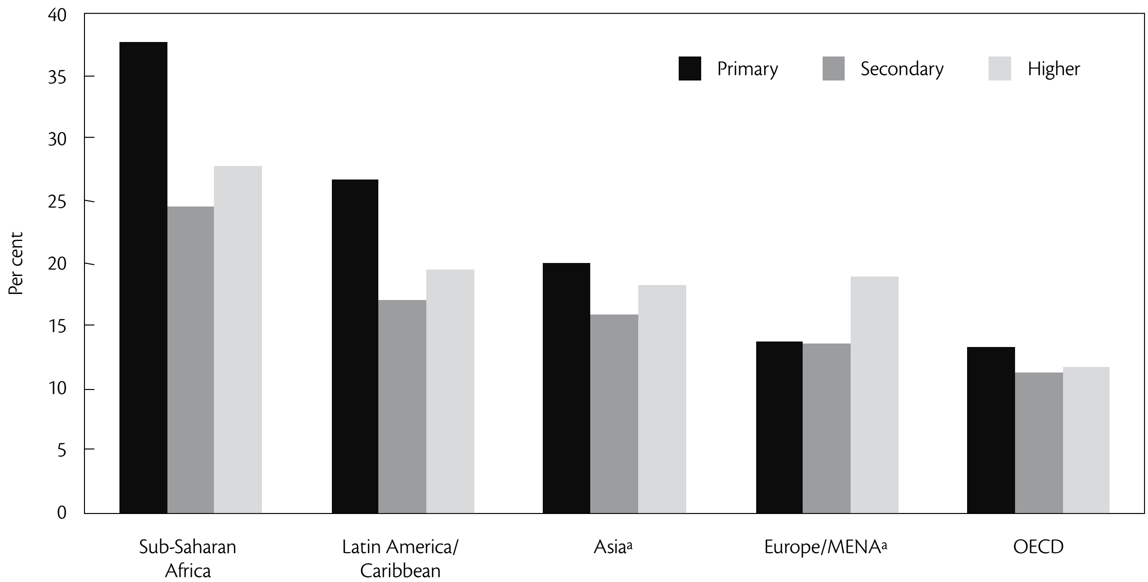

Figure 2 Individual returns to investment in education, by level, latest year, regional averages. Data source: Psacharopoulos and Patrinos (2004). [a] Non-OECD countries

Improving the productivity of capital

Human capital and physical capital are often complementary. Where physical capital embodies new technology it may not be accessible without sufficient human capital, so the investment in the workers pays off quickly through higher capital as well as labour productivity. As new capital often embodies new technology, there is also a potential impact as better-skilled workers attract new capital investment in an industry. Evidence on these pathways is examined below.

Human capital and the adoption of new technology

Nelson and Phelps (1966) applied the principle that education enhances one's ability to receive, decode and understand information in order to rank jobs according to the degree to which they require adaptation to change. They used this classification to test the hypothesis that, since educated people make good innovators, education speeds the process of technological diffusion. They suggested that farmers with higher education levels are better able to understand and evaluate information on new products and processes, and they therefore more rapidly adopt those innovations assessed to be beneficial. This implies that education results in spillovers through the agency of innovation showing the way to imitators, which would increase the total social benefit resulting from higher levels of education. The paper concluded that simply inserting an index of educational attainment into the production function could result in a gross mis-specification of the relationship between education and economic growth.

Benhabib and Spiegel (1994) developed a model in which human capital influenced total factor productivity (TFP) rather than treating human capital as a production factor, and found that human capital affects economic growth through two mechanisms. First, with reference to Romer (1990a), human-capital levels directly influence the rate of domestically produced technological innovation. Second, with reference to Nelson and Phelps (1966), the stock of human capacity affects the speed of adoption of technology from abroad.

The role of human capital in promoting investment

Human capital is generally assumed to have played a key role in attracting investment, but few cross-country studies have been carried out to identify the determinants of investment in developing countries.

Easterlin (1981) hypothesised that education is necessary for the uptake of new technologies in developing countries, and consequently facilitating economic growth. This is supported by the OECD Development Centre's stated belief in a 'virtuous circle' of human capital formation, inward foreign direct investment (FDI) and technology transfers. The OECD working paper (Miyamoto 2003) provides evidence that enterprise training by multinational enterprises (MNEs) in developing countries is an important channel of inward technology transfer for domestic firms, since the technology may transfer to these domestic firms via training spillovers.

The paper outlines four routes to training spillovers:

1. Vertical linkages

- Training provided by MNEs to domestic suppliers or purchasers.
  - The auto industry in Mexico grew rapidly in the 1980s due to foreign car manufacturers locating there. More than 300 domestic suppliers of car parts emerged in 5 years and spillovers appear to have occurred through the provision of shop-floor training, quality-control training, weekly meetings and technical assistance (UNCTAD 2000; Lim 2001).

2. Horizontal linkages

- Gaining skills through region-wide skills-development institutions supported by MNEs.
  - The Malaysian MNE-government partnership collaboratively established two state-run skills-development centres in states facing severe skilled-labour shortages, in order to provide training in technical manufacturing, managerial skills and further education, primarily to workers in domestic firms.

3. Labour turnovers and spin-offs

- MNE-trained workers or managers transfer knowledge to domestic employers or use the acquired skills to start-up new firms.
  - The enterprise training provided by Siemens India Limited consists of 3-year apprenticeships for 140 young, entry-level workers, who rotate periodically through different divisions. Half of the apprentices stay on at Siemens, while the other half are employed in large- and small-scale domestic industries or start-up their own firms (Daguar 1997).

4. Improved capacity of domestic firms to absorb new technologies

- Efforts made by host developing countries to improve their absorptive capacity also help skills transfers.
  - The results of a study based on an enterprise survey in Indonesia demonstrated that domestic firms' R&D and human resource development expenditures were important determinants of technology spillovers (Todo and Miyamoto 2002).

Studies by Root and Ahmed (1979), Schneider and Frey (1985), Hanson (1996) and Narula (1996), investigating the period between the 1960s and 1980s, found no statistical significance of human capital proxies with regard to the ability to attract FDI. This is consistent with earlier FDI in developing countries being focused on accessing cheap labour and/or abundant natural resources. Skilled labour was therefore less crucial during this period.

In contrast, analyses by Noorbakhsh et al. (2001) and Nunnenkamp (2002), focusing on the 1980s to mid-1990s, found that the levels of both the stock and flow of human capital had statistically significant and positive effects on FDI inflows. This is consistent with more recent FDI into developing countries coming from high value-added manufacturing firms, for example, requiring highly skilled labour.

Zhang (2001) supports the above conclusions, citing the example of Singapore, which successfully attracted considerable FDI in hi-tech industries by developing a highly skilled workforce. Other recent studies by international organisations—the World Bank's World Business Environment Survey (World Bank 2001), for example—further support the hypothesis that the quality of human resources is an important decision-making criterion for MNEs.

Country-specific studies on the impacts of increased human capital attracting FDI are few and far between, limited to investigations in a few Asian countries. Broadman and Sun (1997) and Coughlin and Segev (2000) concluded that adult literacy was a key determinant for geographic determinants of FDI in China in the early 1990s. Mody et al. (1998) found that labour quality had a strong impact on expected investments by Japanese MNEs in China, India, Indonesia, Malaysia, the Philippines, Thailand and Vietnam.

The information is limited at this level, but the general conclusion is that human capital is essential for attracting FDI. There is no clear consensus, however, on the minimum level or type of human capital that is most effective in this respect.

Total factor productivity and innovation

A dynamic effect of capacity building is the impact on innovation in management and organisation, and in technical know-how. This can arise from changes in attitudes and the environment that promotes innovation, as well as from recognition of the importance of human skills and knowledge in conducting R&D. Evidence on these areas is discussed below.

Capacity and innovation

Texeira and Fortuna (2003) concluded that human capital and indigenous innovation played a very important role in Portugal's economic growth from 1960 to 2001. They found that a 1% increase in average schooling led to a 0.42% increase in productivity. Also, a 1% increase in the internal stock of knowledge—measured by the real accumulated expenditures on firms' R&D depreciated at a rate of 5% per year—tended to increase productivity by 0.3%. Human capital also plays a role in innovation, as does the policy and economic (enabling) environment. A 1% increase in innovation absorption capability was found to lead to 0.4% rise in productivity. This also highlights the significant role played by R&D investments in the context of productivity gains.

Human capital contribution to R&D and innovation

Human capital is a critical input to the innovation process via R&D. Nelson and Phelps (1966) studied the complementarity between R&D and human capital. Their approach attributed human capital a greater role than as simply another factor in growth accounting because it facilitates innovation, and technology adoption and diffusion. Using cross-country data, Benhabib and Spiegel (1994) found that countries that invest in human capital development are better positioned to identify new opportunities and to develop and adopt new technologies. Boskin and Lau (1996) and Redding (1996) investigated the relationship between investments in human capital and R&D and found them to be strategic complements. Not only do investments in human capital increase the level of firms' R&D (and hence their choice of technology) but furthermore the level of firms' R&D also increases incentives for firms to invest in human capital. Redding's analysis suggested that this interrelationship is an important determinant of economic growth.

The contribution of R&D

Griliches and Lichtenberg (1983) examined the relationship between TFP growth and R&D intensity using detailed data for 193 US manufacturing industries. They disaggregated R&D activities into 'own product R&D', 'own process R&D' and 'imported R&D from other industries' in order to distinguish between, respectively, within-firm, intra-industry and inter-industry effects. The reported results imply that all three types of R&D contribute to industry's measured TFP growth rate. Own-product R&D performed within an industry appeared to have less of an effect than either own-process R&D or imported R&D.

Using 1958–1963 data from a sample of 883 large (1,000 or more employees) US manufacturing companies, Griliches (1986) found a consistent and positive relationship between company productivity and its investments in R&D. The results implied an average gross excess rate of return to investment in R&D of 27%. The paper reported that the stock of R&D capital—measured as the firms' total accumulated R&D expenditures, depreciated annually by 15%—contributes significantly to the observed differences in firm productivity. The gross rate of return to investment in R&D ranged from 51% in 1967, up to 62% in 1972 and back down to 33% in 1977. Differentiating between basic and applied R&D activities, the results implied a premium for basic over applied R&D activities of 5 to 1. Of interest also is the finding that privately financed R&D has a premium of 50–180% over publicly funded R&D in terms of its effects on returns to the firm. One explanation for this striking difference is that government, the broader industry and the public capture much of the returns to public R&D contracted out to the private sector. This implies that the results obtained from this study account for only spillovers within the firm and fail to capture spillovers to the wider industry. Finally, to distinguish between spillovers within the individual firm and to the industry as a whole, Griliches grouped the firms into their specific industries. The only result substantially affected by this modification to the model was the returns to the firm from investments in basic research. These results suggest that 50% of the estimated effect of basic research on individual firm productivity was the result of spillovers that diffuse throughout the industry.

A detailed literature review and critique of the rates of return to research was recently published by the UK Department for International Development (DFID 2004). Its key findings and recommendations included that:

- there is a robust positive relationship between spending on R&D and the return on investment, and this return is higher than that on machines and equipment
- the social return to R&D (30% in advanced economies) is significantly higher than the private return, suggesting a clear role for the public sector since R&D is likely to be under-funded if left to the market
- research and extension in agriculture yields consistently high rates of return, whether for extension and research separately or combined, whether for farm-level observations or for aggregated farm production data and whether for all crops or individual crops
- rates of return to agricultural R&D are significantly higher than rates of return to education in developing countries, but the two are likely to be interdependent.

Cluster economies and human capital

Moretti (2004) assessed the magnitude of human capital spillovers at the community level. He found that a 1 percentage point increase in the supply of college graduates in an area raised the wages of high-school dropouts by 1.9%, of high-school graduates by 1.6% and of college graduates by 0.4%. The effect was larger for less-educated groups, resulting from the increased derived demand for services resulting from higher disposable incomes. However, an increase in the supply of college graduates also increased the wages for college graduates. A conventional demand and supply model would predict this to have a dampening effect on wages, suggesting that there are some cluster economies or spillovers to higher levels of human capital investment. The view that spillovers are related to the amount of interactions between workers in different industries is supported by Moretti's results. Manufacturing plants were found to benefit more from human capital in industries that are geographically and economically 'close' to manufacturing than from human capital in industries that are geographically close but economically 'far'.

All of the above direct and indirect impacts of raising human capacity in an economy contribute jointly to overall economic growth.

Economic growth

There is a large body of economic literature focusing on the contribution of schooling to aggregate economic growth, measured by national income or GDP. Capacity building of individuals contributes to economic growth via the channels described above, as well as through various other indirect impacts, such as improved health and fertility rate.

- Solow (1956) explained economic growth in terms of the growth in the labour force (hours and people) and the growth in physical capital stock (investment less depreciation). Over a 40-year period, he found that output per hour per person in the USA had approximately doubled. He attributed only one-eighth of this rise to increased physical capital for each hour worked per person. The residual—the unexplained portion of growth—was ascribed to growth in technology and improvements in the quality of labour.
- Schultz (1961) observed that the income of the USA had been increasing at a much higher rate than the combined amount of land, hours worked per person and physical capital used to produce income, and that this difference had grown during preceding decades. Adopting the notion of quality of labour and applying it to rapidly increasing wages, Schultz postulated that the unexplained large increase in real earnings represented a return to investments in human capacity, such as in increased levels of schooling. As human capacity rises, the marginal product of labour increases and this is rewarded by growth in wages for workers. Schultz estimated that at least 30% of this increase in national income was attributable to a return to education in the labour force.
- Bowman and Anderson (1963) hypothesised that economic growth was connected to human capital and the results of their analysis suggested that a literacy rate of 30–40% was a precondition for rapid economic growth.
- Jorgenson and Griliches (1967) studied perceived upward biases in the measurement of TFP and found that educational improvements in the US labour force accounted for more than 30% of TFP.
- Krueger (1968) estimated that differences between the human capital stocks of less-developed countries and the USA accounted for more than half of the disparity in per capita incomes.
- Easterlin (1981) linked the establishment of formal schooling on a mass scale with subsequent economic development, via an examination of the economic history of the world's 25 largest nations.
- Lucas (1988) argued that human capital externalities, in the form of learning spillovers, could explain the long-run income differences between rich and poor countries. More recently, other economists have tried to estimate the size of spillovers from education by comparing the wages of otherwise similar individuals in cities/states with different average levels of education.

- Azariadis and Drazen (1990) augmented the neoclassical model of economic growth with spillovers from the stocks of different types of capital and the labour-augmenting outcomes of externalities arising in the process of creating human capital. They found that a high ratio of human investment to per-capita income is necessary for rapid economic growth. They postulated that this was due to a threshold level of human capital required before positive educational externalities and increases in production possibilities can be achieved. They also point to the increasing social returns from the accumulation of human capital.
- Barro (1991) used a cross-section of 98 countries and school enrolment rates as a proxy for human capital stock. He concluded that a 1% higher enrolment rate in primary and secondary education in 1960 contributed approximately 0.025% and 0.03%, respectively, to the average annual rate of a country's economic growth from 1960 to 1985.
- Romer (1990b) developed a growth model in which technological change is driven by intentional investment decisions (making it an endogenous variable, rather than exogenous as previously assumed). He concluded that the stock of human capital determines the rate of growth.
- Mankiw et al. (1992) incorporated human capital accumulation (school enrolment rate) into the Solow growth model as a separate input to production. Their regressions suggested that human capital growth through education contributes about one-third of economic growth.

Social wellbeing

Many of the social benefits associated with raising human capital cannot be bought or sold in a market and hence will not be reflected in income-based measures. Mingat and Tan (1996) highlight the flaws in empirical evidence (see Psacharopoulos (1994) and Psacharopoulos and Patrinos (2004)) that calculates the social returns as private returns minus the public costs of subsidising education. Arguing that aggregate growth performance captures to a significant degree the various spillovers from education, they estimated new values of the social returns to education, using countries' economic performance during 1960–1985 and initial enrolment ratios. Enrolment ratios are defined as the number of pupils enrolled at a given level of education relative to the population in the age group officially corresponding to that level. Taking into consideration the countries' differing economic contexts, the results suggested that low-income countries benefited most from investments to expand primary education, with a full rate of return of 47% at this level. Middle-income country investments to expand secondary education brought the highest overall returns at 52%. In high-income countries, expanding tertiary education yielded the best full returns at 20%. Of significance also was the finding that expanding higher education in low-income countries had relatively poor social returns. This suggests that the capacity to utilise technology and add value to capital investments requires a substantial level of primary education, and only after this is achieved does higher level education add considerable further value.

Haveman and Wolfe (2002) updated their previous results and a number of other studies that attempted to assess the non-market effects of schooling. They compiled a catalogue of impacts of schooling. Twenty pathways via which schooling has an impact were identified, including:

- a positive link between parents' schooling and the schooling of their children
- a positive association between schooling and own health, as well as the health status of family members
- a positive relationship between own education and the efficiency of choices made, such as consumer choices (which has positive effects on wellbeing similar to those of money income)
- a relationship between own schooling and fertility choices (in particular, decisions of female teenage children about non-marital child-bearing)
- a relationship between neighbourhood schooling/social capital and youth decisions about their level of schooling, non-marital child-bearing and participation in criminal activities.

They used willingness-to-pay techniques to estimate the real welfare impacts of schooling, concluding that the standard estimates of the benefits of schooling measured on the basis of observed wage differences understate the true value to individuals. A sample of the estimates of non-market impacts that they arrived at is shown in Table 1.

Haveman and Wolfe (2002) also refer to evidence supporting the positive relationships reported between education and health and fertility in developing countries. A conservative estimate of the value of non-labour market impacts would therefore be equal to estimates of the earnings-based effects of one more year of schooling (US$2,000–4,000). This implies that the full social return to education could be at least twice the private economic rates of return estimated by traditional estimates.

Although Venniker (2003) concluded that the available empirical evidence on the social returns to education is scarce and inconclusive, he conceded that recent theoretical and empirical research does provide some support for human capital externalities.

The enabling environment

A commonly held definition of the enabling environment focuses on the extent to which government policies, laws and regulations set the rules of the game for business, and influence positively or negatively the performance of markets, the incentive to invest and the cost of business operations (DFID 2004). As such, the enabling environment plays a key role in determining individuals' behaviour and firms' performance and, ultimately, the value-added achievable from increasing human capital.

North (1990, p. 3) describes institutions as 'the rules of the game in a society … humanly devised constraints that shape human interaction [and] structure incentives in human exchange, whether political, social or economic'. Basic and necessary 'good institutions' are generally considered to include the rule of law and the protection of property rights, and it is this aspect of institutional strengthening that can be influenced by increasing human capacity to enable increased effectiveness of government policy-making and implementation. It is for this reason that institutional strengthening within government is the companion objective of individual capacity building and an integral part of all development assistance programs.

A recent FAO Regional Conference for Asia and the Pacific (FAO 2004) concluded that investment prospects in agriculture could be enhanced by actions to improve the enabling environment. By increasing the likelihood and scope for complementary private investments, such actions would increase the success of public investments. The report points to a number of important factors affecting the enabling environment for agricultural investment, including:

- poorly devised policies that reduce incentives to exploit comparative advantages and lead to misallocation of resources

Table 1. Selected estimates of the social impact of additional schooling

Non-market impact	Selected estimated values[a]
Cognitive development of children	$350 family income for high-school diploma versus no diploma $440 family income for some college versus high-school diploma
Consumption efficiency	$290 in household income for an additional year of schooling
Own health	$8,950 in increased net family assets for an additional year of schooling
Reduction in criminal activity	$170 reduction in per-capita expenditure on police for an additional mean year of schooling in community.

[a] 1996 US$.

Source: Haveman and Wolfe (2002, p. 72)

- price interventions that fail to correct market failures and often add to them (such as interventions to reduce market risk, offset market power on the part of one player and monopolistic practices)
- high transportation costs due to poor-quality roads and infrastructure, tolls and transport-related taxes that reduce profitability and the incentive to invest
- unpredictable policy regimes, opaque business procedures, non-accountability of public decision-making, and unbalanced and inefficient regulatory regimes that create an unattractive investment climate.

Cumulative investments in human capacity to analyse, develop and implement policies, as well as to change incentives to do so, are an important source of benefits. They are, however, difficult to attribute to specific capacity-building activities.

Evidence for agriculture

Agricultural productivity

A much-cited monograph by Jamison and Lau (1982) provides strong evidence that agricultural productivity is positively correlated with the level of education of the farmer. They found that 4 years of education for farmers translates into a nearly 10% increase in physical agricultural output. Chou and Lau (1987) carried out a similar study in Thailand, estimating that one additional year of schooling adds about 10% to farm output.

The basic linkages connecting agriculture and overall economic growth have long been recognised and form the core of modern development theory and practice. Lewis (1954) emphasised the direct contribution made by agriculture to economic growth, in that increased agricultural productivity provides the non-agricultural sector with labour. Johnston and Mellor (1961) highlighted indirect contributions to economic growth made by agricultural development. These linkages are based on the agricultural sector supplying raw materials to industry, food for industrial workers, markets for industrial output and exports to earn foreign currency for the import of machinery and equipment.

Since the 1970s, there are many studies that have investigated the empirical value of these linkages. Timmer (2005) reports that almost all of these studies estimate an 'agricultural multiplier' significantly greater than one. In Africa, this multiplier is often estimated between 2 and 3 due to the relatively closed economies found in rural Africa.

Research conducted in Asia by Bell et al. (1982) and Hazell and Ramaswamy (1991) produced estimates that every additional $1 of farm income leads to a further $0.80 in non-farm income. Similar studies have also been carried out in Africa. Block and Timmer (1994) concluded that multipliers from agricultural growth are three times as large as multipliers for non-agricultural growth. Hazell and Hojjati (1995) found that every $1 of additional farm income in Zambia created a further $1.50 of income outside the agricultural sector. Delgado et al. (1998) estimated that every additional $1 of farm income led to a further income in other parts of the economy of $0.96 in Niger and $1.88 in Burkina Faso.

Mellor (1976) drew attention to the crucial link between agricultural growth and poverty reduction. More recently, Ravallion and Chen (2004) reported that nearly all of the remarkable reduction in poverty in China between 1980 and 2001 resulted from agricultural growth. They found that growth in urban industrial and service sectors had very little impact in this respect.

The externalities from rural growth outlined above make a strong case in support of significant public funding in agricultural research. It must be noted, however, that investments in agricultural R&D funds compete for funding with other sectors or public expenditure. It is therefore important to establish clear economic justifications for their utilisation.

Agricultural R&D

Timmer (2005) points out that no country has successfully transformed its agricultural sector and established strong rural–urban links to economic growth without sharply improving the level of technology used on its farms. From the 'agricultural revolution' in 18th century England that fuelled the first Industrial Revolution, to the 'green revolution' that stimulated Asia's 'economic miracle', new crop and livestock technologies have raised yields and generated rapid growth in TFP in rural areas. Noting that the skills and financial infrastructure needed to develop the modern science behind crop and livestock technologies and apply it to agricultural problems are unavailable in many poor countries, Timmer emphasises the importance of supporting basic research in international research centres as a global public good. Reinforcing this recommendation, the report cites historic rates of return on such investments that have typically been three to four times the opportunity cost of capital.

Hayami and Ruttan (1985) highlight the importance of adaptive research in national research centres that translates the basic agricultural science from the international centres into locally adapted plants and animals.

Pardey and Beintema (2001) argued that the accumulated stock of scientific knowledge provides a more meaningful measure of a country's technological capacity compared with the amount of investment in current research and innovative activity. On the premise that the stock of scientific knowledge accumulates over time as a result of research activities continuously adding to it, they developed money measures to quantify the stocks of knowledge, based on a discounted accumulation of research spending from 1850 for the USA and from 1900 for Africa. In the USA, for every $100 of agricultural output in 1995 there was a $1,100 stock of knowledge to draw upon. In Africa, the stock of scientific knowledge in 1995 was actually less than the agricultural output that year. The ratio of the US knowledge stock relative to US agricultural output in 1995 was more than 14:1. The authors argued that the stock of knowledge generated domestically is critical to raising returns and emphasised the need to raise current levels of investment in this sector in Africa, alongside developing the necessary policy and infrastructure to accelerate the rate of knowledge accumulation. The authors maintained that developing local capacity to carry forward findings would increase local innovative capacities and enhance the ability of African science to tap discoveries made elsewhere.

Alston et al. (2000) collected 292 generally descriptive studies on the rate of return to investment in agricultural R&D since 1953 and subjected the assemblage to systematic, quantitative scrutiny. An overall average return of 65% per year was calculated for the 1,128 observations and subsequently used in the regression. The estimated annual rates of return averaged 80% for research alone, 80% for extension alone and 47% for the two combined. The key findings of the analysis were as follows:

- There was no evidence to support the view that the rates of return have fallen over time.
- Rates of returns may be higher when research is conducted in more developed countries.
- Longer production cycles were associated with lower rates of return, and natural resource management research generally had a lower rate of return than other categories, whereas crop research had a higher rate.
- Lower rates of return were found for studies that combined both research and extension than for studies evaluating research only.
- The scope of the research and the time lags chosen had important systematic effects on the estimated rates of return.

In addition, it was found that the characteristics of the measures and the analyst conducting the evaluation affected the rates of return reported, suggesting caution in interpretation.

In a later paper, Alston (2002) reported that interstate or international R&D spillovers across geopolitical boundaries might account for half or more of agricultural productivity growth. He also maintained that international technology spillovers and multinational impacts of technologies from international centres were important elements in the total picture of agricultural development in the 20th century. This assertion is similar to the Griliches (1986) results for intra-industry spillovers cited earlier, that 50% of the estimated effect of basic research on individual firm productivity was the result of spillovers that diffuse throughout the industry.

A DFID (2004) report into the linkages between agriculture, economic growth and poverty reduction emphasised that technology is central to accelerating agricultural growth.[1] The recommendations of the report pertaining to the role of agriculture in reducing poverty included:

1 Articles in the international journals *Nature* and *Science* (cited in IRRI (2003)) have called for more funding of rice research, pointing to the continuing importance of international agricultural research centres (IARCs) in generating and sustaining future advances in agricultural technology for the developing world and that the budgets of many IARCs and national counterparts have declined sharply in real terms over the past decade.

- research plans must be developed for specific contexts, with promotion of adaptation and adoption factored in from the beginning, and should reflect agriculture's expected role in growth and poverty reduction, as well as considering the implications of longer-term trends, such as climate change
- research resources should focus on locations and markets where there is potential for improved productivity and strong links to the wider economy, in particular on food staples
- attention should be placed on employment-generating technologies, making better use of water and tackling soil fertility.

The role of education and agricultural extension in the adoption of new technology

Similar to the studies into the role of farmer education in increasing agricultural productivity cited above, Feder et al. (1985) report the well-documented strong correlation between farmers' level of education and the adoption of new technology.

Of course, no level of education will increase adoption alone, especially if information about the new technologies is not widely disseminated. This points to the role of extension in building capacity.

Consistent with the arguments by Nelson and Phelps (1966) cited above, Hiebert (1974) found that the probability of adoption increases as the stock of information pertaining to modern production increases, through extension efforts, for example.

Doss (2003) found that a number of other factors in addition to farmers' level of education influence rates of adoption of new technology. These included farmers' wealth, the costs inherent in adopting the technology, and its suitability to farm size and type. He pointed out that a well-educated farmer may fully understand the potential benefits of adopting new technology, but reject adoption because he believes that the limitations of his own circumstances render these benefits unavailable to him'.

Coutts et al. (2005) emphasised the capacity-building nature of agricultural extension activities, in that 'extension education in all its forms is seen as providing support and input into the ongoing learning, adaptive management or continuous learning process needed to build human and social capital'. The impact is more far-reaching than self-sufficiency. Industry and community members are better able to interact with external bodies in order to achieve their further information and learning needs.

Some rules of thumb

While the empirical evidence is very patchy on most of the pathways from capacity building to benefits, some very tentative rules of thumb emerge.

- A worker's lifetime income is higher, on average, by around 10% for each additional year spent in formal education.
- The firm captures around half of the benefits of their investment in specific training for their workers, the workers capturing the other half, and the individuals trained around a third.
- Improvements in human capital explain around 30% of the increase in total factor productivity.
- Some 50% of increases in (agricultural) productivity can be attributed to interstate or international R&D spillovers.

These rules of thumb need better evidence to be confirmed, but are a starting point for estimating the benefits that flow from investments in human capital. One concern with their application is that they reflect averages across countries, time and the type of capacity-building investment. Thus, they are at best indicative values of what could be expected on average for more specific investments. The next chapter looks at the approaches to evaluation.

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

3 A review of evaluation methods

Introduction

This chapter provides an overview of approaches that have been used in evaluating capacity-building investments. Many of the published evaluations have been undertaken by development agencies to assess the returns on their capacity-building activities. ACIAR undertakes a series of evaluations of their projects each year, and some have considered the capacity-building component of the work, but impact estimates generally treat this as part of the total project. Even the most recent reports, such as that published in 2005 by the World Bank Operations Evaluation Department, acknowledge the lack of an established knowledge base and guidance for evaluating capacity-building activities comparable to that in place for other aspects of the Bank's work. The World Bank (2005) concludes 'capacity building lacks a fully articulated framework for assessing capacity needs, designing and sequencing appropriate interventions and determining results'.

Capacity building in context—what is being evaluated?

Capacity can be defined as the 'ability of individuals, organisations and societies to perform functions, solve problems and set and achieve objectives' (UNDP 2006). This definition can be applied to individuals and organisations. Training and other forms of capacity building are usually designed to enhance the capacity of individuals. Institutional strengthening is usually applied to building the capacity of organisations and institutions (distribution of functions, management structures, relationship flows, resource allocation mechanisms, rules and procedures, and so on). While the focus of this study is on capacity building of individuals the outcome depends critically on the institutional framework in which they work. Individuals need opportunities and incentives to apply their capacity, as well as opportunities and incentives to invest in further building their capacity (enhancement of capacity). Thus, any analysis of the impact of capacity-building activities requires an analysis of the institutional environment in which the individual(s) operate. This is relatively easy to do when the capacity building is part of a specific project, or when it is highly targeted with clear objectives in mind. It is more difficult to do in situations where the transmission mechanisms are indirect. This intersect is the factor that makes evaluation of capacity-building activities difficult.

Figure 3 sets out the challenge for evaluation of capacity-building activities. The three columns in the chart reflect the three tasks identified by the World Bank study.

Assessing the needs follows from desired impacts

Assessing the needs requires clearly articulating the intended impacts of the capacity building. It is reflected in the middle column of Figure 3. Capacity building is not about the accumulation of knowledge and skills for their own sake, but about how they will be used and the changes that will result.

Designing the activity to meet the needs

Designing the activity requires knowing the changes in capacity needed, in order to identify the target participants and ensure that the context is fully taken into account, so that the changes in capacity can lead to the desired impacts. Sequencing refers to other activities that need to occur in order to achieve the intended impacts. The types of issues to be considered in the design phase are reflected in the first column of Figure 3.

Determining the results—evaluation of impact

The evaluation of results is reflected in the final column of Figure 3. The levels of results reflect the assessment of needs and the design questions. The results can be evaluated at the following levels:

- quality of output
- capacity built
- capacity utilised
- impact of capacity utilised
- net benefits of the capacity building (and other associated activities, and hence attribution to the capacity-building component).

Evaluation of capacity-building activities ideally investigates all these levels of results. However, the causal links between each level tend to be more difficult to demonstrate as we move from the output quality to the net benefits. This is due to:

- elapsed time between the levels of results
- other investments contributing to capacity built
- the importance of the institutional environment for capacity to be utilised
- the critical interaction with the enabling environment for impact as a result of capacity utilised.

The final step from measures of impact to net benefits is relatively straightforward compared to the complexity of determining the links between capacity built and utilised, and capacity utilised and impact. It is these complexities that present the challenges for evaluating capacity building as the survey of approaches set out below highlights.

The rest of the chapter is set out as follows. The first section looks at quantitative approaches to evaluation. The second part of the chapter presents an overview of qualitative approaches to evaluation that are generally complementary to the quantitative approaches. Appendix 1 contains more-detailed explanations of the evaluation approaches outlined below as well as a number of useful tools that can be used to implement them.

The next chapter looks at a sample of ACIAR evaluations that have included a capacity-building component.

Quantitative approaches

There are two types of quantitative approach: one aims to measure absolute (and objective) values, while the other aims to provide relative (and subjective) assessments of value.

Measuring impacts and benefits

Benefit–cost analysis (BCA) aims to measure the net benefits of an investment in monetary terms. This enables the comparison of investments across areas of competing opportunity. Some use of impact analysis focuses only on the immediate effects and hence may not accurately reflect benefits. While this is an essential step in undertaking a BCA, in that it aims to measure the direct and indirect impacts of the investment in quantitative terms, these need not be translated into a monetary value.

Indicator analysis can also be quantitative, in that indicators reflect real values. However, interpreting indicators requires some formal model of how these relate to the impact of interest.

BCA is one way of presenting the total impact of an investment. This works well when all net benefits can be expressed in monetary terms. BCA evaluation is not always easy, however. There is no 'cook book' to follow beyond the initial step of mapping the logical pathway from investment to observed or expected impacts—changes in practice and behaviour.

BCA requires the application of analytical skills, appealing to expert judgment and documenting the assumptions that have to be made. The main methods of analysis used to estimate the changes relative to what would otherwise have been the case—the counterfactual scenario—are modelling or econometric analysis:

Modelling

Modelling entails building a model of the relationships identified along the pathway from investment impacts, then parameterising the model in order to estimate the impacts and net benefits. The models may be simple or highly complicated, and capture biophysical relationships and market relationships. The estimation

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

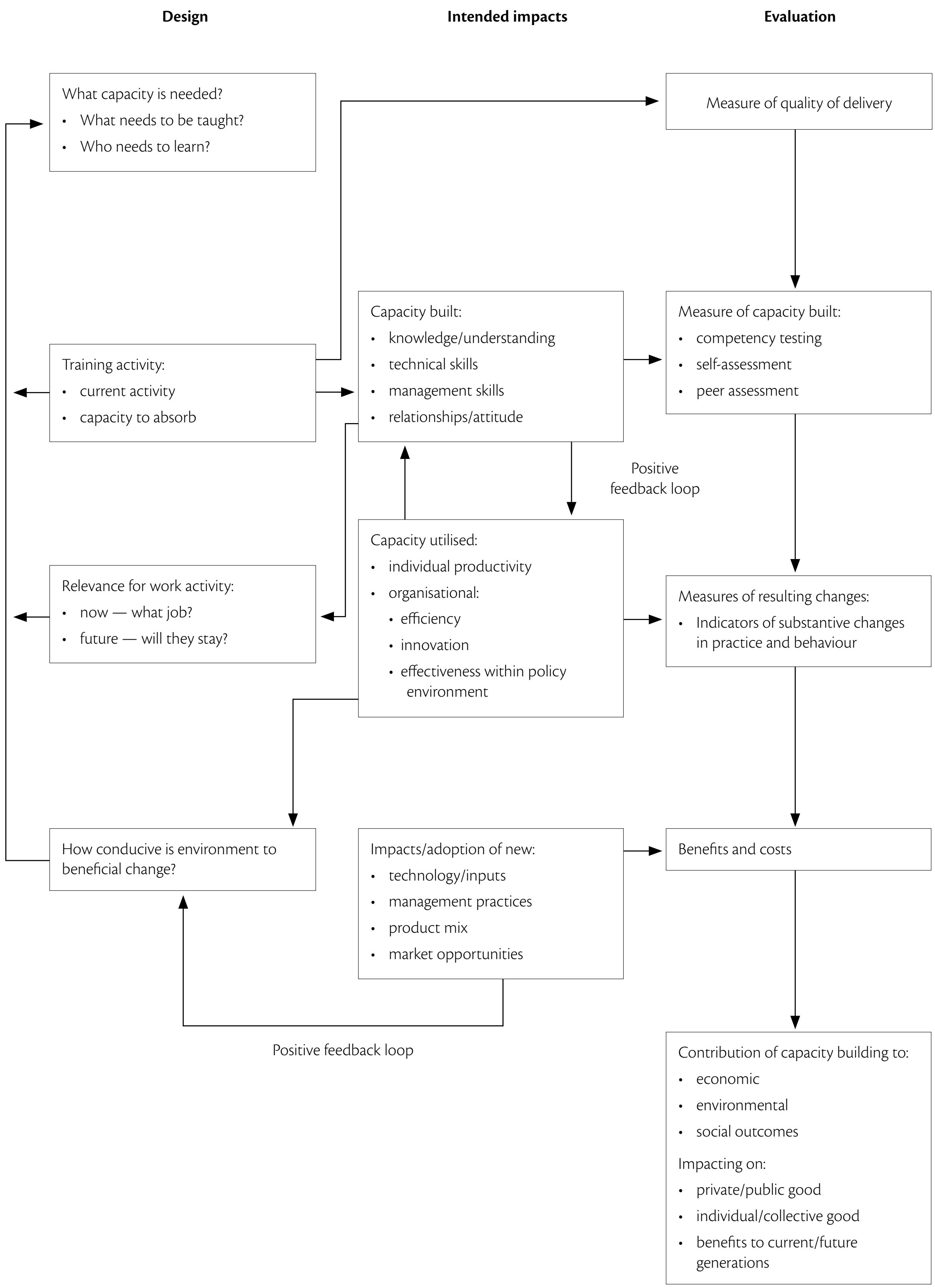

Figure 3. Mapping capacity-building inputs to value-added

of net benefits usually requires an economic model of the markets involved. The pigeonpea improvement case study in chapter 6 is an example of this approach.

Econometrics

Econometric approaches use observed data points to analyse the determinants of the observed changes. These approaches posit some type of model that captures the expected relationships, then use actual data to test whether the posited relationship is supported by the data. It is the best way to objectively parameterise the models described above, but can only rarely be used in isolation. A rare example of using the econometric approach to estimate the impact of capacity building is the study by Brennan and Quade (2004) on rust resistance in wheat in India and Pakistan. An overview of this study is included in Appendix 1.

The importance of combining quantitative and qualitative approaches

While the aim is to undertake a full BCA this may not always be possible due to the:

- diffuse nature of capacity-building impacts
- fact that capacity building is an additional step removed from project impacts, which makes establishing linkages between them more difficult
- failure of individuals to realise the role played by the training in the successful completion of a project and their further professional development
- lack of data and/or measurable impacts.

However, conceptually there should be a clear pathway to benefits if a project is well designed and the capacity-building activity is either integrated or gap-filling. Capacity-building activities that are diffuse, such as some ACIAR Allwright Scholarships, are inherently difficult to evaluate at the benefit level unless the study tracks explicit changes driven by the individual.

Benefits often cannot be directly observed, as external events, such as weather patterns and external price shifts, confound the measures. Thus, estimates of benefits usually rely on modelling the relationship between the impact and the expected benefit. As a result, net benefit values produced by BCAs usually involve making value judgments based, for example, on:

- formal models that capture these relationships
- scientific knowledge
- expert opinion
- established rules of thumb.

Most BCAs incorporate some form of qualitative evaluation in order to substantiate and parameterise the impacts and benefit flows. Ensuring a combination of approaches is used (multiple points of evidence) strengthens the validity of the BCA's quantitative results.

Scoring models straddle the divide between quantitative and qualitative approaches. Although they can be used as a bridge to connect the two approaches, they rarely are and there are very few good examples.

Scoring models

Scoring models are often used in evaluations that assess the achievements against a set of objectives. Where these objectives are expressed as quantitative targets, the analysis is naturally quantitative and an assessment of achievement relative to target can be expressed as a percentage. Scoring models can also be used to convert qualitative information into quantitative information. This facilitates ranking of investment opportunities and helps to explain allocation decisions (why some things were selected and others were not). The scoring approach requires assigning values to specific criteria, with a total score based on a weighted or unweighted sum of the scores. Complex weighting systems can incorporate interactions between various criteria, but generally the criteria are assumed to be independent.

The advantage of scoring systems is that they provide an easy way to compare otherwise complex criteria. They are also useful in ensuring that the right questions are asked and in documenting decisions for accountability purposes. The disadvantages lie in the difficulty of calibrating scores across the people assigning scores, and the manipulation that can go on in scoring, particularly when a weighted scoring system is used.

The problem of information loss in summation (where an average all-round score could result from a brilliant score in several aspects but hopelessness on others) can be addressed by having a multi-criteria assessment. This allows minimum scores to be set for a selected set of criteria to 'qualify'. Those investments that qualify can then be ranked according to the total score. However, multi-criteria and minimum score requirements allow for greater manipulation in the allocations of scores. Balanced score cards and goal-attainment scoring systems are examples of scoring models often used to evaluate development and R&D initiatives. It is important, however, to be aware of the potential for using these approaches to provide false credibility to biased decision-making.

Qualitative approaches

The evaluation framework supports the use of qualitative approaches to substantiate the proposed linkages between the training provided and the intended or observed outcomes. Application of the framework encourages the consideration of factors that also contribute to the impacts but are outside the sphere of influence of the training being evaluated. If, for cost reasons or due to the level of uncertainty about the links between impacts and benefits, a BCA is not feasible, then an analysis that reports measures and indicators of the impacts is the next best approach. This may adopt:

- a multi-criteria analysis that reports on achievement against a set of criteria, or
- a contribution analysis that is used to provide a credible performance story to substantiate the claim that a project has made a significant contribution to an observed change.

Both these approaches entail:

- an informed presentation of the context of the project and its objectives
- a logical argument leading from project inputs to the objectives
- qualitative and/or quantitative evidence that substantiates the links between the project activities and the observed outcomes
- alternative explanations for the observed impacts, including other projects and contextual factors, and a well-supported argument against these other factors (alone) being responsible for the impacts.

This kind of analysis does not attempt to ascribe a specific proportional contribution of the observed impacts to the capacity-building project. The emphasis is on demonstrating, using information obtained from a variety of different sources, that the project made a difference. There are a number of different approaches that can be used to collect and analyse qualitative information and interpret results. The evaluation method adopted will be a combination of the most appropriate tools given the type of activity being evaluated and the information available. Suitable tools to apply in this context include:

- multiple lines of evidence
- 'most significant change'/'story approach'
- case studies
- surveys
- workshops
- interviews.

Appendix 1 contains more detailed descriptions of these tools.

Examples of approaches to qualitatively evaluate capacity building

The United States Agency for International Development (USAID) and the Danish International Development Agency (DANIDA) have carried out large-scale and in-depth qualitative evaluations of their capacity-building projects and programs. The approaches employed are outlined below.

USAID Center for Information and Evaluation (Kumar and Nacht 1990)

The Center for Development Information and Evaluation (CDIE) carried out an evaluation of the overall impact of USAID participant training programs on the development of Nepal. The focus was not on the effects of any specific training activity, but on the cumulative impact of all training activities undertaken over three and a half decades. CDIE did not have any illusions about obtaining precise quantitative data to measure the impacts. Nor did it expect to establish a causal relationship between investment in human resource development and the vast economic and social changes that have taken place on the Nepalese landscape. What CDIE did seek—and succeeded in obtaining—was to gain some credible evidence based on a sound research methodology to answer the question of whether participant training programs made a difference in Nepal.

The evaluation was based on the following three studies:

1. A sample survey of 356 randomly selected trainees focusing on the nature of overseas training, linkages between training and career advancement, the level of skills and knowledge utilisation, and trainees assessment of their own contributions.

2. Examination of trainees' roles in and contributions to the growth and functioning of a few selected organisations that had received a large influx of participant trainees. The emphasis was therefore on institutions, not individuals.

3. In-depth interviews with key decision-makers, planners, educationists, political leaders and business elites in Nepal to gather their assessment of the impact and support.

The assessment was therefore conducted at three levels—individual, institutional and societal. The information gathered is summarised in Appendix 2.

DANIDA (Ministry of Foreign Affairs, Denmark) (Boersen and Therkildsen 2003)

DANIDA's 'capacity development outcome evaluation' (CDOE) methodology focuses on organisations and networks whose outputs are important for a particular sector. Placing the emphasis on the output constraints within the organisations and in their respective contexts helps to determine whether bottlenecks preventing more general and far-reaching outcomes are internal to the organisation concerned or external 'enabling environment' issues. This clearly aids the targeting of future capacity-building initiatives.

CDOE provides a framework of 15 steps for the effective targeting and evaluation of capacity-building activities (see Appendix 2). The framework is not intended as an instruction manual on how to quantitatively evaluate capacity-building outcomes. Rather, it focuses on the immediate impacts that can be directly attributed to specific capacity-building activities. There are three major reasons for this approach:

1. It is extremely difficult to attribute general outputs, outcomes and impacts to specific capacity-building activities.

2. Focusing on outputs enables the appropriate organisations to be targeted by capacity building and relevant 'enabling environment' factors to be taken into consideration.

3. Too much emphasis has been placed on inputs to capacity building rather than outputs that enhance organisational performance. Changed outputs are the immediate effects of enhanced capacity.

Changes in organisational outputs are proxy indicators of organisational capacity change. They can therefore be used to assess whether or not capacity-building efforts are effective and they help provide a clearer basis for political accountability.

CDOE also emphasises the value of having a result to aim for, rather than just activities. This helps focus attention on the issues at hand, even if it is acknowledged, for any number of good reasons, that targets may not be reached.

Appendix 2 provides more details on the types of questions asked to gather information applicable to this method.

Data and information sources

All evaluations require access to data and information. The source of data or information often depends on the type required. At the outset, it is important to verify that the data and information required are available from a reliable source. If no reliable source can be found and collecting the data as part of the evaluation is impractical, different measures and indicators with a reliable source of data must be determined. Data and information constraints are a fact of life that must be accommodated by any evaluation, especially those set in rural areas in developing countries.

Quantitative data relating to the adoption of a new technique, for example, might be available from the relevant department of agriculture, household surveys and/or documentation from previous projects carried out by the same or a different organisation. It might be necessary to collect the data as part of the evaluation project using agricultural survey techniques. However, unless these data have additional uses this may not be a cost-effective approach.

Qualitative information useful for attributing the observed increase in use of a new technique would have to be elicited from farmers and agricultural extension workers using survey questionnaires and interviews.

Cross-checking, triangulation and validation

Given the complex impacts of most capacity-building activities, the difficulty of applying experimental techniques to evaluate impacts, the limited information on capacity utilised (particularly baseline data) and the often-conflicting views on the impact of such utilisation, it is particularly important to check and validate the results. Triangulation is a validation technique that uses different data sources, methods of data collection and analysis, evaluation specialists and/or theoretical perspectives to assess and crosscheck findings from multiple points of view and thereby increase confidence in the results.

One important way of building confidence in results is to use more than one source of information to check the consistency of findings across methods. Reviewing findings with stakeholders during the evaluation process also provides a crucial means of checking evaluation results against local and informed opinion. If participants raise any serious doubts about the results, the information sources and methods of analysis and interpretation should be verified. Triangulation can be time and resource-intensive but, given the potentially controversial and influential nature of evaluation findings, it is crucial that cross-checking of information be built into evaluation procedures.

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

4 Overview of ACIAR capacity-building evaluations

Many of the projects evaluated in the ACIAR Impact Assessment Series (IAS), adoption studies and an evaluation of the Allwright Fellowship Scheme have explicitly referred to capacity building or training as comprising a significant part of the projects being assessed. The benefits of the capacity-building activities identified are listed, along with the evaluation methods used. (Appendix 3 of this report provides a brief synopsis of capacity-building evaluations carried out under the ACIAR IAS.)

A number of different types of capacity-building activities were identified by the studies, including:

- development of training methods
- short-term, in-country training
- development of 'how to' manuals
- work experience in project teams
- long-term, postgraduate training in Australia
- training Australian scientists and postgraduate students
- agricultural extension activities
- promotion of collective action
- instruction in survey techniques.

Unfortunately, the vast majority of the IAS studies did not attempt to estimate the value of the capacity-building activities. However, many of the authors referred to the significance of the activities in contributing to the outcomes of the projects concerned.

A rare exception is the training provided as part of two wheat rust projects in India and Pakistan (IAS No. 25). A description of this study can be found in Appendix 1 to this report. A number of factors came together to make quantification possible:

- both projects concerned were almost entirely focused on a single capacity-building activity—postgraduate scientific training in Australia
- all or a very high proportion of training in this field in the target areas was provided by the two projects being assessed
- detailed records were available from the collaborating R&D organisations about the baseline and subsequent education and experience of all the scientists currently active in the specific field concerned in the target areas
- the availability of a highly relevant previous evaluation of R&D outcomes that drew on local expert scientists to provide informed estimates of disease incidence and severity in the different target areas and the yield loss associated with each level of disease incidence and severity.

These factors (and some brave but testable assumptions) enabled a quantitative evaluation of the net benefits of, and rate of return on, a capacity-building activity. This evaluation points to the importance of incorporating indicators into the project at the design stage and establishing a valid set of baseline data against which to compare the circumstances during and after the project.

The other ACIAR studies also provide insights into how capacity-building activities can be evaluated in the future.

- It is important to record in detail the cost of the training activities, as well as the trainees' contact details, levels of education and experience and work circumstances.
- If the capacity building is entirely integrated into a project, one approach is to attribute the overall benefits in proportion with the cost share of the training exercises. In this situation, capacity building simply has the same benefit–cost ratio as the overall project.
- Indicators of capacity built such as 'knowledge of alternative income sources' and 'awareness of the trade-offs between logging and conservation', while potential indicators for outcomes, require clear and robust linkages of attitudes to action to be established.
- The benefits of working in the project team are often significant, yet capacity built by 'learning by doing' is rarely captured. This is a crucial element of ACIAR's capacity building and options to measure this source of capacity need further investigation.
- The ability to attract more funding as a result of capacity building (leverage) provides an opportunity for quantifying one outcome of the capacity building. Attribution needs to be carefully considered, however.
- Flow-on effects of capacity-building activities can be indicated by the amount of subsequent training provided by previous trainees. That undertaken by new trainees requires additional interpretation.
- The larger the variety of interactions, training programs and exchange experienced by the individual and/or the organisation, the more difficult it is to attribute measured outcomes to a specific activity and, hence, the more relevant a 'contribution' evaluation method will be.
- The spillover of knowledge, experience and technologies is one of the most difficult outcomes to identify. Attribution is particularly complex, as it is the quantum of training and associated activities that generates spillovers. In this area, illustrative stories, such as those collated and analysed by the most-significant-change method of evaluation, may provide the best evidence.

A crucial factor raised by the IAS studies that made attempts to evaluate the benefits of capacity-building activities more successful is the necessity of combining qualitative and quantitative information. All benefit–cost analyses involve value judgments to enable the quantification of costs and benefits. Expert opinions, although inherently subjective, offer a valuable source of information that can be combined with quantitative data to establish outcome measures and the strengths of the links between inputs, outputs, outcomes, impacts and measured benefits. Such observations also permit insights into other factors that affect the magnitude of benefits, such as relevant training provided by other organisations, long-term trends in targeted agencies and industries, and the general situation concerning the so-called enabling environment.

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

Part II
Suggested methodology

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

5 The evaluation framework

An overview of the evaluation framework

Most evaluations of capacity building stop well short of attributing observed benefits to the training. The furthest most evaluations go is to claim that the capacity building made a significant contribution to the overall outcomes attributed to a project as a whole. This is because attention is only rarely paid to elucidating and substantiating the assumed linkages between the training provided and the intended or observed benefits.

This framework aims to clearly link and, if possible attribute, benefits such as increased agricultural productivity to specific investments in capacity-building activities. The goal is to be able to measure the benefit flows that arise and to assess the return on the investment—that is, the benefits generated by the investment made. Where possible benefits and costs are measured in dollars, but where monetary values are highly uncertain and/or inappropriate, other measures can be used to reflect benefits.

The framework has three parts:

- The analytical framework presents the array of pathways through which capacity-building investments can result in benefits. The focus is on agriculture, so the benefits accruing to farmers and rural communities are the main concern. The benefits accruing to the individuals involved in the training and flowing indirectly from the scientific developments (in the country and in Australia) can also be identified for estimation.
- Applying the framework requires assessing what can be measured, how the data can be analysed and assigning the responsibilities for measurement and analysis. While the goal is to measure benefit flows, this may be too costly or, where the pathways are indirect, too complex, so other evidence of benefits should be identified for collection. This may be at the impact and/or capacity-utilised level.
- Tools for estimating impacts and benefits are the third part of the framework. Examples of tools have been provided in chapters 1 and 2 and are not discussed further here.

Each part of the framework should be developed over time, as learning occurs when undertaking evaluations. Application to ex-ante and ex-post evaluation may see new pathways identified, and methods of measurement and analysis should improve and new tools should be developed. Figure 4 summarises the evaluation framework.

The evaluation framework can be used ex ante when developing a project design, in early implementation when setting up the monitoring and evaluation system, or ex post when conducting an evaluation of a completed project.

The analytical framework

The analytical framework set out here focuses on evaluating the benefits attributable to a particular capacity-building activity. This requires mapping the pathways from the capacity-building activity to benefits. These pathways may be direct or indirect, strong or weak, and certain or highly uncertain. The mapping should seek to classify the pathways identified according to these criteria.

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Application of the analytical framework is the first step in valuing benefits considered attributable to the training being evaluated. Evaluation of benefits is generally easier when the pathways are direct, strong and certain. However, even when they are indirect and somewhat uncertain, as long as they are expected to be strong, a good case should be possible for undertaking a formal BCA if the data are available to do so.

The analytical framework is presented in Figure 5. It shows an array of potential pathways for a range of capacity-building activities. The pathways described are based on the review of the literature presented in chapter 2 and the ACIAR evaluations described in chapter 4. The framework aims to identify the changes at each level. Working from bottom to top, these changes are as follows.

1. Capacity-building inputs:

- expenditure on training by suppliers and participants, including the value of time and in-kind support.

2. Capacity built in the individual trainees, the immediate change in capacity due to the training input. This may include:

- knowledge gained
- skills developed
- awareness and understanding enhanced
- contacts and networks formed
- confidence and credence developed.

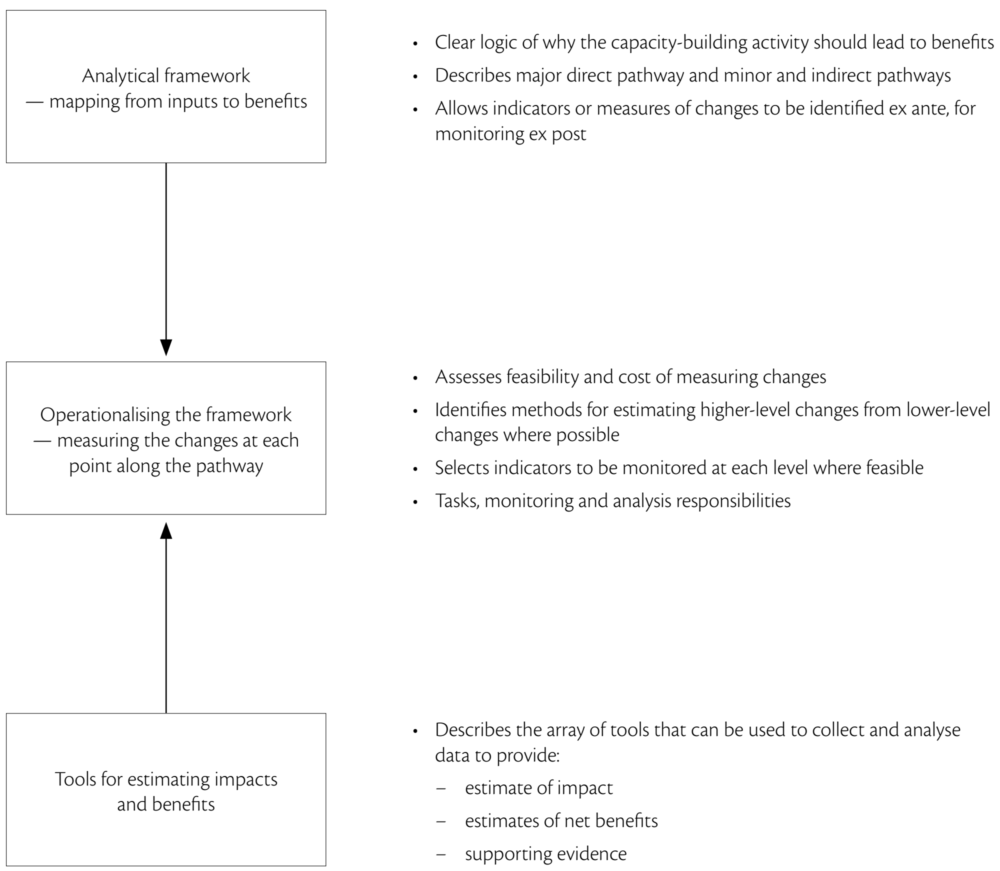

Figure 4. The evaluation framework

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

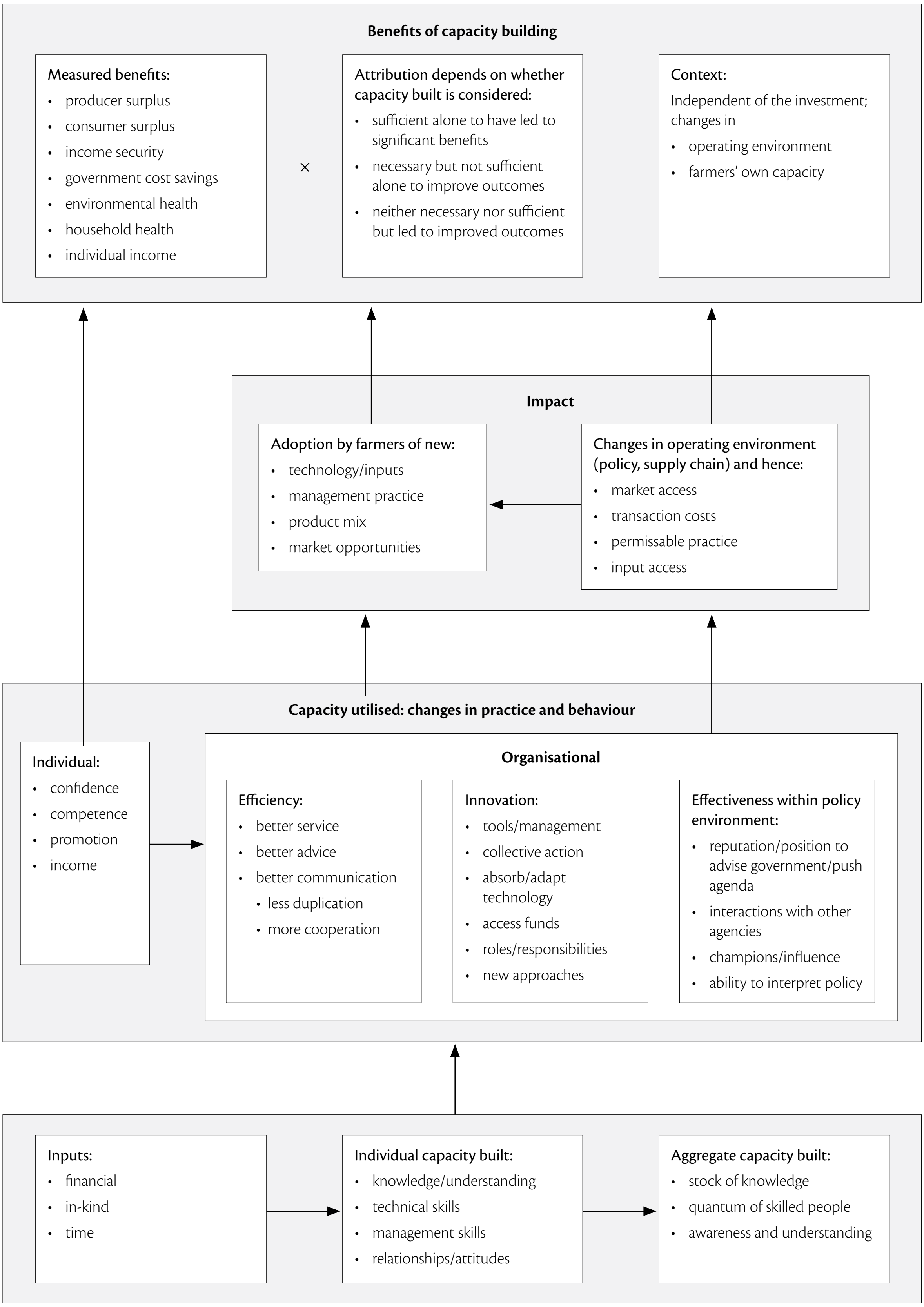

Figure 5. The analytical framework: pathways to benefits and attribution to project/s

3. Capacity utilised by the organisation for which the trainees work. The change in practice and/or behaviour resulting from the utilisation of the new capacity built could include:

- training of other staff, which in turn leads to:
  - application of the capacity to work to improve quality, effectiveness and/or efficiency of service delivery, policy advice
  - utilisation of new technologies
  - greater networking, accessing information, improved communications etc.

4. Impact on the clients (farmers) of changes arising from capacity utilised. These can be:

- observable changes in the technologies and techniques employed by farmers, and/or
- changes to the operating environment for farmers such as market access, regulations, access to resources; transport and other infrastructure.

5. Observed benefits and external factors:

- the benefits accruing to farmers and other stakeholders as a result of the newly adopted technologies or techniques
- factors external to the training being evaluated that might also have contributed to these observed benefits.

These levels are further categorised in Figure 5 according to the dominant outcomes identified by the literature review. It must be emphasised that not all of these linkages between the levels will be relevant to every individual capacity-building exercise.

Applying the framework

This section of the evaluation framework guides the user through five steps for applying the framework. The steps are summarised in Figure 6. These steps map the pathways and establish the means by which the validity of the identified changes can be substantiated:

1. utilise the framework to identify the changes occurring as a result of the training (map the pathways)
2. determine measures and indicators required to verify the identified changes
3. establish the data required for the measures and indicators, verify the availability of these data from appropriate sources and select the most appropriate tools for the collection and analysis of the data
4. determine the extent to which benefits can be attributed to the capacity-building activity
5. assign responsibilities for data collection and evaluation and reporting.

Step 1. Map the pathways—changes due to capacity building

In order to demonstrate that a capacity-building activity has led to the benefits observed, it is first necessary to identify linkages between a capacity-building activity and the benefits attributable to it. These linkages are the changes that occur between the different levels as set out in the analytical framework (Figure 5). They can be identified on the basis of established theory, rules of thumb, prior evidence or reasonable expectations.

Step 1 of the evaluation framework requires the user to identify these changes at each level, mapping the links on the pathway from inputs to benefits. This provides a testable assertion that the training being evaluated has brought about benefits via the identified pathways. Ideally, the project's accompanying logistical framework will provide much of the information required, in the form of its intended impacts.

This approach encourages the evaluation to include measures and indicators of change at each of the different levels along the pathways identified. In this way, the rationale behind the assumed linkages can be assessed using a combination of quantitative and qualitative data. Taking into account changes in context and external factors that might also have contributed to on-farm impacts and any resulting measurable benefits, helps in the assessment of benefits to the training being evaluated. The strength of the linkage, whether it be direct or indirect, and the level of certainty in the linkage, should also be assessed.

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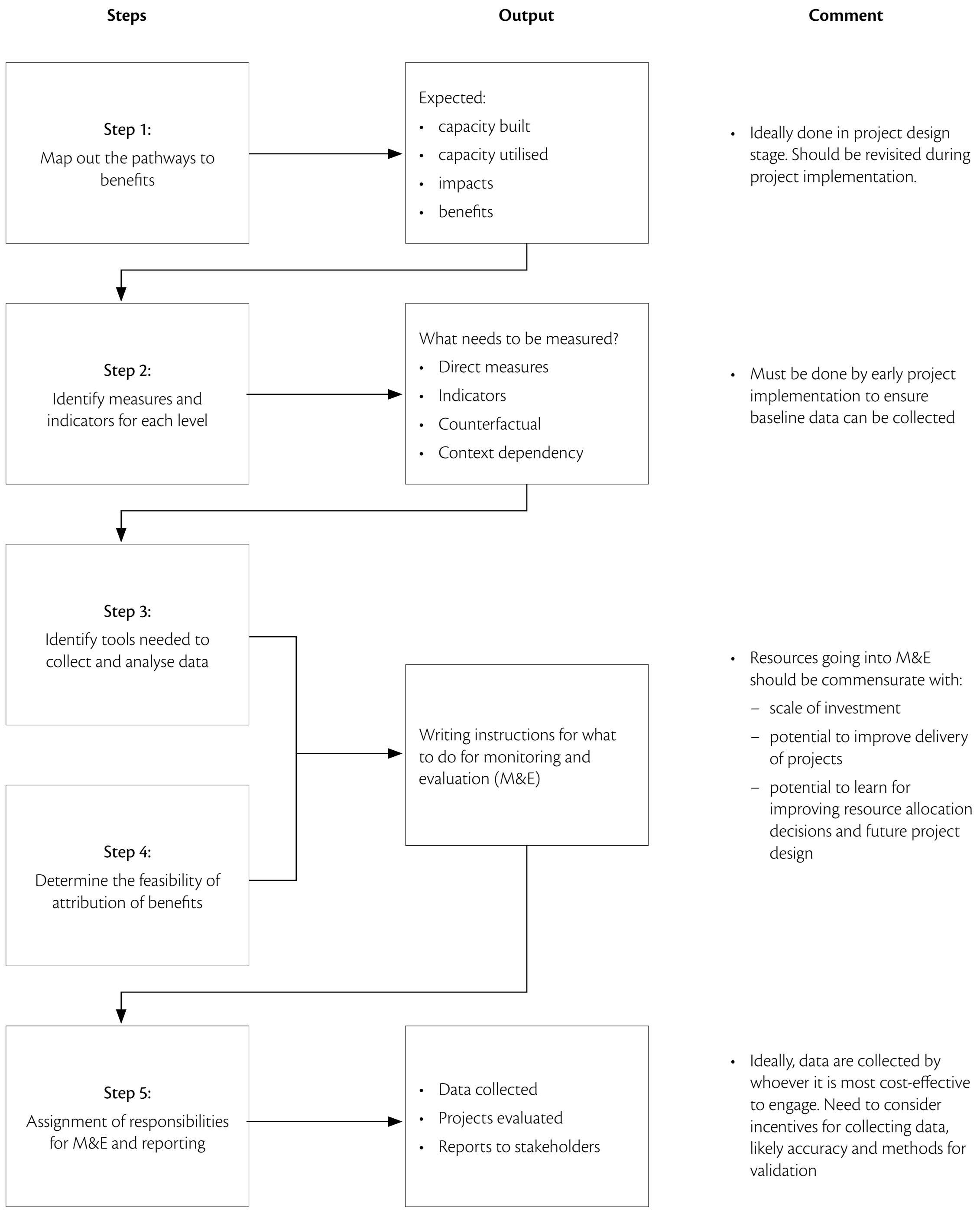

Figure 6. Applying the framework

It is important to remember that not all pathways will be applicable to a particular capacity-building activity. The categories are intended as a guide to enable an evaluation team to identify the pathways relevant to the project being assessed. The categories and examples are not exhaustive, however, and the framework should be regarded as a living document and updated as new pathways and categories emerge.

Step 2. Determine measures and indicators to verify the identified changes

Once the change occurring as a result of the training has been identified at the respective level, measures and/or indicators that enable the validity of this link in the pathway to benefits to be verified must be determined. Ideally measures will be available at each level:

- Inputs are the measures of financial cost, in-kind contribution in dollars, time (opportunity cost dollars) associated with the capacity-building activity.
- Capacity built measures change at the individual level, examples are competency results, measures of attitudinal change; subjective assessment of learning achieved. Measures can also be made of a broader organisation/industry or even national level in terms of changes in the stock of knowledge, skills and so on.
- Capacity utilised measures change at the organisational level (or at farm level if the capacity is built in farmers). Examples are productivity improvement in the organisation, adoption of more innovative approaches, expansion and/or improvement of quality of services provided, and increased effectiveness within the policy environment. The last point relates to the organisation improving its ability to adjust internal policies to improve service delivery to respond to and influence policy at all levels of government.
- Impact measures change in the target stakeholder's practice and behaviour. Most target stakeholders are farmers, but some may be legislators or participants at points in the value chain beyond the farm gate such as transport and handling, distribution, processing and retail. Changes might include adoption rates of a new technology or variety, changes in market-access arrangements, lower costs or greater availability of transport for product to market, and productivity improvements in processing. Measures of impact should include unintended as well as intended impacts.
- Benefits measures change in the welfare of the target and other stakeholders. It will usually include changes in producer surplus (profitability), in consumer surplus (including household consumption bundles for subsistence agriculture), in health status (if affected directly by the impacts, not indirectly through better nutrition due to higher income) and in environmental condition. It may also include measures of confidence, reduced risk exposure (income stability), reduced inequality, and changes in power and participation that may or may not be able to be valued in monetary terms.

All these changes need to be measured as changes relative to what otherwise would have been the case—the counterfactual.

Counterfactual

The counterfactual scenario takes into account the most likely scenario in the absence of the training. This is usually not static, but a continuation of existing trends—good and bad. The art in this respect is to make reasonable and prudent assumptions that reflect the general consensus of expert opinion canvassed.

Baseline data provide an important insight into the counterfactual and are essential for measuring changes. Ideally, baseline data for all measures and indicators selected should be collected before the training takes place and baseline control groups of individuals not undertaking the training should be established to facilitate direct comparison measurements. In some cases, however, it will be necessary to establish the baseline data ex post.

A common misconception is that, if another organisation would have conducted the training, then this forms the counterfactual. The evaluation is of the capacity-building activity, not the organisation that carried it out. The counterfactual scenario must therefore attempt to predict what would have occurred in the absence of the training, regardless of who carried out the training; for example, to what extent and over what time would new skills, acquired as a result of the training, have been picked up simply through learning by doing?

Another conundrum faced in this respect is *selectivity bias*; those selected for training are likely to be the best and the brightest with the greatest potential for professional growth. It is therefore logical to conclude that, in the absence of the training provided by ACIAR/Crawford Fund, these people would be selected for other training activities run by different aid organisations. While this is an important consideration, the rationale stated above—that it is the training that is being evaluated and not the organisation carrying out the training—is also strongly applicable to this scenario. The selection of the best and the brightest to undertake training is an integral part of the capacity-building process and to select anyone other than best candidates would be at variance with the aims of the training.

Step 3. Establish the data required, data sources and appropriate tools

Data to be collected

The selected measures and indicators determine what kind of data is required. For example, if an adoption rate is chosen as a measure of impact, quantitative data will be required on the area of land in the target area:

- suitable for the application of the technique
- using the technique before the training took place
- using the technique after the training took place.

To attribute any increase in adoption to the training, however, it is advisable to supplement the quantitative data with qualitative information that substantiates the link between the training and the adoption rate.

Direct measures

Direct measures are the preferable means of assessing change, because they provide information relating directly to the change being assessed. A direct measure at the impact level, for example, would be measured adoption rates of a new agricultural technique—the area of land of the relevant type on which the technique has been newly employed.

Indicators

In many cases, however, direct measures will be unavailable and indicators of change have to be used. An indicator measures change in a factor considered closely correlated with the actual change being assessed. For example, at the impact level, sales of equipment used to employ a new agricultural technique could be used as an indicator for the utilisation of the technique. This indicator is not as reliable as a direct measure, because nothing is known about the extent to which this equipment is used once bought. It may sit unused because it is difficult to use, or it may be shared by a number of farmers in the same village and so be used on a much larger area than the purchaser's farm.

Step 4. Determining attribution

Attributing project or program benefits to capacity-building activities is difficult, as they are rarely undertaken in isolation. Capacity-building activities are often an important ingredient in a recipe where none of the ingredients can be left out if a palatable and nutritious outcome is to be produced.

Three broad approaches to estimating the share of the benefits attributable to a capacity-building activity have emerged, depending on if the capacity built is considered:

- neither necessary nor sufficient, but led to improved outcomes
- necessary but not sufficient, or
- sufficient in isolation to have resulted in significant benefits.

Capacity building is neither necessary nor sufficient, but improves outcomes

When it is considered that the outcomes would have otherwise been achieved over time, or an alternative found that would achieve the change in practice or behaviour, one of the following two approaches can be used to attribute benefits to capacity building.

- Bring-forward approach:
  - Used where the changes would have come about through normal processes, but the investment in capacity building brought forward, by a number of years, the changes and hence the impact. The focus of measurement

is on the time to impact without the capacity-building activities compared to the time with. This is illustrated in Figure 7.

- Marginal-gain approach
  - Similar to the bring-forward approach, but the investment in capacity building raised the quality of the changes and hence the magnitude of the impact. The focus of measurement is on the effect that higher quality has on the size of the impact.

Capacity building is necessary but not sufficient

Where capacity building is one of many necessary and inseparable factors contributing to the successful completion of a project or program, the following two approaches permit the attribution of benefits to capacity building based on proportional costs or relative importance:

- Cost-share approach:
  - This apportions the share of the benefits (net of implementation costs) to capacity building based on the share of the expenditure going to the capacity-building activities. This is appropriate when the activity is necessary but not sufficient to achieve the change in practice or behaviour.
- Relative importance approach:
  - This apportions the share of benefits on the basis of a subjective assessment (triangulated) of the contribution (percentage) of the capacity-building activity to the outputs achieved. This can be used if the training would have been sufficient to get part of the outputs, with an assessment made of how much. It can also be used when the training is necessary but not sufficient, but a strong case must be made as to why the training components were worth more than the other components.

Capacity building is sufficient in isolation to have resulted in significant benefits

When capacity building alone is considered to have resulted in significant benefits, normal impact assessment should be undertaken, with full attribution to the capacity-building activity. Where this activity filled a gap that was critical to achieving the outcome, and without the activity would not otherwise have been filled, the other investments can be regarded as sunk costs.

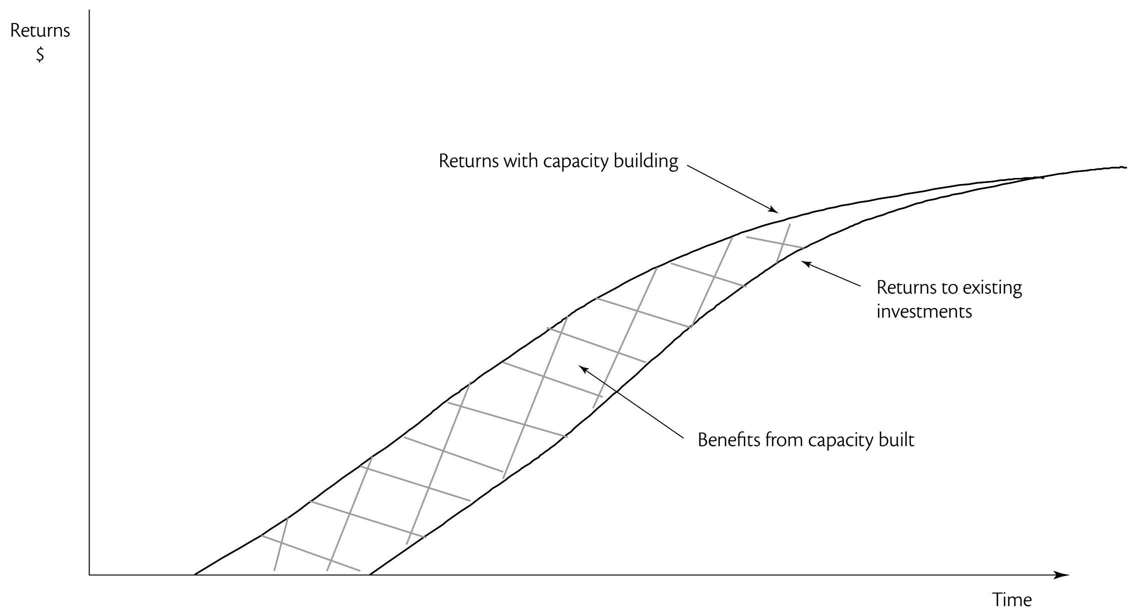

Figure 7. Benefits of bringing forward project impacts

Step 5. Assigning roles and responsibilities

It is not enough for an evaluation framework to say which data to collect and how to analyse them; it should also provide guidance on the assignment of roles and responsibilities for evaluation. Most importantly, it needs to provide guidance on how much to invest in evaluation, as high quality evaluation is not cheap. The roles and responsibilities and the level of investment in evaluation depend on the purpose of evaluation. The main uses of evaluations are:

- Diagnostic:
  - to identify what went right or wrong to correct, or improve future, program or project design and implementation.
- Predictive:
  - to assess the value of future investments as an input into the investment decision.
- Accountability:
  - to demonstrate that value for money has been delivered to the funding bodies.

How much to spend on monitoring and evaluation (M&E) is a difficult question. As a general rule 5–10% of a project/program budget is usually earmarked for M&E. Much of this is focused on project monitoring for risk and other management purposes. This is complementary to, but not the same as, monitoring changes for the purpose of evaluation (see IFAD (2006) for guidelines on implementing and M&E system). As a general rule, if M&E is:

- only about accountability, spend as little as satisfies funding bodies
- being used in investment decisions, spend only where the investment decision can be changed as a result of the findings of the evaluation
- used for diagnostic purposes and to improve design, spending should be determined by the learning that can be achieved from the evaluations. Thus, evaluating projects that have failed is just as important as those that are successful. The greatest value comes from involving organisations and project designers and deliverers in the evaluation, so that they learn what creates value.

Roles and responsibilities

Roles and responsibilities need to be determined by the agency commissioning the evaluations. The following can be taken as guiding principles:

- As far as possible, involve the participants in the training and their organisations in the collection of data on capacity built and capacity utilised.
- When negotiating with an organisation on the training of its staff, identify the measures of capacity utilised and impact that they, as an organisation, are interested in monitoring. Helping them undertake this monitoring effectively and hence creating an incentive to share the information, adds value for the organisation, as well as providing better data for evaluation.
- Ensure that baseline data are collected in the design or early implementation phase of the project, by the organisations involved where possible, but otherwise by the project designers or those implementing the training.
- Have a clear timetable for monitoring the measures and indicators agreed to by the organisations involved.
- Determine the sample size required for a significant reflection of capacity utilised and impact measures. Where participants have come from a range of agencies or regions, a minimum sample would be five participants or 20% of the cohort trained. If the cohort is highly diverse, a larger share is required for representative sampling.
- Where possible, involve those undertaking the analysis of the data in the design of the monitoring.
- To minimise the potential for biased reporting, independent analysts are preferable to engaging those who either delivered or participated in the activity. However, there are trade-offs, as commissioned evaluations are generally more expensive and there is less potential to involve the analysts in the design of the monitoring. There is also the possibility that an external analyst is unfamiliar with the work area and may misinterpret information.

Examples of how to apply the framework

Using the framework requires applying the first step described above to each of the different levels identified in Figure 5—capacity built, capacity utilised and resulting impacts and benefits.

Examples from previous evaluations of capacity building carried out by ACIAR are provided in a table at the end of each section to illustrate how the framework is applied. In most cases, the capacity-building elements of the projects were not assigned a specific value by the IAS reports. The examples are intended to provide insights into how the robust pathway approach employed by this framework makes feasible the quantitative evaluation of capacity-building activities. Brief descriptions of the capacity-building aspects of the projects assessed by the example IAS reports are given below.

Brief descriptions of the example evaluations

IAS 18: Controlling *Phalaris minor* in the Indian wheat belt

This report evaluated a single ACIAR-managed project, 'Herbicide-resistant weeds of wheat in India and Australia: integrated management', which encouraged the adoption of zero tillage—a technology that had previously failed to capture the interest of Indian farmers.

Capacity building was in the form of training Indian weed scientists in herbicide resistance and holistic weed management solutions at the University of Adelaide and the International Maize and Wheat Improvement Center (CIMMYT). The training enabled the scientists to develop weed-management systems extending beyond the conventional heavy reliance on herbicides.

The authors of the report did not compute a value for the capacity-building components, but acknowledged that the value may well be significant.

IAS 25: Genetics of, and breeding for, rust resistance in wheat in India and Pakistan

This report evaluated two related ACIAR-funded projects, 'Genetics and breeding for rust resistance in wheat' that included the training of scientists in rust resistance for wheat. Eight scientists from India and Pakistan came to the National Wheat Rust Control Program during the projects to receive detailed, hands-on training. The scientists returned to their own countries and put into practice the skills learned in that training.

The training increased research capacity in wheat rust resistance in both countries, increasing rust resistance in both India and Pakistan to higher levels than would have been the case without that training. The value of the two ACIAR-funded projects was estimated as the value of that improvement in rust resistance. As discussed in Appendix 1 to this report, a limitation of the evaluation is that it did not trace the pathways from capacity built to capacity utilised and impact, but instead directly linked measures of capacity built to changes in yields.

IAS 33: Research into conservation tillage for dryland cropping in Australia and China

This report evaluated two related ACIAR-funded projects, 'Conservation/zone tillage research for dryland farming' and 'Sustainable mechanised dryland grain production'. The main capacity-building aspects of the projects concerned the training of Chinese scientists and the development of appropriate conservation-tillage (CT) equipment for China. Younger Chinese scientists were invited to spend 3–5 months working with the project team at UQG, where they gained direct experience with the scientific approaches and application of the CT technologies in Australia. The visiting scientists made significant contributions to the projects in China and all remain employed in CT and related areas. One of the scientists was subsequently appointed Director of the Agricultural Engineering College at the Chinese Agricultural University and provided expert advice to the China's Ministry of Agriculture on CT policy.

The projects provided financial support to three Chinese PhD students to study in Australia. One of these students contributed to the project work in China but the other two did not return to their country.

The general outcome of both projects was the demonstration of practicable controlled-traffic farming and CT systems for more-sustainable dryland grain production in Australia and China.

Capacity built

The intended skills to be acquired should be explicitly expressed in the project logframe. If not, the course content should provide detail to establish this fact. Examples of the potential measures and indicators of this change in capacity, as well as the data required, the data sources and appropriate evaluation tools are outlined below.

Step 1. Identify the changes

At this most immediate level of output, likely changes resulting from capacity building are:

- increased skills and additional competencies
- changed attitudes of the individual trainees
- development of contacts and networks
- increased stock of knowledge and capacities within the organisation
- the creation of champions.

In some cases, increasing skills, competencies and changing attitudes will be the only intended outcomes of a capacity-building activity. For example, it is sometimes necessary for an organisation to build up its stock of capacities and/or knowledge, in order to accumulate a critical mass of these endowments before any impacts are observable further along the pathway to benefits. If this is the case, it is important for the evaluation to acknowledge the limited intended impact of the training and bear in mind that these outcomes may form stepping-stones on the way to more visible impacts delivered by future projects. This highlights the importance of recording the previous projects upon which a new round of training is based, so that an evaluation team can easily take into account previous activities that have made it possible for a new project to achieve more-measurable benefits.

Champions can be created intentionally or by accident. They embrace the new skills and attitudes acquired from the training and disseminate them further into and across organisations. Senior officials in an organisation sometimes receive training simply to keep them abreast of developments occurring lower down the hierarchy. Creating champions in this way can facilitate the rapid accommodation of changes in practice and behaviour that might otherwise be resisted. Champions created via capacity building can thus play a significant role in the success of any project.

Table 2 provides examples of capacity built in three previous ACIAR projects, where capacity building was considered to have made a significant contribution to the project benefits.

Often, however, the capacity built is a more immediate means to an end, the first vital link in the pathway to benefits. Capacity is built with a view to utilising it.

Step 2. Measures and indicators

The role of measures and indicators at this level is to establish that the trainees have acquired the intended capabilities. The most prevalent direct measure is therefore:

- the number or proportion of trainees passing a post-training competency test—the pass rate.

Indicators that can be used in the absence of pass rates include:

Table 2. Examples, from ACIAR IAS, of capacity built

Project	Capacity built
IAS 18	• Understanding of the application of zero tillage techniques • Increased capability to monitor and respond to changes in the performance of rice–wheat cropping • Skills to develop holistic solutions to weed management beyond the use of herbicides
IAS 25	• Better understanding of disease resistance in Asian wheat varieties • Improved capacity to analyse and develop higher resistance
IAS 33	• Understanding of conservation tillage, controlled traffic farming and their application in Australia

- content of the training course
- attendance
- quality of delivery of the training
- trainee satisfaction.

These indicators do not establish with certainty that the trainees have acquired the intended capabilities, but they represent different factors closely correlated with this output that can be applied ex post, if necessary.

Measures of changes in the stock of knowledge or quantum of attitudes and understanding generally need to be assessed at an organisational level. Documented reports can provide an indicator of the stock of knowledge, especially if written by the staff or compiled with their involvement.

The measures and indicators of capacity built described above are widely applicable to all kinds of capacity-building activities, regardless of the subject matter and context. A pass-rate measure would require a test to have been incorporated into the training package.

Had a direct measure not been built into the project, any of the indirect indicators described above could be used ex post to signify that the trainees at least had the opportunity to acquire the intended capacity.

Step 3. Data requirements, sources and appropriate tools

The data required for directly measuring the acquisition of skills and competencies as a result of the training activity are the competency-test results. The source of these data would be the training records kept by the organisation or individual conducting the training. The appropriate evaluation tool would, of course, be the post-training competency test itself. These results should be compared with initial competency levels. This requires pre-course testing if the added value of the training is to be assessed.

The data required, data source and most appropriate tools for measuring capacity built using the indirect indicators listed above are shown in Table 3.

Table 3. Data required, data source and most-appropriate tools for measuring capacity built

Indicator	Data required	Data source	Tool
Pass-rate	Test results	Training organisation or trainer	Competency test results
Quantum of capacity built	Existing capacity: sum of study years plus years of experience Capacity added by training, equivalence to experience and 'life' of training (see IAS 25).	Records kept by organisation(s) involved in relevant work in target area(s); Previous similar estimates Expert opinion	Document review Key stakeholder interview
Quality of training course	Assessment of content of training course	Training organisation or trainer	Expert document review
Attendance	How many trainees attended how many training sessions	Attendance sheets kept by the training organisation or trainer	Document review
Quality of delivery of training	Trainees' opinions	Trainees	Post-training survey
Trainee satisfaction	Trainees' opinions	Trainees	Post-training survey
Reports—stock of knowledge	Review of reports	Organisation	Expert review

Capacity utilised

Capacity utilised falls into two broad categories based on changes for:

- the individual—through promotion, their own productivity and confidence
- the organisation—through improvements in efficiency, innovation and/or the effectiveness within the policy environment.

Step 1. Identify the changes

Generally, the organisation gains when an individual gains, but this is not always the case, especially if the individual uses the training to access opportunities elsewhere. The framework focuses on changes at the organisational level as, with the exception of the owner operator, it usually is at this level that capacity utilised flows through to intended impacts and benefits.

The framework employs three broad organisational pathways via which the utilisation of enhanced capacity leads to client impacts and ultimately to measured benefits:

- efficiency
- innovation
- effectiveness within the policy environment.

These broad categories are intended to guide the user in identifying the links between capacity built and capacity utilised, but they are not exhaustive. Different categories may emerge as the framework evolves and the user is strongly encouraged to seek out new pathways appropriate to the capacity-building activity being evaluated.

Efficiency and effectiveness

Efficiency refers to 'doing the same things better'. It comes about as the improvement in skills and knowledge or application of technology means that more can be achieved for less time and effort. General examples of outcomes at this level include the organisation providing:

- higher levels of output for a given level of resources
- better-quality services (more timely, consistent and relevant)
- more extension services to a wider geographical area
- more appropriate advice.

Efficiency enhancements might also arise as a result of improved communications within the organisation that have led to a reduction in the duplication of work and/or increased cooperation with and across teams.

Innovation

Innovation concerns 'doing things differently'; for example, the skills and knowledge may have allowed new tools to be adopted or management practices to evolve. These changes may enable the organisation to perform its tasks more effectively or to undertake new tasks and take on new responsibilities.

Such developments might include:

- new approaches to work, new products and/or services developed
- absorption and adaptation of technology to local conditions
- the proven ability to access increased funding.

Other important aspects of innovation are its ability to:

- enhance the reputation and position of the organisation
- create champions within it
- attract winners from outside the organisation.

Effectiveness within the policy environment

The impacts of capacity-building activities on the organisation's effectiveness within the policy environment are generally diffuse, difficult to link to specific training exercises and, therefore, very hard to measure via observation. As Figure 5 illustrates, both increased efficiency and innovation within an organisation can spill over into outcomes that impact on effectiveness within the policy environment as a result of the organisation's achievements in these areas raising its profile. However, if the objective of the training is to influence specific aspects of policy and governance within the organisation and/or at different levels of government, the task of linking it with policy and governance outcomes might be easier.

Outcomes in this respect might be observable via:

- changes in processes and information going into government policy development
- greater and more effective interaction with other agencies
- inclusion of trainees/staff members on decision-making committees
- provision of advice to government on policy directions
- a change in policy direction within the organisation or at different levels of government.

Step 2. Measures and indicators

Measures and indicators of capacity utilised aim to confirm that the skills and competencies acquired during the training activity being evaluated have been used by the organisation. This further substantiates that the measured benefits are, at least in part, attributable to the training. Since it takes time for capacity utilisation to become apparent, a year or two must usually be allowed to pass before changes in practice and behaviour are assessed. It is nonetheless important to embed the selected measures and indicators into the project logframe to facilitate evaluation after the project has been completed. This may require the organisation concerned to maintain detailed records of its activities and outputs relating to the evaluation.

The outcomes of training for the individual in terms of subsequent professional development also offer a useful indicator of the extent to which the new capacities have been utilised. A promotion or an increase in income after the training provides an indication that the organisation has recognised and rewarded the acquisition and implementation by the trainee of the new skills and competencies. This is also true, to a lesser extent, for the continued employment of the trainee in the years after undertaking the training. A general rule of thumb is that, for firm-specific training, the employee captures around half the benefit in higher income while the firm captures the rest in higher profitability.

It is important to be aware of the 'selection error' inherent in evaluating the impact of capacity building from the individual's perspective. It is often the case that the individuals selected to attend capacity-building activities are already those most able and likely to succeed professionally, due to either high-level personal ability or influential contacts.

Changes in the effectiveness and efficiency of an organisation can often be observed via the number of outputs produced, such as:

- research papers
- reports
- workshops held and number of participants
- client queries dealt with successfully
- villages or provinces receiving services
- quality of services provided.

With regard to outcomes of capacity utilisation reflected via organisational innovation and effectiveness within the policy environment, the measures and indicators are essentially the same as the changes in practice and behaviour listed earlier. Rather than repeat the list here, it is more instructive to use examples from previous evaluations to illustrate the selection of suitable measures and indicators at this level. Table 4 provides examples of measures and indicators of capacity utilised applicable to the three ACIAR IAS evaluations cited above, accompanied by the relevant data requirements, data sources and appropriate evaluation tools to use.

Step 3. Data requirements, sources and appropriate tools

Data requirements at this outcome level run across the whole range. If the measures and indicators have been embedded into the project, quantitative data should be available from the documentation maintained by the organisation concerned. The number, location and level of attendance of extension services carried out by the organisation, for example, should be well documented. If this is the case, a well-targeted document review will provide the evaluation team with the information needed.

The indicators can be qualitative too, and using them requires obtaining informed opinions from those involved, both as recipients and providers of services. An example is the provision of a disease-identification workshop for farmers. Immediate opinions can be elicited from recipients via a post-workshop survey that includes requests for information about the quality of the service, both in terms the delivery and relevance to the farmers attending the workshop. Such a survey should also record the contact details of the participants to enable feedback to be obtained at a later stage. This feedback will be of great use when assessing the on-farm impacts.

Key stakeholder interviews, particularly within the organisation and with individuals with a good overview of the organisation, can also play a significant role in obtaining crucial information in this respect. This is especially true when attributing to the training organisational innovation and changes in the organisation's effectiveness within the policy environment.

Impacts on clients (farmers)

Benefits beyond those accruing directly to the individual in terms of income or satisfaction, or to the organisation in terms of its efficiency (cost saving for government), usually rely on change by farmers (or others along the value chain) or a change in the context in which they

Table 4. Examples from ACIAR IAS of data required, sources and tools for measuring capacity utilised

IAS No.	Measure/indicator	Data required	Data source	Tool
18	• No. of training workshops/ participants	• Workshops/ attendance list	• Organisational records	• Document review
	• Rates of disease detection	• Results of field work	• Organisational records	• Document review
	• No. of monitoring exercises	• Details of monitoring	• Trainees	• Key stakeholder survey
	• No. of new solutions	• Documentation of solutions	• Other organisation staff	• Most significant change
25	• Populations developed	• Laboratory reports	• Organisational records	• Document review
	• Rate of identification of disease resistances	• Laboratory/field reports	• Organisational records	• Document review
	• Amount/quality of advice provided to breeders	• Documentation of advice provided to breeders	• Organisational records	• Document review
		• Opinions	• Breeders and organisation staff	• Key stakeholder survey
				• Most significant change
33	• Number of university courses/students	• Enrolment details	• Universities teaching subject	• Document review/ survey
	• Continued employment	• Employment details	• Organisational records	• Document review
	• New equipment developed	• What equipment?	• Organisational records	• Document review
	• Proportion of funding	• Total funding and funding obtained by organisation/ trainees	• Government records	• Document review
	• Change in policy	• Old/new policy and reasons for change	• Government officials	• Key stakeholder survey

operate. For example, new techniques and technologies developed by organisations deliver benefits only if farmers adopt them. Improved market access is valuable to farmers if they use it to gain higher returns on their products. This mapping from organisational changes to client impacts is a difficult but essential step for evaluation at impact and benefit levels.

Step 1. Identify the changes

Impact on the clients (farmers) of changes that might arise from the utilisation of capacity built as a result of the training being evaluated will often fit into one or both of two categories:

- observable changes in the technologies and techniques employed by farmers
- changes to the operating environment for farmers, such as market access, regulations, access to resources, transport and other infrastructure.

Step 2. Measures and indicators

Facilitating on-farm impacts requires that:

- farmers are provided with (and take) the opportunity to adopt the results of the research
- farmers are trained, if necessary, in the use of new technologies and techniques
- the success of these training events is documented via adoption rates for the technologies and practices concerned.

These necessary actions translate directly into measures and indicators of on-farm impacts:

- level of awareness among farmers concerning the technology/technique concerned
- quality of delivery and relevance of the training and self-assessment by farmer participation on their likely use
- adoption rates of the new or targeted technology/technique.

Other probable indicators of on-farm impact include:

- sales of associated equipment or inputs
- sales of final product.

Validation of the measures is important. This may be through analysis of relevance, such as the area of suitable land in the targeted area or other ways of testing the validity of the measures.

It is important to follow up research into adoption rates with attempts to explain why adoption rates for different technologies and techniques were higher or lower than expected. Success in the laboratory does not always lead to success in the field and the difference between these different impacts often lies in the suitability to local conditions of the technology or technique under review. It is not enough to assume that theoretical or laboratory results will be achieved in practice. In fact, as a rule of thumb, only around 50% of outcomes achieved under trial results is realised under normal conditions for grain production. Another significant factor in this respect is the sustainability of an approach under the prevailing circumstances, such as the local availability of relevant skills and ongoing costs for maintenance, for example.

Step 3. Data requirements, sources and appropriate tools

Similar to the previous outcome levels, the measures and indicators of on-farm impact listed above most often describe the data required to employ them. Table 5 provides examples of measures and indicators that might have been employed in the ACIAR evaluations had this evaluation framework been used, together with details of the data required, data sources and appropriate evaluation tools.

Measured benefits

The examples of applying the framework provided so far have helped to identify and substantiate the pathways from capacity-building inputs to on-farm impacts. It is these impacts that lead to measured benefits that can be attributed to the training being evaluated. It is important to distinguish between general benefits observed and those with an explicit link to the capacity-building activity in question.

Step 1. Identify the changes

Benefits can be divided into conventional triple bottom line (TBL) categories, namely economic, social and environmental benefits. It is important to remember that one impact, such as adoption of integrated pest management, may result in any number of benefits under these different categories.

Economic benefits are primarily:

- producer surplus accruing to farmers
- consumer surplus accruing to the general population
- greater income security for farmers
- savings in government expenditure.

Social benefits primarily arise from:

- greater employment opportunities
- better health and/or nutrition (especially for subsistence farmers)
- poverty reduction and other aspects of human development
- increased local participation in decision-making.

Environmental benefits primarily arise from:

- reduced pollution
- more efficient water usage
- revegetation
- protection of biodiversity.

Step 2. Measures and indicators

Although many factors will contribute to measured benefits, the measures selected should be those most likely to have been kept as official records, government statistics or market-based information. It is important to measure these overall impacts accurately, since they provide the quantitative basis for any attribution of benefits to the specific capacity-building activity being evaluated.

Table 5. Examples from ACIAR IAS of data required, sources and tools for measuring on-farm impact

IAS No.	Measure/indicator	Data required	Data source	Tool
18	• Zero-tillage adoption rate • Weed prevalence • Herbicide use	• No. of farms/suitable land area using zero tillage • Incident rate and severity of weed outbreaks • Volume of herbicide sold	• Organisational records • Farmers/field workers • Herbicide sales figures/ farmers	• Agricultural survey • Key stakeholder interviews • Document review/ survey
25	• Adoption rates for seeds exhibiting greater disease resistance • Disease incidence • Disease severity	• Area sowed with disease-resistant seeds • Incident rate and severity of disease • Reasons for adoption	• Organisational records • Farmers/field workers	• Agricultural survey • Key stakeholder interviews • Most significant change
33	• No. of workshops/ participants • Demand for training • On-farm adoption rates • Equipment sales • Significance of training	• Workshops/ attendance list • Details of training requests • Suitable land area in target zone and adopting area • Sales figures • Opinions	• Organisational records • Organisational records/ public contact persons • Organisational records/ farmers/field workers • Market records • Trainees/field workers/ organisation directors	• Document review • Document review/ key stakeholder interview • Agricultural survey • Document review/ surveys/key stakeholder interview • Key stakeholder interviews/surveys/ most significant change

Estimates of economic benefits are usually made using models of demand and supply that allow the estimation of producer and consumer surplus. Where there are significant flow-on effects to other industries, a general equilibrium model is required to assess the changes in economic surplus arising from the measured impact. A detailed discussion of what approaches are appropriate to different impacts and market conditions is provided in 'Guidelines for economic evaluation of R&D' (GRDC 1997).

The framework extends beyond the estimation of the standard economic benefit measures. Benefits under each of the TBL categories above may be measured in terms of monetary values (willingness to pay for non-market benefits) and in terms of an observed direct measure (such as income variability for income security). An instrumental variable that uses a factor highly and reliably correlated with a benefit might also present itself, such as the area of habitat protected as an indicator of protection of biodiversity.

Table 6 provides a range of examples of benefit measures and indicators for these three different categories.

Table 6. Examples of measures and indicators of benefits

Benefit category	Benefit	Measure/indicator
Economic	• Producer surplus	• Yield • Production costs • Price premium
	• Consumer surplus	• Prices • Variety of produce
	• Income security	• Income fluctuation • Market access • Variety of produce • Alternative income sources
	• Government expenditure saving	• Government expenditure
Social	• Employment opportunities	• Different types of work
	• Improved health/nutrition	• Days of illness • Calories per day
	• Poverty reduction/human development	• Number/per cent of population below national poverty line • Human development index rating • Stakeholder opinion
	• Increased participation in decision-making	• Local government public liaison positions/committees • Community consultation groups in operation • Stakeholder opinions
Environmental	• Reduced pollution	• Air/water/land toxicity • Stakeholder opinions
	• More efficient water usage	• Water consumption • Trips to water source per day • Stakeholder opinion
	• Revegetation	• Awareness and understanding of issue • Expenditure on activities • Land area being revegetated
	• Protection of biodiversity	• Awareness and understanding of issue • Expenditure on activities • Area of habitat protected

Step 3. Data requirements, sources and appropriate tools

Based on Table 7, much of the data required to employ the measures it identifies, such as yield, prices and variety of produce, might be readily available from a central source. Potential sources of these data include national, regional or local government departments, non-government organisations and donors sponsoring (and evaluating) related projects in the same geographic area. Other, more-qualitative data, such as that relating to work options and awareness and understanding of issues, are likely to require surveying farmers and others directly involved, identifying the key stakeholders and interviewing them in more detail.

Table 7 provides some examples with regard to the running examples taken from the ACIAR IAS evaluations.

Part III of this report presents two case studies applying this capacity-building evaluation framework.

Table 7. Examples, from ACIAR IAS, of data required, sources and tools for measuring benefits

IAS No.	Measure/indicator	Data required	Data source	Tool
18	• Yield • Production costs • Yield premium	• Before and after yield (estimates) • Decrease in expenditures on herbicide and tillage • Increased yield estimates due to early sowing	• Studies of 1990 experience • Studies of estimated savings • Yield loss due to late sowing	• Document review • Document review • Market/farmer surveys • Recent studies
25	• Value of yield losses	• Qualitative estimates of incidence and potential/ present severity of disease • Yield loss due to incidence and severity • Representative yields and prices • Levels of R&D capacity	• Local wheat pathologists • Local plant pathologists/ previous studies • Government/market yield and price records • Organisational records on years of study and experience and levels of current involvement	• Scoring model/key stakeholder interview • Key stakeholder interview/ document review • Document review/key stakeholder interview • Regression of change in yield on level of human capacity
33	• Yield • Costs • Soil degradation	• Current and future planned area adopting conservation tillage (CT) • Yield increase and cost decrease due to CT/controlled-traffic farming (CTF) • Soil erosion rates	• Government records/ policies • Published yield and costs data in target areas • Environmental benefit studies of CT/CTF	• Interviews • Experiments • Regionally disaggregated model • Stochastic Monte Carlo routine • DREAM (ACIAR)

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

Part III
Case studies

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

6 Case study one: pigeonpea improvement

Introduction

The objective of this case study is to test the capacity-building evaluation framework developed in chapter 5. The framework provides a guide to evaluating the contribution made by training and other capacity-building activities separately from technical outputs arising from associated R&D projects. The capacity building may be integrated into these projects or an independent activity.

The ACIAR-funded pigeonpea improvement projects represent an ideal case study for testing the framework, because:

- an evaluation of the projects' overall impacts has already been completed (Ryan 1998)
- a central aim of the projects was 'to improve the research capacity of the co-operators in partner countries in the areas of design, experimentation and evaluation of introduced breeding material' (Ryan 1998, p. 9), mainly via collaboration between Indian scientists and Australian experts
- the previous evaluation found that a major benefit of the projects resulted from the development of skills resulting from the active participation in the projects of Indian scientists from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

The third point strongly implies that the benefits attributed to the projects by the previous evaluation were due in significant part to an increase in the research capacity at ICRISAT resulting from participation of its scientists in the projects.

Background

In 2005, 3.5 million hectares (ha) of land were planted to pigeonpea (*Cajanus cajan*) in India, yielding 2.9 million tonnes. This represents approximately 90% of world pigeonpea cultivation (FAO 2006).

The area planted to pigeonpea increased from 2.4 million ha in 1961 to 3.5 million ha in 2005—an average annual increase of slightly less than 1% per year. Over this period, yield has increased by an annual average of approximately 2% (faostat.org).

Pigeonpea has been regarded traditionally as a subsistence crop in India, often as a minor component in intercropping systems with cereal, fibre and oilseed crops. Since the introduction of improved pigeonpea genotypes in the mid-1980s, however, farmers have started sowing larger areas of pigeonpea as a commercial crop (Mueller et al. 1990).

Pigeonpea plants, like all legumes, can fix nitrogen into the soil as they grow. This enriches the soil and benefits the crops planted after pigeonpea. The development of improved pigeonpea genotypes with shorter maturation periods has made it possible for pigeonpea to be grown in a wider geographic area and in crop-rotation systems with wheat and rice. In many traditional cereal-growing areas, persistent rotation of cereal crops, such as rice and wheat, has led to soil degradation and falling yields. In turn, this has led to the increased application of fertiliser and, consequently, environmental problems such as the contamination of groundwater supplies and soil acidification.

Pigeonpea is consumed as dhal in India, providing high levels of dietary protein. The wider geographic area where improved pigeonpea genotypes can be grown thus represents an additional opportunity for alleviating poverty in parts of India where agricultural land is marginal, malnutrition common and commercial crops non-existent. The stalks of the plants also provide a substantial amount of fuel. This is particularly valuable in areas where wood and other fuels are scarce.

The ACIAR projects

The ACIAR pigeonpea-improvement projects did not take place in isolation. Much work was done by other organisations on developing shorter-duration and higher-yielding pigeonpea genotypes before the ACIAR projects commenced in 1982. The Indian Council for Agricultural Research (ICAR) and ICRISAT also conducted independent research in parallel to the ACIAR projects and after their completion in 1988.

Prior work on pigeonpea improvement

The ACIAR projects followed more than 10 years of research into short-duration pigeonpea (SDPP) by the University of Queensland (UQ), which used genetic material from India to explore the potential of pigeonpea as a new crop in Australia. A central consideration of this research was to develop genotypes that could be farmed mechanically, rather than in the labour-intensive manner employed by subsistence farmers in India.

Over this period, the UQ team developed informal relationships with the Indian national program and ICRISAT. The same UQ team was commissioned by ACIAR to undertake the pigeonpea-improvement projects. It is therefore important to acknowledge the *social capital* built between these organisations before the ACIAR projects, irrespective of any additional human capital formation.

Description of the ACIAR projects

ACIAR provided support to two related pigeonpea-improvement projects (8201 and 8567) from 1982 to 1988. These projects were aimed at improving the grain yield potential of pigeonpea using modern plant breeding, along with physiological, agronomic, processing and socioeconomic research.

The projects involved two kinds of investments: technical investments and capacity-building investments. The technical investments comprised the provision of breeding materials from both Australia and India considered suitable for developing new genotypes adapted to Australian, Indian and other countries' agricultural requirements. The following capacity-building activities comprised the other major input to the ACIAR projects:

- long-term visits to Australia by three ICRISAT scientists (Dr Saxena for 3 years, Dr Gupta for 1 year and another ICRISAT staff member for 1 month)
- postgraduate training funded by the AIDAB/ACIAR Fellowship program
- training project collaborators in partner countries
- pest-management training in Indonesia and Thailand.

Outcomes

The ACIAR project evaluation reported a range of scientific outputs including the:

- identification of a male sterile line, subsequently used in the development of pigeonpea hybrids by ICRISAT and ICAR
- development of an understanding of the inheritance of traits and the design of efficient methods of recombination and selection for use in breeding programs
- undertaking of physiological studies of crop growth and development, photothermic responses in phenology, water stress tolerance and reproductive biology
- evaluation of the potential of SDPP in a range of farming systems

- contribution to the release of at least four SDPP cultivars.

In addition to these scientific outputs there were:

- 24 publications arising from the projects facilitated the spillover of knowledge-based outcomes
- long and short-term training of collaborators from the National Agricultural Research Service and ICRISAT ensured that there would be a cadre of scientists to carry forward the research agenda beyond the life of the ACIAR projects (Ryan 1998).

The projects did not develop any genetic products that were subsequently adopted by farmers. However, the technology, knowledge and skills developed by the projects were considered to have contributed significantly to the development and adoption of SDPP.

Benefit measures

The economic model used in the project evaluation incorporated the following benefit measures:

- yield effect
  - reduction in unit production costs arising from higher yields
- nitrogen-fixing effect
  - reduced expenditure on fertiliser due to the natural nitrogen-fixing characteristics of pigeonpea plants.

The model also separated out the benefits into two categories, in order to more accurately represent the distribution of SDPP adoption on land previously sown to:

- traditional pigeonpea genotypes (60%)
- non-leguminous crops or left fallow (40%).

Table 8 shows the values used for the benefit measures. These were derived mostly from a detailed study on the adoption of SDPP genotype ICPL 87 in southern India (Bantilan and Parthasarathy 1997).

The increase in yield gained by replacing traditional pigeonpea varieties with SDPP is used as a proxy for the value-added of production of SDPP on fallow land. As such, it represents a lower bound rather than an average increase in value-added. All pigeonpea plants have nitrogen-fixing characteristics, so no nitrogen-fixing benefit is gained from substituting traditional pigeonpea genotypes with SDPP. The nitrogen-fixing effect (A$17.20 per ha) was applied only to the estimated 40% of SDPP adoption sown on land previously sown to non-leguminous crops or left fallow.

Benefits

The evaluation of the ACIAR projects (Ryan 1998) detailed the investments in SDPP made by ICAR, ICRISAT and UQ in the years preceding and following the ACIAR pigeonpea-improvement projects. The interaction and sharing of knowledge across the different institutes—arguably a significant factor in ensuring the success of projects—made it difficult to separate out the returns to the ACIAR investments alone. The evaluation therefore considered the combined investments into SDPP made by UQ and ACIAR and found them to be jointly critical in leading to the identification of the new, higher-yielding SDPP genotypes. The estimation of benefits was also limited to adoption impacts arising in India, due to the lack of data available concerning SDPP adoption elsewhere.

The ACIAR/UQ pigeonpea research investments were considered to have brought forward in time the adoption of SDPP in India. The most likely counterfactual scenario in the absence of the ACIAR/UQ investments was considered to be a 3-year delay in adoption. Alternative counterfactual scenarios that applied a 1-year and a 5-year delay in adoption were also considered to test the sensitivity of the evaluation to this assumption.

Table 8. Benefit measures used in the ACIAR project evaluation

Benefit	Unit	Measure
SDPP yield	t/ha	1.35
Unit production cost reduction	A$/t	48
Nitrogen-fixing effect	A$/ha	17.20
Year of adoption	Year	1984
Adoption rate in first year	%	0.3
Year of maximum adoption	Year	2005
Maximum adoption rate	%	35

Source: Ryan (1998).

The benefits of bringing forward in time SDPP adoption were estimated by comparing the baseline scenario (adoption commencing in 1984) against these counter-factual scenarios (adoption commencing in 1985, 1987 or 1989). Each of these scenarios was evaluated using the economic model described above, including realised and projected benefits to 2007 as well as only benefits already realised to 1997.

Regarding realised and projected benefits to 2007, Table 9 shows that SDPP adoption in 1984 resulted in estimated gross benefits of A$219 million. Subtracting the discounted costs of A$28 million—the sum of all investments in pigeonpea improvement made by ICAR, ICRISAT, UQ and ACIAR—resulted in an estimated net present value (NPV) of A$191 million. The most likely counterfactual scenario resulted in estimated net benefits of A$150 million, subtracting only A$20 million in costs—the investments in pigeonpea improvement made by ICAR and ICRISAT.

The realised and projected net benefits to 2007 of the ACIAR/UQ investments of around A$8 million were thus estimated as A$41 million. This represents an internal rate of return (IRR) of 48.9%.

The net benefits already realised to 1997 were estimated at A$31 million, representing an IRR of 25.6% (Ryan 1998).

The importance of capacity building

Many ACIAR-funded R&D projects rely on enhancing the skills of project participants and broadening the scope of their professional experience in order to bring about change. Agricultural R&D often has a long lead time—from initial experimentation, through successive rounds of laboratory testing, field-testing and on-farm-trials—before any successful results can be translated into the adoption by farmers of a new variety, breed or method.

Building the capacity of local scientists and their organisations is implicit in most ACIAR projects and the primary objective of these two projects was to develop scientific products and enhance human capital in partner countries. The following excerpt from the 1985 project review (McWilliam et al. 1985, p. 5) strongly asserts that capacity building was the major outcome of these projects:

> The stimulation of creativity in scientific research should be a major thrust of any new project. One of the long-term benefits of the project should be the research experience gained by the young scientists from Australia, South-East Asia and the South Pacific who have participated in this applied crop improvement program. The long term goal of ACIAR projects cannot be to solve all the production problems of a crop but to steer local scientists to creative research by which they can solve particular problems as they arise.

Table 9. Estimated benefits of the ACIAR projects

Scenario	Realised and projected benefits to 2007			Realised benefits to 1997 only		
	Discounted gross benefits (A$m)	Discounted costs (A$m)	Net benefits (A$m)	Discounted gross benefits (A$m)	Discounted costs (A$m)	Net benefits (A$m)
Baseline: adoption 1984	219	28	191	103	28	75
Counterfactual 1: adoption 1985	201	20	181	89	20	69
Counterfactual 2: adoption 1987	170	20	150	65	20	45
Counterfactual 3: adoption 1989	145	20	125	47	20	27

Source: Ryan (1998).

Dr Paul Ferrar, a team member involved in the pigeonpea-improvement projects and former ACIAR employee of 19 years standing, further supports this assertion. Dr Ferrar (pers. comm., 14 July 2006) was keen to emphasise the crucial role played by capacity building in all ACIAR projects in which he was involved:

> I was firmly convinced that the major benefit from ANY ACIAR project was capacity building and the establishment of research networks and friendships between project colleagues that lasted after the end of the project (in many cases). In some projects there were valuable scientific discoveries as well, but even then I would say that the biggest overall gain was in human terms rather than scientific.

An interesting feature of the 1998 project evaluation was its finding that the breeding material introduced from Australia did not lead to the identification, release and adoption by farmers of new, higher-yielding pigeonpea genotypes. The evaluation concluded (Ryan 1988, p. 21) that the projects:

> … had, as [their] major benefit, the spillover of scientific knowledge and intermediate scientific products, such as sources of genetic male sterility and photo-period insensitivity, rather than final genetic products which were widely adopted by farmers.

This conclusion was strongly supported by Dr Saxena, who assisted in tracing the pathways from his capacity-building experiences as a project participant through to the adoption of the improved pigeonpea genotypes by Indian farmers.

Since the 1998 evaluation, the pioneering work carried out under the ACIAR pigeonpea-improvement projects has led to the identification, field-testing and release of yet more productive, extra-short-duration pigeonpea (ESDPP) genotypes. Wild pigeonpea hybrid genotypes have also been successfully developed and trialled, but have yet to be released.

From the perspective of 2006, it now appears clear that the benefits attributed to ACIAR/UQ by the previous evaluation were, to a significant extent, the result of the pigeonpea-breeding skills acquired by ICRISAT scientists. The ACIAR pigeonpea-improvement projects promoted the development of these skills by facilitating the participation of local scientists in long-term exchange visits to Australia and ongoing mentoring by Australian experts. This collaborative mode of project implementation provided both the Indian and the Australian scientists with an invaluable opportunity for learning by doing.

Applying the framework

Applying the framework requires:

- identifying the links along the pathway from the capacity-building activities to the measured benefits
- substantiating each significant link using appropriate measures, such as indicators and expert opinions
- taking into consideration external inputs influencing the outcomes
- measuring the benefits with the ACIAR capacity-building contribution against the most likely scenario without the ACIAR contribution.

There are two ways to use the framework. The first is to trace the progression 'forwards' through the framework, from the training activity being evaluated to the impacts attributable to it. This involves determining the capacity built by the training and tracking how this capacity was used to produce project outputs and outcomes.

The second way—the method employed for this case study—is to determine the project impacts and then track 'backwards' through the framework to establish what influence the capacity building had on the achievements made by the projects.

Dr K.B. Saxena, now an expert pigeonpea breeder at ICRISAT who participated in the capacity building associated with the ACIAR projects and has worked on the topic ever since, has been the principal source of information in this respect. Discussions with Dr Saxena identified three major impacts attributable, in part, to the capacity-building aspects of the project:

1. release and on-farm adoption in India of SDPP genotypes
2. identification, development, release and adoption in India of ESDPP genotypes
3. identification, development, field-testing and on-farm trials in India of hybrid pigeonpea (HPP) genotypes.

All these impacts relate only to India. Successful trials of ESDPP genotypes have taken place in Sri Lanka and the Philippines, as well as at latitudes as far south as New Zealand and as far north as South Korea. There are also reports of pigeonpea adoption in Peru, but it is as yet too early to know the extent of the impact these developments will have. Since India represents approximately 85% of the current world market for pigeonpea, the magnitudes of any impacts outside India are likely to be small by comparison.

Project inputs

The objective of this evaluation is to estimate the strength of the links between the capacity built by the projects and the later development of improved pigeonpea genotypes (SDPP, ESDPP and HPP) that have been successfully adopted by farmers.

This evaluation focuses on a 3-year postdoctoral fellowship at the University of Queensland undertaken by Dr K.B. Saxena of ICRISAT. This long-term capacity-building activity involved professional collaboration rather than formal training. Dr Saxena described three elements of capacity building, in order of relative significance:

1. Learning by doing:
   - collaboration with experts in the practical application of knowledge, which led to effective on-the-job training.
2. Access to knowledge/knowledge transfer concerning:
   - plant breeding techniques developed during earlier UQ projects
   - the concept of photo-insensitivity and its link with early maturation
   - the viability of high-density cropping in semi-arid environments.
3. Working with experts:
   - contact with plant breeding scientists from different organisations and experts in other disciplines promoted the benefits of a multidisciplinary approach and established a network of scientists, working collaboratively on related topics and sharing knowledge.

Figure 8 provides an overview of the pathways from these capacity-building activities to the observed benefits, using the template presented in chapter 5. The following text traces the contribution made by the skills, knowledge and techniques acquired from the capacity building to the subsequent release and adoption of shorter duration, higher yielding pigeonpea genotypes.

Capacity built

Collaboration and knowledge exchange between experts led to a perpetual cycle of skills improvement and utilisation, which led, in turn, to further increases in capacity and so on. The framework illustrates schematically the pathways from capacity building to benefits.

The capacity-building activities enhanced the skills of the individual ICRISAT scientists selected, and expanded the knowledge base of their organisation, ICRISAT. The scientists increased their capacity to:

- screen breeding materials for beneficial characteristics, such as photo-insensitivity
- select genotypes for further breeding on the basis of adaptability to different climatic environments
- undertake crossbreeding
- test the cultivars developed under laboratory and on-farm conditions.

Contacts made through the training activities subsequently led to the creation of an international network of scientists working on the development of shorter-duration, higher-yielding pigeonpea and ongoing professional relationships developed between the Australian and Indian research scientists involved.

In addition, Dr Saxena highlighted the importance of the capacity building with regard to improving his capacity to follow scientific journals and keep up with relevant developments elsewhere.

The capacity building was also considered to have expanded the knowledge base at ICRISAT, including an increased understanding of:

- inheritance traits
- the physiology, phenology, water-stress tolerance and reproductive biology of pigeonpea

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

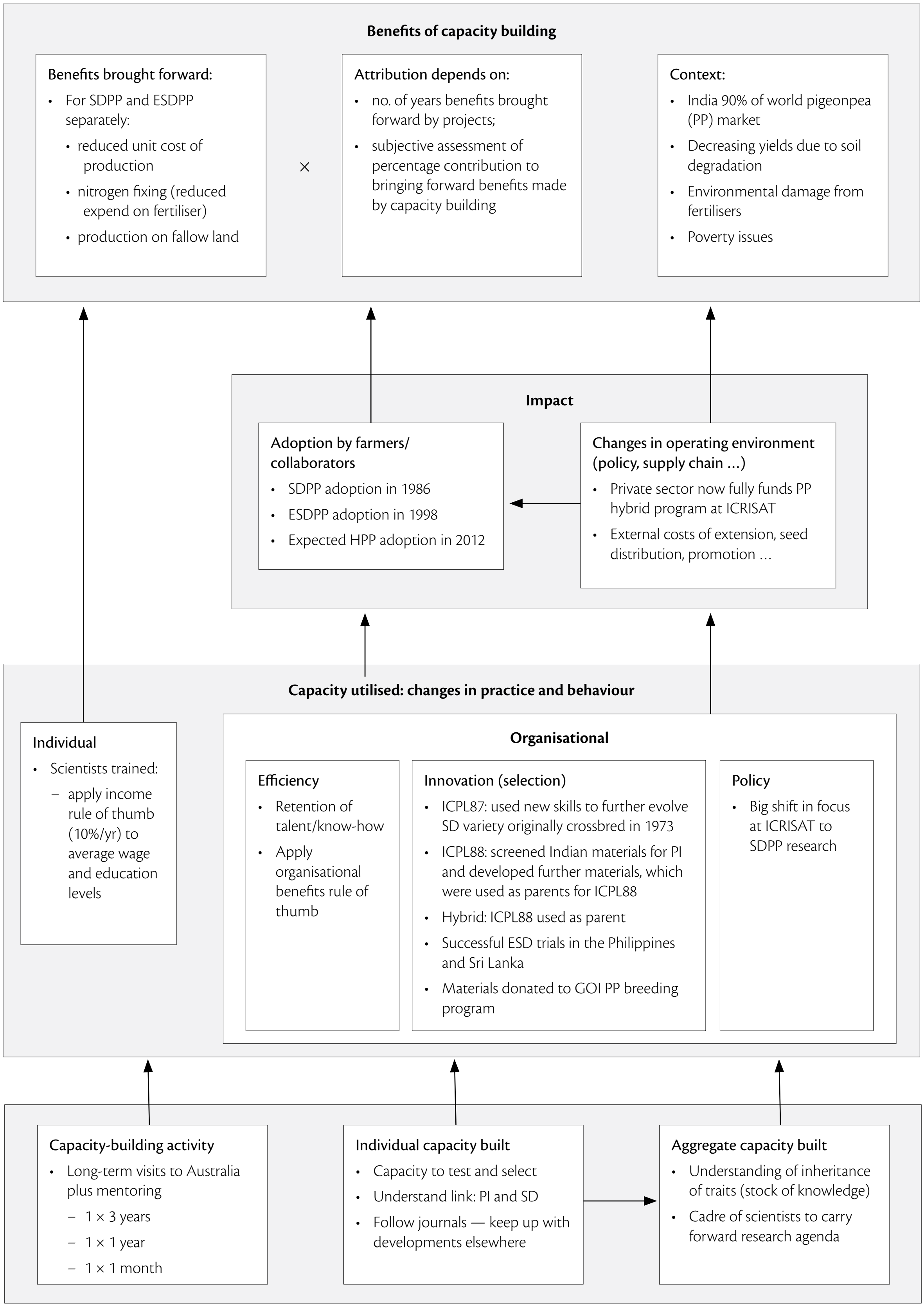

Figure 8. Pathways to benefits and their attribution to postdoctoral fellowship work in Australia

- the advantages of a cross-disciplinary approach to crop improvement compared with reductionist, disciplinary research
- the potential improved pigeonpea genotypes in a range of environments, thus transforming perceptions of pigeonpea from a subsistence crop to a commercially viable crop.

This enlarged knowledge base was embodied in the scientists and other participants in the project. Together, these individuals formed a cadre of scientists to carry forward the research agenda beyond the life of the ACIAR projects—an evolving process that continues today.

Capacity utilised

Rules of thumb regarding capacity utilised

Dr Saxena has published more than 200 research articles and two books on pigeonpea breeding and presented papers at pigeonpea conferences since he returned to ICRISAT from Australia in 1982. This demonstrates a continuous contribution to the pigeonpea improvement program at ICRISAT stretching almost 25 years to date. Dr Saxena considers the time he spent in Australia to have played a principal role in his development as a plant breeder. His lengthy and continuing employment at ICRISAT is also an indicator of the organisation making use of his skills.

Two rules of thumb developed in chapter 2, about the effect of education on individual income and the organisational returns to capacity building, can be applied here. The rule of thumb for the individual states:

> A worker's lifetime income is higher, on average, by around 10% for each additional year spent in formal education.

Indicators of organisational capacity utilised

Project outputs are often good indicators of capacity being utilised. The 1998 evaluation cites two achievements of the projects that offer themselves as indicators of capacity utilised, namely:

- contribution to the release of at least four SDPP genotypes
- 24 publications arising from the projects, which facilitated the spillover of knowledge-based outcomes.

Since 1998, many more genotypes have been released by ICRISAT, including the extra-short duration ICPL 88039. The hybrid pigeonpea variety identified as attributable to the capacity building being evaluated has also been field tested with very promising results.

Other significant demonstrations of capacity being utilised by ICRISAT are:

- the design of efficient methods of recombination and selection for use in breeding programs
- the focus of pigeonpea improvement research at ICRISAT on photo-insensitive breeding materials
- the identification of a genetic male sterile line that has been used in the development of pigeonpea hybrids by ICRISAT and ICAR
- the initiation of a significant shift of the ICRISAT pigeonpea improvement program to focus almost entirely on non-traditional shorter-duration materials and production systems
  - this demonstrates how ICRISAT embraced the new knowledge transferred to it during the projects to the extent of changing its official policy direction for pigeonpea improvement.

These intermediate outputs and scientific developments form the link between the utilisation of capacity built and the benefits arising from the adoption of SDPP, ESDPP and HPP by farmers in India. Figure 9 provides a schematic overview of the impact of the capacity utilised, which differs across the three different generations of pigeonpea.

Short duration pigeonpea

SDPP genotypes were identified and developed before the commencement of the ACIAR pigeonpea-improvement projects. ICPL 87 is a short-duration pigeonpea variety that resulted from pedigree selection from the cross 'ICPL 73032' made in 1973. This original cross could not, therefore, have been influenced by the ACIAR projects. ICPL 87 was not released until 1986, however. This is 4 years after the start of the projects and the return of Dr Saxena from his 3-year sojourn in Australia.

Dr Saxena was directly involved in the further development of ICPL 87 before it was released and subsequently adopted by farmers. It is therefore reasonable to assume that some credit for the impact of this variety is attributable to the capacity-building elements of the ACIAR projects.

Extra-short duration

The ESDPP genotype ICPL 88039 was developed in 1988, during the ACIAR project funding period, and the capacity built was instrumental in making possible further developments after the projects had been completed.

In particular, during his fellowship in Australia, Dr Saxena screened Indian breeding materials for an extended photo-period and established a link between low photo-sensitivity and early maturity. The identification of this link is regarded as the crucial step in the development of all shorter-duration pigeonpea genotypes.

Dr Saxena returned to India in 1982, where he continued to work at ICRISAT, using his improved skills in crossbreeding to develop additional breeding and parental materials that were subsequently used to create ICPL 88039.

Hybrid

The links between new capacity utilised during and after the completion of the ACIAR projects and the development of HPP genotypes are less concrete than for ESDPP. However, the project leader, Don Byth, constantly emphasised the vital role to be played by hybridisation in achieving dramatic increases in pigeonpea yields. Although this was never a dominant theme of the projects, the project team was aware that a male sterility system had to be found in order for hybrid pigeonpea genotypes to be created.

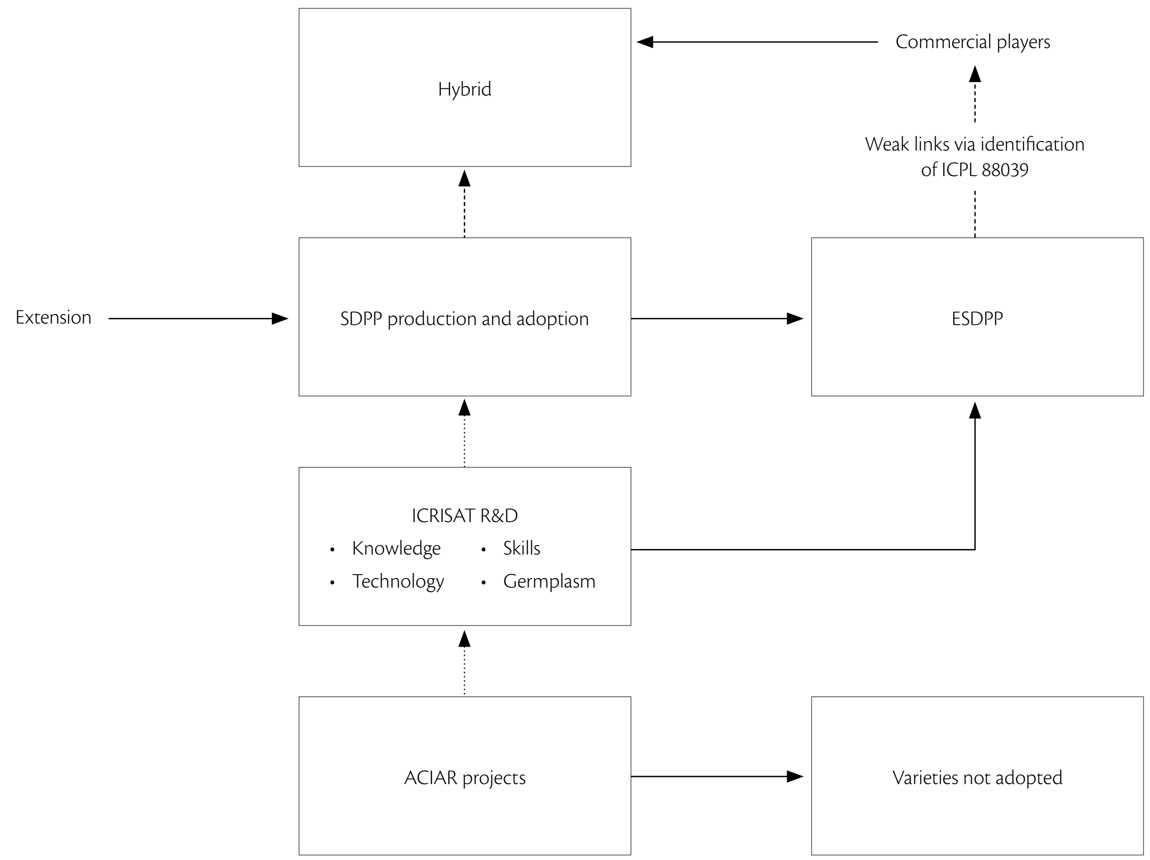

Figure 9. Simplified overview of the pathways from capacity building to benefits

During the project period, a male sterility system was identified at UQ in Australia and another at ICRISAT in India. Attempts were made during the projects to develop a short-duration hybrid by deliberately crossbreeding the male sterility systems with photo-insensitive breeding materials, in order to generate a new male sterility line that was photo-insensitive. These materials were taken back to ICRISAT and used in its breeding program. No direct outcomes were achieved, however, due to the fallibility of the genetic male sterility system in use at the time.

The development at ICRISAT of functional cytoplasmic male sterility from the cross of *Cajanus scarabaeoides* (a closely related wild species of pigeonpea) and cultivated pigeonpea, has led to the successful generation of a number of promising hybrid genotypes. While this process would have undoubtedly drawn upon the skills acquired during the ACIAR projects, the link is considered indirect and too weak for any attribution to the ACIAR projects.

Of particular interest, however, is the development at ICRISAT of a hybrid adapted to North Indian conditions using the extra-short-duration variety ICPL 88039 as a parent. This suggests that some of the benefits associated with the adoption of this hybrid in particular are attributable to the ACIAR capacity building based on the attribution to ACIAR of benefits associated with the adoption of ICPL 88039.

Determining the impact

The next step in quantifying the contributions of the capacity building to the development of improved pigeonpea genotypes is to estimate the impact that the introduction of these improved genotypes has had. This involves determining the adoption patterns of the improved pigeonpea genotypes and the differences between the impacts of traditional and improved genotypes. The major effects are the same as those used by the ACIAR project evaluation described above, namely:

- increased yield of the improved pigeonpea genotypes leading to a reduction in unit production costs
- savings on fertiliser expenditures resulting from the nitrogen-fixing characteristics of pigeonpea planted on land previously left fallow or planted to non-leguminous crops, such as rice–wheat rotations.

All pigeonpea genotypes, like other leguminous crops, exhibit environmentally beneficial characteristics beyond the fertiliser effect singled out above. As a result, the adoption of pigeonpea in non-traditional areas contributes to the sustainability of farming. These additional environmental effects are discussed below.

In addition, the recent geographical expansion of pigeonpea facilitated by the development of ESDPP is likely to make a significant contribution to reducing malnutrition and poverty in the hilly areas of northern India at altitudes of up to 2,000 metres.

Adoption patterns

Table 10 provides an overview of the data and estimates of adoption for the different pigeonpea genotypes. This information was obtained from ICRISAT (Dr C. Bantilan, pers. comm.). Supporting information about these estimated adoption patterns was obtained during discussions with Dr Saxena at ICRISAT and Dr R. Gupta at CIMMYT, India.

Short-duration pigeonpea

The first adoption of SDPP took place in 1986 at a rate of 3% of total pigeonpea output, reaching an estimated maximum adoption rate of 30% in 1997. The division of this adoption rate between 60% substitution for traditional pigeonpea genotypes and 40% planting on previously fallow land or replacing non-leguminous used in the ACIAR project evaluation was confirmed as a reasonable estimate by Dr Bantilan. This ratio has a significant impact on the benefits of SDPP adoption associated with natural nitrogen-fixing legume characteristics exhibited by all pigeonpea plants and is further discussed below.

Extra-short-duration pigeonpea

ESDPP was first released and adopted in 1998, quickly making up 5% of production and attaining its maximum adoption rate of 35% by 2002. ESDPP was released in areas where farmers had already become familiar with SDPP. This helps to explain the rapid adoption of ESDPP, which offers even greater advantages over traditional pigeonpea genotypes, including:

- an even shorter maturation period
- suitability to cropping in a larger geographic area
- improved yield and nitrogen-fixing effects
- higher levels of drought- and disease-resistance.

Adoption studies conducted by CIMMYT in India confirm that ESDPP adoption has been rapid where it has been introduced in traditional rice–wheat rotation cropping areas in the Indian Gangetic Plain (IGP). This is due to a combination of reasons, including:

- the shorter duration ensures that wheat sowing is not delayed
- the increased profitability of ESDPP as a commercial crop
- the environmental benefits associated with pigeonpea
- the concerns of farmers in the area about the future viability and sustainability of growing rice.

ESDPP adoption has been either in substitution for SDPP or on previously fallow land. The 60:40 ratio between substitution for traditional pigeonpea and planting on fallow land used for SDPP in this respect is also considered a reasonable estimate for ESDPP.

This has led to an increase of more than 550% in the total area planted to pigeonpea in the districts studied, as shown by Figure 10.

Hybrid pigeonpea

Field trials of HPP have been conducted with promising results, and adoption is expected to begin in 2012. At present, there is insufficient data available to enable estimates of HPP adoption rates to be made. Given ICRISAT's policy not to release any HPP genotype unless it has a yield at least 30% above that achieved by ESDPP, it is expected to represent an attractive proposition to Indian farmers when released. The adoption of HPP is not expected to commence until the penultimate year of the 30-year evaluation period. With the discount rate, the benefits need to be large to influence the rate of return estimates. More importantly, the links with the ACIAR capacity-building activities being evaluated are weak, and many other investments have contributed to the development of HPP genotypes. For these reasons, no attempt was made to quantify the benefits resulting from the future adoption of HPP.

SDPP adoption has declined since ESDPP was introduced

The level of adoption SDPP has fallen rapidly since 1998 in areas where ESDPP has been released. Figure 10 clearly illustrates this effect in the Sonepat and Ghaziabad districts, north-western IGP, India, where the adoption of ESDPP has led to a reduction of almost 75% in the area planted to SDPP, from 450 ha in 2001 to 125 ha in 2005.

The replacement of SDPP with ESDPP affects how the impacts of ESDPP are measured when estimating the benefits of improved pigeonpea adoption. This is discussed in more detail below.

Table 10. Adoption patterns for the different improved pigeonpea genotypes

Adoption pattern factor	Unit	SDPP	ESDPP	HPP
First year of adoption	Year	1986	1998	2012
Adoption rate in first year	%	3	5	No data
Approximated increase in adoption per year	%	3.86	7.5	No data
Maximum adoption rate	%	30	35	No data
Year maximum adoption achieved	Year	1997	2002	No data
Proportion substituting for traditional pigeonpea	%	60	60	No data
Proportion on fallows/replacing cereal crops	%	40	40	No data

Source: Drs C. Bantilan, K.B. Saxena and R. Gupta, pers. comm.

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

Measuring the impact

The measures used in this study to estimate the impact of the ACIAR projects are based on information obtained from Drs Bantilan and Saxena at ICRISAT and Dr Gupta at CIMMYT. It also draws on information in ICRISAT (2001).

The impact of the ACIAR projects

The impacts arising from the ACIAR projects are the earlier adoption by Indian farmers of SDPP and ESDPP detailed above; that is, the adoption profile for each variety was brought forward by a number of years as a result of the ACIAR projects.

The ACIAR project evaluation assumed that, in the absence of the ACIAR/UQ research, the most likely scenario would have been a 3-year delay in the adoption of SDPP. This study found no reason to change this assumption for SDPP. It further assumed that the ACIAR projects also brought forward the adoption of ESDPP by 3 years.

Capacity-building impact

The combination of the strong convictions held by the 1985 project review team, the 1998 evaluation, project team members and Dr Saxena cited earlier leads to the conclusion that the ACIAR capacity-building activities played a very significant role in bringing forward in time the adoption of SSDP and ESDPP. It was also considered that the capacity building would have had a significant impact on the development of improved pigeonpea genotypes had the technology transfer of Australian breeding material not have taken place during the ACIAR projects.

These factors led to the conclusion that the capacity building significantly improved the outcomes of the ACIAR projects and may have been the major reason for the projects having an impact. It was therefore decided to evaluate the benefits attributable to the capacity building, based on a combination of the benefits brought forward and relative-importance approaches detailed in step 4 of the evaluation framework outlined in chapter 5. As discussed above, the ACIAR projects were assumed to have brought forward by 3 years the benefits of adopting both SDPP and ESDPP. The share of this overall impact attributable to capacity building required subjective assessment.

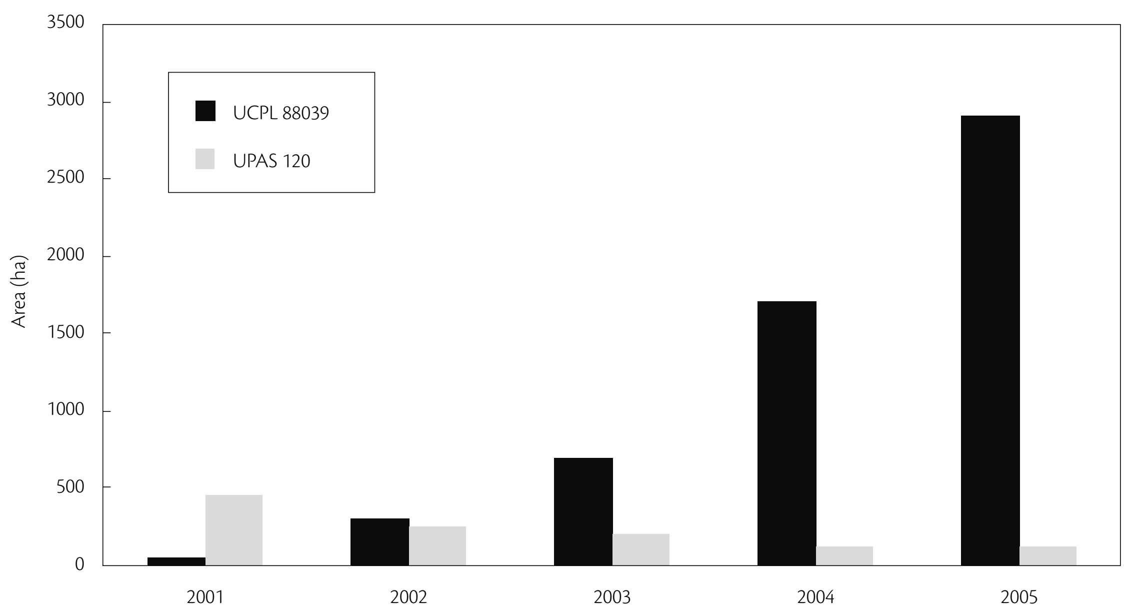

Figure 10. Area spread of the ESDPP variety ICPL88039 in two districts in the north-western IGP, India. Data from R. Gupta, pers. comm., June 2006

Based on the conclusions of the 1998 evaluation that capacity building was the major outcome of the projects, it seems reasonably prudent to attribute to capacity building 50% of the benefits estimated for the projects as a whole. This estimate appears all the more conservative when it is acknowledged that this case study has focused on only one particular capacity-building activity with traceable outcomes.

The other capacity-building activities noted earlier were more diffuse and hence difficult to track to specific impacts. They involved disseminating vital skills and knowledge throughout the partner organisation in such a way that tracing particular outcomes attributable these activities is not feasible.

Impact measures

Table 11 provides a summary of the measures used to estimate the impact of adopting SDPP and ESDPP. Since adoption of ESDPP has taken place in areas where SDPP was previously adopted, the far-right column shows the advantage gained from replacing SDPP with ESDPP that is used in the estimates.

Yield improvement over traditional pigeonpea genotypes

As discussed earlier, the adoption of the improved pigeonpea genotypes is associated with improved yield compared with the traditional genotypes they replaced. This can be estimated as a reduction in production costs per tonne, taking into account overall production cost increases per hectare resulting from additional inputs and effort required by the changeover. Different levels of savings are associated with the adoption of SDPP and ESDPP.

Yield improvement effect on fallow land

Some 40% of improved pigeonpea adoption has been on previously fallow land. This clearly has a much lower opportunity cost than replacing traditional pigeonpea or other crops with the new varieties. It is therefore reasonable to assume that the net benefits associated with improved pigeonpea adoption on fallow land are greater than the reduction in unit production costs associated with the substitution of traditional pigeonpea or other crops.

Unfortunately, there are no data available upon which to base estimates of these greater benefits. As such, the same yield improvement effect estimated for substituting traditional pigeonpea or other crops with improved pigeonpea genotypes is used as a lower bound of the benefits associated with planting SDPP and ESDPP on otherwise fallow land.

Short-duration pigeonpea

Yield improvements for SDPP were based on comparisons with traditional pigeonpea yields. A unit production cost reduction of 1500 rupees (Rs) was estimated (Drs C. Bantilan, K.B. Saxena and V.K. Chopde at ICRISAT, pers. comm.) or A$42.63 per tonne at an exchange rate of Rs35.1877 to A$1, as quoted on 21 July 2006 (online currency converter: www.xe.com).

Extra-short-duration pigeonpea

In the same way, the reduction in unit production costs associated with the adoption of ESDPP is estimated at Rs2000 (A$56.84) per tonne of yield. Since approximately 60% of ESDPP adoption has been in substitution for SDPP, the full yield-improvement effect is applicable to only the 40% of ESDPP planted on previously fallow land or in substitution for other crops. The yield improvement effect employed for the adoption of ESDPP in substitution for SDPP was therefore equal to the additional unit production cost reduction of A$14.21 per tonne.

Table 11. Yield and nitrogen-fixing effects of SDPP and ESDPP adoption

Adoption impact effect	Unit	SDPP	ESDPP	ESDPP advantage
Yield	t/ha	1.5	1.8	0.3
Unit production cost reduction	A$/t	42.63	56.84	14.21
Nitrogen-fixing effect, per hectare	A$/ha	14.21	18.47	4.26

Source: Drs C. Bantilan, K.B. Saxena and V.K. Chopde, pers. comm., 18 July 2006.

Nitrogen-fixing effects

In addition to the yield-improvement effects, there are benefits to subsequent crops due to the nitrogen-fixing characteristics of pigeonpea plants. These are applicable to only improved pigeonpea genotypes planted on land previously planted to non-leguminous crops or left fallow, assuming that non-leguminous crops were planted after pigeonpea on this proportion of the land.

The estimates of nitrogen-fixing effects per hectare listed in Table 11 are based on the cost to farmers of using fertiliser to provide the soil with the same amount of nitrogen fixed naturally by the pigeonpea plants. Drs Bantilan, Saxena and Chopde derived these estimates from:

- empirical observations of the amount of nitrogen per hectare provided to the land by the different pigeonpea genotypes
- the price of nitrogen provided by urea fertiliser
- the improved crop yield response associated with nitrogen fixed naturally rather than provided by fertiliser.

The different crop densities, nitrogen-fixing effects and yields of SDPP and ESDPP result in different estimated savings on fertiliser expenditure for the respective genotypes.

Short-duration pigeonpea

The nitrogen-fixing effect of SDPP was estimated at Rs500 (A$14.21) per hectare.

Extra-short-duration pigeonpea

The nitrogen-fixing effect of planting ESDPP on previously fallow land was estimated at Rs650 (A$18.47) per hectare. The reason for this higher nitrogen-fixing value compared with that estimated for SDPP is the higher density of cropping typically associated with the adoption of ESDPP.

In addition to this primary nitrogen-fixing benefit, the greater nitrogen-fixing effect of ESDPP compared with SDPP results in a further benefit of A$4.26 per hectare of ESDPP planted in substitution for SDPP, as shown in Table 10.

Figure 11 shows the distribution of the ESDPP benefits resulting from the yield improvement and nitrogen-fixing effects in addition to the total benefits attributable to SDPP adoption.

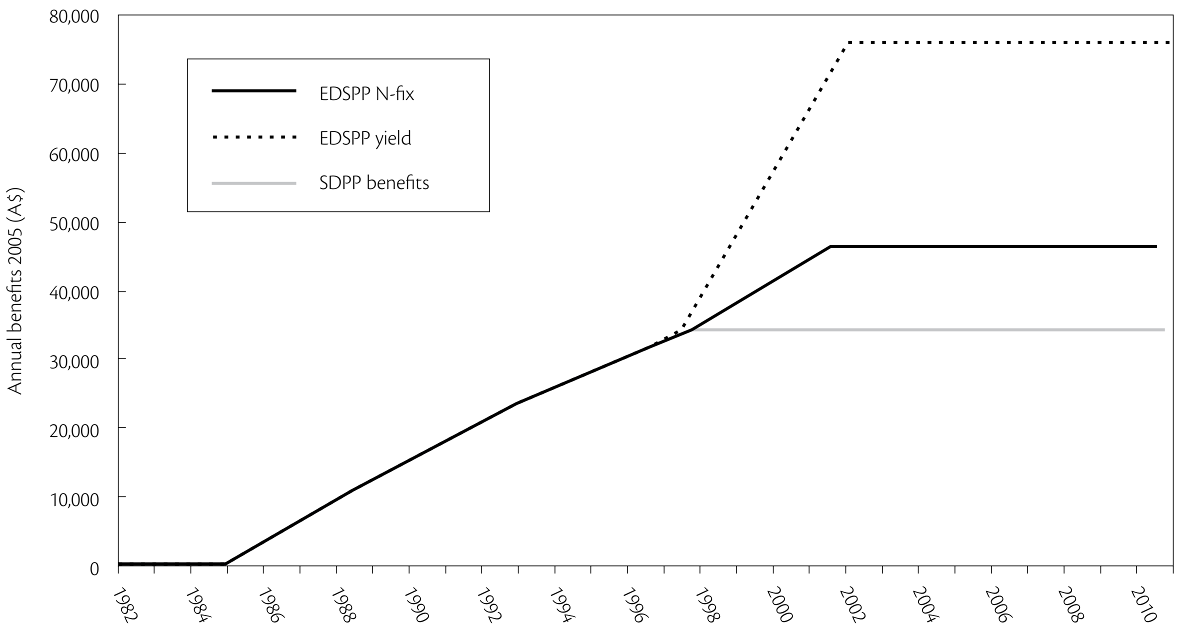

Figure 11. Additional benefits from ESDPP adoption. Data from CIE model, based on Ryan (1998) model

Environmental effects

The use of fertilisers leads to contamination of groundwater through the run-off of fertiliser residues. In turn, this leads to an increased risk of illness in people dependent on the contaminated water source. Any reduction in the use of fertiliser therefore decreases the risk of groundwater pollution and the associated costs of human illnesses, such as intestinal disturbances, viral hepatitis and typhoid fever.

These benefits remain qualitative in this study due to a lack of data and appropriate measures.

Poverty reduction effects

The very deep root systems of the ICPL 88039 ESDPP genotype enable it to access nutrients in degraded soils that have been leached too far below the ground for other plants and pigeonpea genotypes to reach. On-farm trials have demonstrated that ICPL 88039 can be grown at altitudes of up to 2,000 metres on otherwise marginal agricultural land. This represents a great opportunity for poverty reduction in the poverty-stricken villages of the Himalayan foothills, where ICPL 88039 can provide desperately needed protein and a viable commercial crop.

Estimating these effects would require knowledge of the social value and flow-on effects of higher income and improved nutrition resulting in these areas. Since no studies into the poverty-alleviation impacts of adopting improved pigeonpea varieties have been carried out to date, these effects remain unknown. In addition, any estimation of the value of subsistence to the individual would represent a double counting of changes in consumer and producer surplus. These potential poverty-reduction effects therefore also remain qualitative only in this study.

Estimating the impact

Following the ACIAR project evaluation, the impact of adopting improved pigeonpea genotypes is divided into two streams with regard to:

1. substitution for traditional genotypes
2. sowing improved pigeonpea genotypes on previously fallow land or in substitution for cereal crops.

These effects are common for the two generations of improved pigeonpea considered by this evaluation, although their magnitudes differ as detailed above. The impacts are estimated for the adoption of improved pigeonpea genotypes in India only.

The ACIAR project evaluation contains a detailed description of these effects within the economic framework of supply and demand (Ryan 1998, pp. 23–25). This report provides a shorter, less-technical description of the economic theory behind the estimated impacts.

Impact of the yield improvement effect

Producers substituting improved pigeonpea genotypes for traditional varieties benefit from an increase in yield. Farming the new genotypes requires greater expenditure on inputs, however, and the respective reductions in the unit cost of production reported above take these increased costs into consideration.

The unit production cost reduction represents a downward shift in the supply curve from *S1* to *S2*, as illustrated schematically in Figure 12, because farmers can now supply pigeonpea at a lower price. For the reasons discussed above, the same unit-production-cost reduction is assumed for planting improved pigeonpea in substitution for other pigeonpea genotypes and on land previously kept fallow or planted to non-leguminous crops.

Since no change in the quality of the product or consumer preferences has taken place, the demand curve (*D*) is assumed to remain constant. The downward shift of the supply curve therefore leads to a movement along the demand curve, resulting in a change in market equilibrium. The price of pigeonpea falls from *P*1 to *P*2 and the quantity increases from *Q*1 to *Q*2. This leads to changes in both the producer and consumer surplus. The lion's share of benefits accrues to the Indian farmers who adopt the improved pigeonpea genotypes. The total change in economic surplus is equal to the shaded area in Figure 12.

The following parameters, adopted from the ACIAR project evaluation, were used to estimate these changes:

- elasticity of supply 0.51
- elasticity of demand –0.76
- initial price per tonne A$528

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

Impact of the nitrogen-fixing effect

The nitrogen-fixing effect associated with the adoption of improved pigeonpea genotypes does not affect the yield of pigeonpea. Rather, the benefit farmers obtain impacts on the production of crops planted subsequent to pigeonpea. This impact was therefore estimated separately before the resulting benefits were added to those estimated for the yield improvement effect. The effect of lower cost of supply (or higher yield) of these subsequent crops does not have a significant impact on their overall quantity and price. This is based on the assumption that production costs were lowered due to reduced use of fertiliser.

Other countries

While there is potential for similar impacts in countries other than India, it is as yet too early to estimate their magnitude. To date, the most promising circumstances are in:

- the Philippines
  - trials of ICPL 88039 have been very successful as an intercrop with rice. This has resulted in great demand just 1 year after the trials, but no recorded on-farm impacts are available at present.
- Sri Lanka
  - trials of ICPL 88039 have also been very successful but no further progress has yet been achieved.

Dr Saxena believes the potential for success of improved pigeonpea genotypes in countries other than India is dependent on whether or not development agencies in those countries with the potential to benefit from improved pigeonpea genotypes are willing to allocate their limited resources to promoting the crop. This belief is based on the manner in which these developments have taken place in India, whereby local development agencies have been the main drivers of promotion. This has been a key to successful adoption.

Benefit–cost analysis

As outlined above, an update of the benefit–cost analysis contained in the ACIAR project evaluation was carried out to incorporate more-recent data about SDPP adoption and the subsequent adoption of ESDPP in 1998.

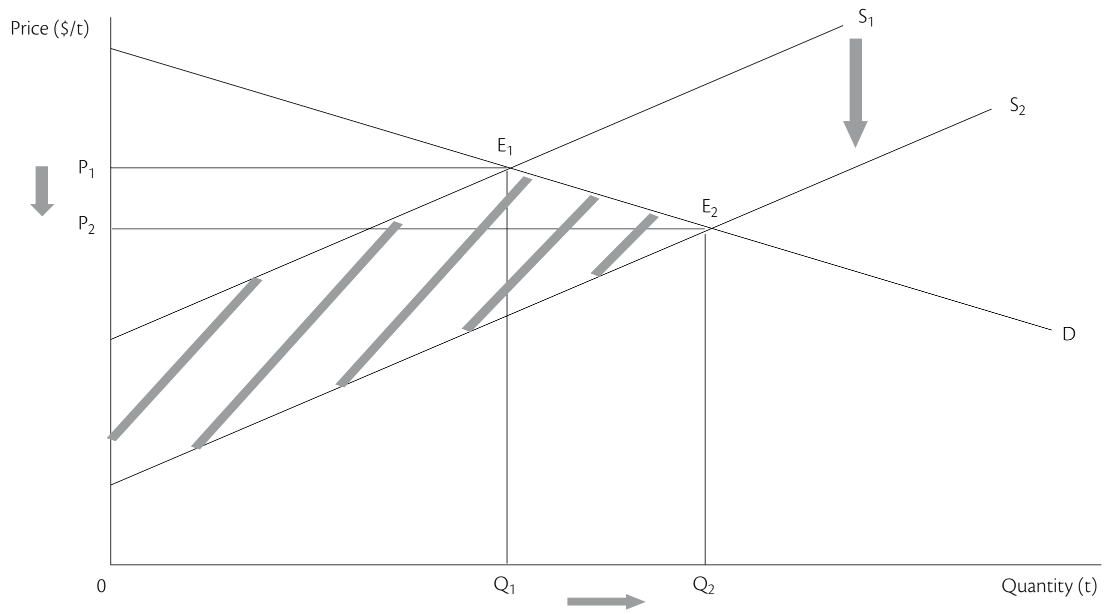

Figure 12. Supply shift caused by yield-improvement effects

The benefits attributable to the capacity-building elements of the ACIAR projects were then estimated on the basis that capacity-building activities comprised 30% of the overall project costs and gave rise to 50% of the overall project benefits.

The analysis was run over a 30-year period from 1982, the start of the ACIAR projects, to 2011.

Modelling the yield-improvement effects

The yield-improvement effects described above were estimated using the same economic evaluation computer model as the ACIAR project evaluation described in Lubulwa and McMeniman (1997). The changes in producer and consumer surpluses resulting from the yield improvement associated with the adoption of SDPP and ESDPP were estimated separately and then summed.

The analysis used the following estimates of total pigeonpea output in India when evaluating the yield improvement effects of adopting SDPP and ESDPP:

- before SDPP adoption in 1986 – 2.176 million tonnes (Ryan 1998)
- before ESDPP adoption in 1998 – 2.828 million tonnes (CIE calculation).

These values were used as the initial quantities in the estimation model for the adoption of SDPP and ESDPP, respectively. The increase in total pigeonpea output in India between 1986 and 1998 is consistent with the estimated maximum SDPP adoption rate of 30% attained in 1997.

Modelling the nitrogen-fixing effects

The nitrogen-fixing benefits associated with SDPP were estimated by multiplying the:

- total area of land planted to pigeonpea
- SDPP adoption rate
- share of adoption on fallow land (40%)
- savings in fertiliser per hectare.

The resulting estimated area of adoption on fallow land also represents the overall increase in land area planted to pigeonpea due to the adoption of improved pigeonpea.

The nitrogen-fixing effects are twofold with regard to ESDPP adoption. The full benefits for planting ESDPP on fallow land were estimated following the process outlined above, applying a saving in fertiliser expenditure of A$18.47 per ha. The benefit of the additional nitrogen-fixing effect associated with ESDPP adoption in substitution for SDPP was estimated similarly by multiplying:

- total area of land planted to pigeonpea
- ESDPP adoption rate
- share of adoption replacing SDPP (60%)
- additional saving of A$4.26 per hectare in fertiliser expenditure associated with the adoption of ESDPP in substitution for SDPP (A$18.47 – A$14.21).

The total land area in India planted to pigeonpea in 1982, approximately 3 million ha, was sourced from the Food and Agriculture Organization website (FAO 2006).

Baseline and counterfactual scenarios

When assessing the benefits brought about by these projects it is important to remember that they result from bringing forward in time the impacts described above. That is, as a result of the project outputs, the impacts occurred at an earlier time than they otherwise would have in the absence of the projects. The benefits of the projects therefore equal to the difference between the:

- baseline scenario—the observed flow of benefits attributable to the projects using the parameters set out in the preceding text
- counterfactual scenario—the flow of benefits delayed by 3 years in the absence of the projects.

Figure 13 shows the estimated benefit streams for both baseline and counterfactual scenarios, as well as the benefits of bringing forward by 3 years the adoption of SDPP and ESDPP. Table 11 details the nominal dollar values shown in Figure 13. The final row displays the NPVs of the benefit streams, which are discounted back to 1982 at a rate of 5% per year.

Estimated benefits

Annual benefits start accruing in the baseline scenario (with the projects) with the adoption of SDPP in 1986 and increase steadily until maximum SDPP adoption is reached in 1997, delivering an annual benefit of A$33.082 million. From 1998 to 2002, the annual benefits increase at a higher annual rate due to the adoption of ESDPP, which occurred more rapidly than SDPP adoption. Maximum ESDPP adoption was achieved in 2002, providing a total annual benefit of A$76 million, with A$42.9 million derived from ESDPP. These benefits are maintained from 2003 to the end of the evaluation period in 2011. The total estimated benefits for the baseline scenario amounts to A$1,198.6 million in nominal dollars.

The same pattern delayed by 3 years describes the annual benefits realised under the counterfactual scenario (without the projects). SDPP adoption and the stream of benefits commence in 1989, with adoption of ESDPP following in 2001. The total estimated benefits in the absence of the projects are A$894.8 million.

The far-right column of Table 12 tracks the annual difference between the estimated benefits for the two scenarios, depicted by the lowest line in Figure 12. This value represents the benefits of bringing forward the adoption of improved pigeonpea by 3 years and is therefore equal to the estimated benefits attributable to the projects. These benefits increase in the baseline scenario until 1988 and then remain approximately constant at around A$9 million per year after SDPP adoption commences in the counterfactual scenario in 1989 until 1993. Before ESDPP adoption begins in the baseline scenario in 1998, the annual benefits of the bringing forward adoption decrease to about A$7 million in 1997 adoption of SDPP in the counterfactual scenario increases. The adoption of ESDPP in the baseline scenario leads to a sharp increase in annual benefits, peaking at A$27.6 million with maximum ESDPP adoption in 2002. In 2005, ESDPP adoption reaches a maximum in the counterfactual scenario and the benefits of bringing forward adoption become zero.

Costs

The costs of achieving the benefits associated with the baseline and counterfactual scenarios are different. The baseline scenario must include the overall investment in pigeonpea improvement, whereas the counterfactual scenario must omit all expenditures on the projects being evaluated. The cost of bringing forward the benefits is equal to the difference between the estimated values of these two investments.

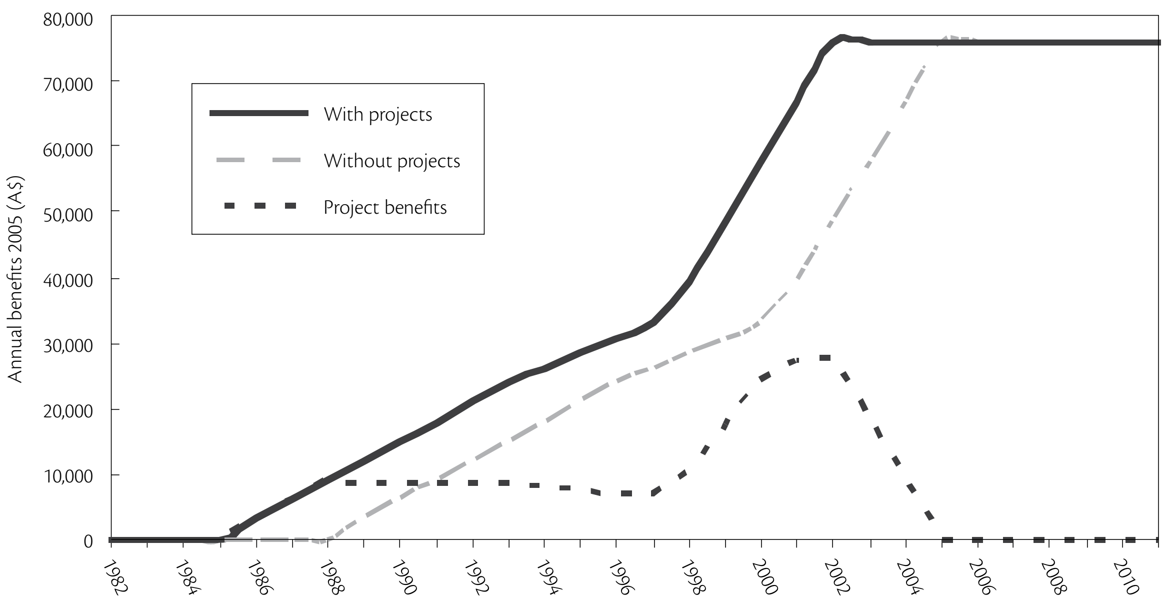

Figure 13. Benefits of bringing forward by 3 years adoption of SDPP and ESDPP. Data from CIE model, based on Ryan (1998) model

Table 12. Benefits associated with the adoption of SDPP and ESDPP

Year	With projects	Without projects	Benefits brought forward
	A$'000 (nominal)		
1982	0	0	0
1983	0	0	0
1984	0	0	0
1985	0	0	0
1986	3,296	0	3,296
1987	6,234	0	6,234
1988	9,174	0	9,174
1989	12,116	3,296	8,820
1990	15,059	6,234	8,825
1991	18,005	9,174	8,831
1992	20,952	12,116	8,836
1993	23,901	15,059	8,842
1994	26,194	18,005	8,189
1995	28,488	20,952	7,536
1996	30,784	23,901	6,883
1997	33,082	26,194	6,888
1998	39,180	28,488	10,692
1999	48,343	30,784	17,559
2000	57,526	33,082	24,445
2001	66,730	39,180	27,550
2002	75,953	48,343	27,610
2003	75,953	57,526	18,427
2004	75,953	66,730	9,223
2005	75,953	75,953	0
2006	75,953	75,953	0
2007	75,953	75,953	0
2008	75,953	75,953	0
2009	75,953	75,953	0
2010	75,953	75,953	0
2011	75,953	75,953	0
Total	**1,198,596**	**894,785**	**303,811**

Source: CIE model based on Ryan (1998) model.

Overall investment in pigeonpea improvement

The ACIAR project evaluation included an estimate of the total expenditure on the development of short-duration pigeonpea genotypes in India, taking into consideration the major investments by ICRISAT, ICAR, UQ and ACIAR from 1969 to 1995. In order to include an estimate of the additional non-project costs incurred up to the release of ESDPP, this analysis incremented these nominal dollar costs by additional investments by ICRISAT and ICAR up to and including 2001, the year in which ESDPP is adopted in the counterfactual scenario. These investments were estimated in line with expenditures on pigeonpea improvement in 1995 and inflated using the non-farm GDP deflator in order to maintain a constant value in real terms. Table 13 provides an overview of these nominal dollar investments. The total investment in pigeonpea improvement amounted to A$46.8 million.

ACIAR/UQ project investments

As in the ACIAR project evaluation, the investments in improved pigeonpea made by UQ and ACIAR are considered inseparable. Their combined nominal dollar expenditures amounted to about A$3.5 million, as shown in the far-right column of Table 13.

Cost of capacity building

No record was kept of specific project expenditures on capacity-building activities. Indeed, there is no documentation of which project elements were regarded as capacity-building activities.

It is therefore necessary to estimate a reasonable share of project costs allocated to capacity-building activities and test the sensitivity of the results to this assumption. For the purposes of this evaluation, 30% (approximately A$1.1 million in nominal dollars) was considered a reasonably prudent estimated share of overall project costs for capacity building. Cost shares of 50 and 80% were also considered.

Net benefits

Table 14 shows the results of the benefit–cost analysis for the capacity-building activities associated with the ACIAR/UQ pigeonpea improvement projects. All values are expressed in 2005 dollars discounted to the start of the evaluation period in 1982.

Table 13. Estimated major investments in short duration pigeonpea to 1997

Year	ICRISAT	ICAR	UQ	ACIAR	Total costs	ACIAR/UQ costs
	A$'000 (nominal)					
1969			70		70	70
1970			70		70	70
1971			70		70	70
1972			70		70	70
1973		10	70		80	70
1974		20	150		170	150
1975		30	150		180	150
1976		40	150		190	150
1977		40	150		190	150
1978	2	44	150		196	150
1979	60	44	250		354	250
1980	136	44	250		430	250
1981	212	44	250		506	250
1982	401	44	250	177	872	427
1983	462	44		108	614	108
1984	701	44		220	965	220
1985	1,073	44		91	1,208	91
1986	1,785	50		171	2,006	171
1987	2,021	55		268	2,344	268
1988	1,954	60		270	2,284	270
1989	2,299	70		142	2,511	142
1990	2,006	75			2,081	
1991	2,407	80			2,487	
1992	2,897	85			2,982	
1993	3,254	90			3,344	
1994	2,535	95			2,630	
1995	2,383	100			2,483	
1996	2,419a	106a			2,525	
1997	2,462	108			2,570	
1998	2,465	108			2,573	
1999	2,488	109			2,597	
2000	2,611	114			2,725	
2001	2,671	117			2,788	
Total	41,704	1,914	2,100	1,447	46,777	3,547

[a] 1996–2001 estimates based on 1995 investments.

Source: Ryan (1998).

With regard to cost, the baseline case includes the overall costs up to 1998, the year in which ESDPP was released. The counterfactual scenario incorporated all non-project costs incurred up to 2001, in order to take into account the additional 3 years of investment required by ICRISAT and ICAR to facilitate the release of ESDPP in the absence of the ACIAR/UQ projects.

Net benefits attributable the ACIAR/UQ projects

The left-hand side of Table 14 reports the outcomes associated with the baseline and counterfactual scenarios, as well as the resulting values associated with bringing forward by 3 years the adoption of improved pigeonpea. The analysis concurs with the ACIAR project evaluation that the overall investments in pigeonpea improvement were highly beneficial, represented by the difference between the baseline benefits of A$493.4 million and costs of A$41.2 million—an NPV of A$452.3 million. In the absence of the ACIAR/UQ investments, the NPV of the pigeonpea-improvement programs in India is still large at A$321.9 million.

The difference between the above benefit estimates for the baseline and counterfactual scenarios provides the benefits associated with bringing forward by 3 years the adoption of improved pigeonpea. The costs of achieving this objective include only ACIAR/UQ investments in pigeonpea improvement; that is, $8.4 million. This results in a NPV for the ACIAR/UQ projects of A$131.8 million, a BCR of 16.75 and an IRR of 19%.

Net benefits attributable to capacity building

The right-hand side of Table 14 shows the outcomes of the analysis for the capacity-building activities associated with the ACIAR/UQ projects. Assuming that capacity building was responsible for at least 50% of the impact of the projects and accounted for 30% of the project expenditure, leads to an estimated benefit of A$70.1 million, against costs of A$2.5 million. The resulting NPV of the capacity-building activities is therefore A$67.6 million, which represents a benefit–cost ratio (BCR) of 27.92 and an IRR of 23%.

Individual and organisational benefits based on rules of thumb

The benefits to the individual were estimated according to the rule of thumb:

A worker's lifetime income is higher, on average, by around 10% for each additional year spent in formal education.

This benefit was estimated using the following assumptions:

- an average annual income in India of A$649[2] (ILO 2006)

[2] Average monthly wage in India in 2001—Rs1893—annualised and converted to Australian dollars at the exchange rate of A$1:Rs35 used in the analysis.

Table 14. Net benefits of ACIAR/UQ capacity-building activities[a]

Scenario	ACIAR/UQ projects		Capacity-building activities	
	Benefits	Costs	Benefits @ 50%	Costs @ 30%
	2005 A$ million		2005 A$ million	
Baseline	493.4	41.2		
Counterfactual	353.2	36.8		
Brought forward	140.2	8.4	70.1	2.5
NPV	131.8		67.6	
BCR	16.75		27.92	
IRR	19%		23%	

[a] All values have been converted to 2005 dollars using the non-farm GDP deflator and discounted to 1982 at an annual rate of 5%.
Source: CIE calculations.

- 3 additional years of education
- 30 years of employment after training.

The benefits to the individual resulting from the capacity building were therefore estimated at A$5,841 (3 × A$649 × 0.1 × 30).

The benefits to ICRISAT, the organisation providing the training, were estimated according to the rule of thumb:

> The firm captures around half of the benefits of its investment in specific training for its workers, the workers capturing the other half, and the individuals trained around a third.

The estimated individual benefit of A$5,841 therefore represents one-third of the benefits associated with an organisation's investments in specific training for its workers. The benefit accruing to ICRISAT is therefore equal to half of three times A$5,841, which amounts to A$8,762. The individual and organisational benefits, totalling A$14,603, are therefore negligible in relation to the overall estimated benefits attributable to the capacity building.

Sensitivity testing

In order to test the sensitivity of the analysis to the assumed 30% share of costs allocated to capacity-building activities, the outcomes were also estimated for higher cost shares of 50 and 80%, holding benefits attributable to capacity building constant at A$70.1 million. The values reported in Table 15 demonstrate that even 80% of project expenditure on capacity building reduces the NPV of the capacity-building activities by only a small amount, to A$63.4 million, with a BCR of 10.47 and an IRR on the investment of 15%.

Conclusion

Consultation with project participants and team members, and reference to the ACIAR project evaluation, lead to the strong conclusion that capacity building played a major role in the success of these projects. A 50% share of the project benefits was attributed to the capacity-building activities as a conservative estimate. Lack of information concerning project expenditures on capacity building necessitated the rough approximation of a 30% cost share. The results were shown not to be particularly sensitive to this assumption.

It should be acknowledged that this capacity-building evaluation was limited to just one particular capacity-building activity—the 3-year postdoctoral fellowship undertaken by Dr K.B. Saxena at the University of Queensland. Several other activities were incorporated into the project, including the strong element of 'learning by doing' often present in ACIAR-funded research and development projects with partner organisations in developing countries. Lack of time and insufficient information concerning these other activities, however, resulted in the evaluation being only partial.

As such, this evaluation may be considered a low estimate of the value of the contribution capacity building to project outcomes.

An implicit task of this test case was to apply the framework to an ACIAR project and discover what data and other information are required to use it most effectively. The lessons learned from this case study, and the case study in chapter 7, are included in chapter 8 of this report.

Table 15. Testing sensitivity to project cost share allocated to capacity building

Scenario	Benefits	Costs	NPV	BCR	IRR (%)
	2005 A$ million				
30% costs	70.1	2.5	67.6	27.92	23
50% costs	70.1	4.2	65.9	16.75	19
80% costs	70.1	6.7	63.4	10.47	15

Source: CIE calculation.

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

This evaluation has demonstrated that capacity building has long-term benefits that reach far beyond the completion of the project in which the capacity was built. Although the method employed in this evaluation saw the benefits of bringing forward the adoption of SDPP and ESDPP fall to zero in 2005, future expected benefits would also be attributable in part to these capacity-building activities. For example, it would seem reasonable to partially attribute to the capacity building that occurred during the ACIAR/UQ pigeonpea improvement projects the benefits associated with the future adoption of the wild pigeonpea hybrids discussed in the case study.

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

7 Case study two: Crawford Fund GIS training and use in irrigation-scheme efficiency in Vietnam

Introduction

This case study applies the capacity-building evaluation framework developed in chapter 5 to a Crawford Fund training activity. The activity evaluated was selected based on the responses to a tracer study on Crawford Fund activities in Vietnam, conducted by the Effective Development Group (EDG).

The Crawford Fund award was a 3-week specialised training program in an aspect of GIS that was linked to the ACIAR project LWR1/1998/034, 'System-wide water management in publicly funded irrigation schemes in Vietnam', one of two water-management projects in that country. The advantage of selecting this activity is that ACAIR had recently completed an impact assessment of the ACIAR projects (Harris 2006). The estimates of the value of the training activity draw on this assessment.

The tracer study

The tracer study undertaken by EDG:

- tracked down former participants in capacity-building activities funded by the Crawford Fund in Vietnam since 1994
- surveyed the traced participants about the
  - quality and relevance of the training
  - knowledge gained
  - application of the knowledge at work
  - personal impact on the participants
  - organisational impact
- for a selected number of respondents, undertook face-to-face interviews with participants, their superiors and other key informants to provide more-detailed information and validate the survey responses.

Unfortunately, the participant in the training selected for this case study was unable to participate in this second stage. However, other key informants were identified and able to provide information, so the case study was continued.

Background

The ACIAR projects[3]

A major obstacle to increasing the agricultural productivity of irrigated land in Vietnam is the inefficient delivery and usage of water in irrigation systems. In the Red River Delta (RRD), irrigation and drainage operations use large amounts of electricity to power pumps and the infrastructure is generally in poor condition. Since the expense of upgrading the infrastructure is considered too high at present, options for improving irrigation and productivity are limited to changing the way in which water delivery and usage is managed in the hundreds of irrigation schemes across Vietnam.

3 The majority of the information relating to the ACIAR projects is taken from ACIAR project documentation (2002, 2003) and the project evaluation (Harris 2005).

ACIAR has funded two projects on water management in public irrigation schemes in Vietnam. The projects studied the operational performance of three irrigation schemes with the objective of improving their management of water resources by changing operational procedures.

The first project, 'Integrated water management in pumped irrigation systems in the Red River Delta of Vietnam' (LWR2/1994/004), was carried out between 1994–95 and 1998–99. The second project, 'System-wide water management in publicly funded irrigation schemes in Vietnam' (LWR1/1998/034), commenced in January 1998 and was completed in December 2003. The training being evaluated was utilised in the second project.

The overall objective of the second ACIAR project, LWR1/1998/034, was to use the existing physical infrastructure to improve water management by changing the operating procedures that determine the schedule of water deliveries. The project was divided into three subprojects with the objectives shown in Table 16. Each of the three subprojects was carried out at two irrigation schemes: a pump-operated scheme at Dan Hoai in the Red River Delta in northern Vietnam and a gravity-fed scheme in Cu Chi, southern Vietnam. Only the first subproject utilised the training.

Subproject 1, 'Irrigation system operation, management and institutional arrangements', led to the following outputs (ACIAR 2002):

- Rapid data collection processes were established at the irrigation schemes, covering irrigation and drainage infrastructure, and crops and soils.
- Each scheme developed an impressive GIS combined with 18 layers of mapping information, including natural resources, infrastructure, division of land, and performance data. This enabled the standard irrigation main system operation (IMSOP) model to be adapted to conditions at pump-based irrigation schemes in the RRD.
- The IMSOP model was used to simulate the operation of and retrospectively analyse the system, and to monitor the existing operation and field trials of alternative operational scenarios. This process demonstrated that the existing, system-specific constraints could be overcome by implementing improved operational procedures to achieve a more efficient use of water that would:
  - more closely equate the supply of irrigation water with demand
  - enable crop diversification into higher-value crops
  - make operation simpler and reduce costs
  - increase yields.

The Crawford Fund training

The Crawford Fund training was used to fill an identified gap in the skill base required for a department of the Government of Vietnam to participate effectively in the ACIAR project. A Crawford Fund awardee spent 3 weeks in Australia at the University of Melbourne and the Victorian Department of Primary Industries:

- working with GIS and remote-sensing specialists on mapping, air-photo registration, data management and asset data linkages with GIS

Table 16. Subprojects and objectives of ACIAR project LWR1/1998/034

Subproject	Objective
1. Irrigation system operation, management and institutional arrangements	To further develop a set of technical, management and institutional measures arising from ACIAR project LWR2/1994/004 and to extend them to additional irrigation schemes in northern and southern Vietnam.
2. Performance of irrigation systems	To carry out a system-wide evaluation of irrigation performance of rice-based irrigation systems to determine the impact of the proposed water-management improvements.
3. Crop area monitoring	To develop new methods to monitor crop-pattern development, composition and area using synthetic aperture radar remote sensing.

Source: ACIAR (2003).

- gaining familiarity with software packages that were applied to creating contour maps for the three irrigation systems.

The capacity-building activities comprised hands-on experience with, and observation of, Australian experts, rather than formal training activities. The training covered the development of GIS databases from mapping information available in Vietnam and included:

- digitising paper maps
- adding extra features to digitised maps
- registering aerial photographs
- comparing and contrasting maps with photos and correcting maps as appropriate.

Further interactions between the Crawford Fund awardee and Australian experts took place at later dates in Vietnam.

The awardee's responses to the survey questions posed in stage one of the tracer study indicated satisfaction with the training received, in terms of both the quality of delivery and content.

Other capacity-building activities undertaken by the ACIAR project

The project also undertook capacity building separately from that provided by the Crawford Fund. Specific activities included:

- intensive in-country training of key Vietnamese project personnel
- a 1-week study tour for senior staff members from the following organisations to observe Australian approaches to irrigation and water resource management:
  - Vietnam Institute for Water Resources Research (VIWRR), Hanoi
  - Southern Institute for Water Resources Research (SIWRR) Ho Chi Minh City
  - Ha Tay Provincial Agriculture Department, Hanoi
  - Dan Haoi Irrigation System, Hanoi
  - Cu Chi Irrigation System, Ho Chi Minh City
- a GIS training program that provided an introduction to GIS concepts, methods and applications for 15 participants from VIWRR in Hanoi
- informal training on inputting asset information into the GIS asset database for staff at VIWRR, SIWRR and Cu Chi Irrigation Management Company.

These capacity-building activities are not being evaluated in this case study.

The contribution of Crawford Fund training

Tracer survey results

The Crawford Fund awardee's responses to the Effective Development Group (EDG) tracer survey questions covering knowledge gained during the training were all positive with regard to increased:

- knowledge of international trends and activities
- capacity to carry out research
- laboratory analysis skills
- technical skills
- understanding of GIS issues and principles.

Questions about the following matters were considered irrelevant, however:

- acquisition of new ways to approach to work problems
- techniques learned for managing and organising people and projects
- communication within networks of GIS experts.

The fact that the awardee considered these questions to be irrelevant to this training activity is most likely because the short-term training received was tightly focused on filling capacity gaps to enable fulfilment of a particular role within a specific project. These more widely applicable topics relate more to professional development in terms of project-management, organisational and networking skills.

There was no recognition of the training having had any organisational or personal impact. These responses and the following assessment point to the interesting outcome where a participant may not recognise the value of their own contribution. This is more likely when they fill a highly technical role and are involved in only a segment of a larger project.

Capacity built

The capacity built was specific skills in GIS application required for the implementation of the IMSOP model. The awardee held a senior position in the department, was able to undertake the required work with the project, and had the technical and English-language skills to rapidly learn the application.

Professor Hector Malano, Head of Department of Civil and Environmental Engineering at the University of Melbourne, Australia, the leader of both the ACIAR projects concerned, reported that the capacity building successfully enhanced the Crawford Fund awardee's GIS skills to the extent required by the project. The awardee's own assessment in the EDG survey was that technical skills had been developed.

Utilisation of capacity

The awardee and one other NIAPP staff member prepared all the GIS databases and carried out all GIS mapping tasks for the project. These inputs were used to build the IMSOP and asset management models that were subsequently installed at the participating irrigation companies. The IMSOP model clearly demonstrated the advantages of implementing improved operational procedures and was a key factor in encouraging the irrigation-management companies to trial new rules and prepare to adopt them.

Professor Malano reported that the Crawford Fund awardee's training was 'very productive and important' and had played a significant role in the successful completion of the project. Without the training, the tasks would most likely have taken much longer to complete and the outcomes would have been of lower quality. The skills built were applied to collect data and prepare GIS maps that formed an essential input for the development and testing of the new operational rules subsequently adopted by the participating irrigation companies. At the time these skills were not available in the agency that had the authority to undertake the GIS mapping required to support the ACIAR project.

The project review (ACIAR 2002) reported that the organisational and technical capability of the irrigation management company staff at Dan Haoi and Cu Chi had significantly improved as a result of training provided by Australian and Vietnamese researchers. The staff were considered fully capable of operating the software tools developed by this project and to understand the proposed changes in the operation of the supply system. However, as noted above, this aspect of capacity building is not being evaluated.

Estimating the impact

Figure 14 provides an overview of the pathways from the capacity-building activity to the observed benefits, using the template presented in chapter 5. The impacts relate to only the two irrigation companies targeted by the project. Given Professor Malano's informed opinion that similar inefficiencies are present in all other irrigation schemes in Vietnam, however, there seems to be great scope for replication of this ACIAR project. Follow-up projects would be able to draw on the skills and experience developed by the Crawford Fund awardee and others in the same organisation, potentially increasing the benefits attributable to the capacity-building aspects of the project.

Estimating the contribution made by capacity building to the project impact

Project outcomes

The Crawford Fund awardee's improved capacity enabled all the GIS database preparation and mapping tasks required by the project to be carried out. The project team used these outputs to build two irrigation-scheme-specific models:

- The IMSOP model is a steady-state representation of the hydraulic operation of the main and secondary canals in an irrigation system. It was developed to calculate water supply and demand at defined off-take points according to input data on cropping patterns and soil types. The model allows for transmission losses and determines the accumulated flow requirements starting at the downstream end of the system (see H. Malano et al. (1999)).

- The asset-management database created was used to track the condition and performance of the physical infrastructure of the irrigation schemes and to carry out financial modelling about, for example, the replacement and repair of infrastructure over long periods of time. Examples of irrigation-system assets in this context include canals, hydraulic infrastructure for water distribution, pump stations, regulators and bridges.

These models were successfully installed at each of the participating irrigation schemes. The IMSOP model was used to assess the historical performance of the water-delivery system, analyse the usage of water and evaluate alternative operational scenarios using virtual testing techniques. This led to the adoption of new operational rules by the irrigation companies concerned, leading directly to the benefits estimated by the ACIAR project evaluation.

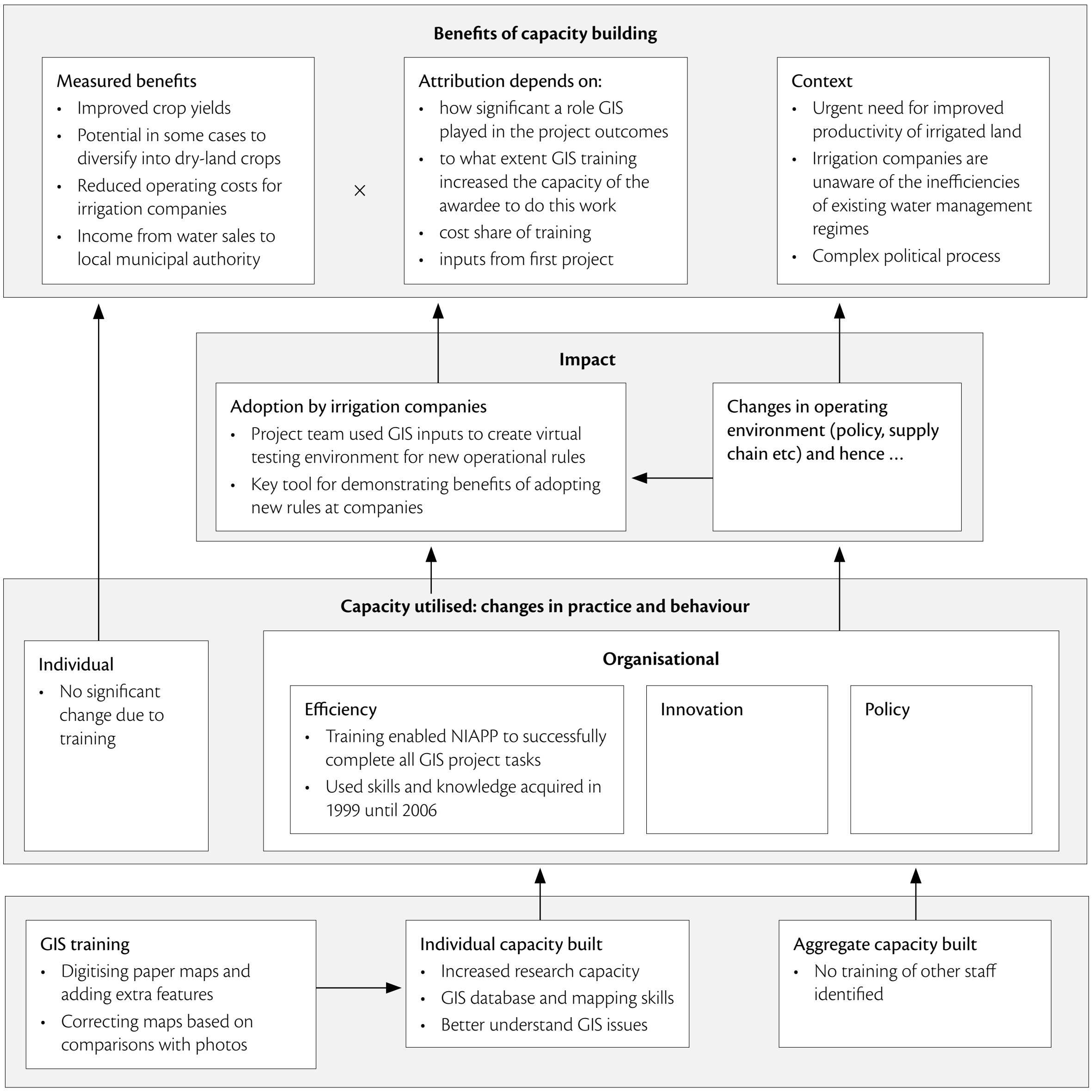

Figure 14. Pathways to benefits and their attribution for an intensive 3-week GIS training session in Australia

The ability to test alternative water-delivery regimes in a virtual environment and demonstrate the resulting benefits was crucial to convincing the irrigation companies to field test and ultimately adopt new operational rules.

Project impacts

The impacts measured in the ACIAR project evaluation (Harris 2006) are:

- increased yield of crops affected by the changed water supply
- reduced costs of pumping water
- increased revenue resulting from the bulk sale of the water saved.

Adoption patterns

Table 17 sets out the adoption patterns for the new operational rules at the Dan Haoi and Cu Chi irrigation schemes.

Project benefits

This study uses the measures of impact made by the ACIAR project evaluation (Harris 2006). The project benefits were evaluated separately for each scheme. Two streams of benefits were identified:

- improved crop yields due to the water supply more closely matching requirements
- savings resulting from reduced water pumping costs (La Khe) and the price at which the saved water can be sold for other uses (Cu Chi).

Table 17. Adoption patterns for new operational rules for irrigation schemes

Year	Dan Haoi	Cu Chi
	Percentage adoption of new rules	
1994–2003	0	0
2003–04	17	25
2004–05	33	50
2005–06	50	75
2006–07	83	100
2007–08	100	100
2010–24	100	100

Source: Harris (2006).

Harris (2006) reports both of the ACIAR irrigation water-management projects in Vietnam overall economic benefits have a present value of A$14.7 million in 2003–04 dollars over a 30-year evaluation period (1994–95 to 2023–24. Table 18 shows the estimated benefits, in nominal dollar terms, of the two linked ACIAR projects.

The project leader, the irrigation company managers and the evaluation team, considered all of the benefits outlined above attributable to the ACIAR projects.

Adapting the project BCA results for this analysis

The ACIAR project evaluation (Harris 2006) was adapted for this evaluation study by:

- using a 30-year evaluation period commencing in 1998, the year the second project started, rather than 1994, the start of the first project
- considering only benefits attributed to the second ACIAR project (LWR1/1998/034), since the training occurred after the first project had been completed and was applicable only to the second project, which utilised GIS
- applying the ACIAR costs for the second project plus 20% of the costs of the first project to the project BCR in order to take into account the contribution made by the adaptation of the IMSOP model to Vietnamese conditions that took place during the first project
- converting the nominal Australian dollar values into 2005 dollars using the non-farm GDP deflator and discounting the annual estimated benefit and cost streams back to 1998 using a discount rate of 5% per year.

Decomposing the total projects benefits into the two projects

Table 19 shows the distribution of costs across the two projects and over time.

The benefits attributable to the second ACIAR project comprise the benefits estimated for the adoption of the new operational rules at Dan Haoi and Cu Chi irrigation schemes only, as shown in Table 20. The values are given in nominal Australian dollars.

Benefits started accruing to both irrigation schemes in 2003, increasing according to their respective patterns of adoption of the new operational rules. The Dan Haoi scheme is expected to reach maximum annual benefits of A$313,000 in 2008 upon full implementation of the new rules. At Cu Chi, where the adoption rate is expected to be more rapid, maximum benefits of approximately A$1.7 million are expected to arise one year earlier, in 2007. The large increase in estimated benefits at Cu Chi in 2006 is the result of predicted commencement of the sale to the Ho Chi Minh City municipal authority of the water saved by implementing the new rules.

Over the whole project-evaluation period, the nominal value of estimated benefits for both irrigation schemes in total amount to about A$44 million. This results in a present value of approximately A$15.5 million in 2005 dollars, using a discount rate of 5%.

Attribution for the Crawford Fund training

The GIS training under evaluation was:

- very short term
- small scale
- targeted to achieving outcomes specific to the ACIAR project
- a minor input to the overall project.

These factors indicate that the capacity building funded by the Crawford Fund was one of many necessary and inseparable factors contributing to the successful completion of the ACIAR project, but insufficient in isolation to achieve the change in practice and behaviour that led to the project benefits. As a result, the cost-share approach detailed in step 4 of the evaluation framework outlined in chapter 5 of this report was selected as the most appropriate method for estimating the benefits attributable to the GIS capacity building.

Table 18. Estimated benefits of the ACIAR projects

Year	La Khe		Dan Haoi	Cu Chi		Total benefits
	Yield	Water	Yield	Yield	Water	
	A$'000 (nominal)					
1998–99	74	4	0	0	0	78
1999–00	153	9	0	0	0	162
2000–01	250	12	0	0	0	262
2001–02	341	16	0	0	0	357
2002–03	368	17	0	0	0	385
2003–04	395	16	56	149	0	616
2004–05	365	15	104	268	0	752
2005–06	365	15	156	343	0	879
2006–07	365	15	208	478	874	1,940
2007–08	365	15	260	611	1,064	2,315
2008–09	365	15	313	611	1,064	2,368
2009–10	365	15	313	611	1,064	2,368
2011–2024	5,110	210	4,382	8,554	14,896	33,152
Total	**8,881**	**374**	**5,792**	**11,625**	**18,962**	**45,634**

Source: Harris (2006).

Applying the cost-share approach

Evaluating the benefits attributable to capacity building on the basis of its proportional cost share required:

- estimating the benefits and costs relevant to the evaluation of the capacity building
- estimating the costs of the capacity building and therefore the percentage share of the project expenditures on capacity building
- multiplying the estimated benefits relevant to the evaluation of the capacity building by this percentage, to give the gross benefits attributable to capacity building
- subtracting the costs of capacity building from these benefits to give the net benefits attributable to capacity building.

Project costs relevant to the evaluation of capacity building

As discussed above, the project costs relevant to the evaluation of the GIS capacity building associated with the project are equal to the cost of the second project plus 20% of the cost of the first project.

Because most of the costs for the first project were incurred before the start of the evaluation period, it was necessary to convert the nominal annual costs shown in Table 19 into a single 1998-dollar value. The upper part of Table 21 illustrates this process, which enabled an accurate estimate of these costs to be included in the first year of the evaluation period.

The left-hand column of Table 21 shows the annual costs of the first project in nominal dollars amounting to a total of A$685,000 over the 5 years of the project. The central column shows these values converted into 1998 dollars using the non-farm GDP deflator, thus reflecting the inflationary impact on the values over time. The 1998-dollar present values shown in the right-hand column take into account the time value of money, assumed to be 5% per year in this evaluation and used to discount the benefits estimated above for the years after 1998. This results in a 1998 present value of the first project's costs of A$778,871.

The lower part of Table 21 shows the nominal annual costs relevant to the capacity-building evaluation. The overall nominal costs relevant to the capacity-building evaluation are therefore estimated at slightly more than A$1 million. This resulted in a present value of A$1,162,082 million.

Table 19. Distribution of ACIAR project expenditures

Year	La Khe	Dan Haoi and Cu Chi	Total expenditures
	A$ (nominal)		
1994–95	137,338		137,338
1995–96	137,338		137,338
1996–97	137,338		137,338
1997–98	137,338		137,338
1998–99	137,338	179,010	316,348
1999–00		179,010	179,010
2000–01		179,010	179,010
2001–02		179,010	179,010
2002–03		179,010	179 010
Total	**686,692**	**895,048**	**1,581,740**

Source: Harris (2006).

Costs of capacity building

The Crawford Fund provided A$2,000 for the awardee's GIS training in Australia. Other costs, including expenses paid to GIS specialists and the awardee's accommodation for 3 weeks in rural Victoria, were estimated to amount to A$4,000, leading to an estimated total cost of A$6,000 expended in 1999. This equals A$7,412 in 2005 dollars, which amounts to a present value of the costs of capacity building of A$6,723, discounted to 1998 at a rate of 5% per year.

Percentage share of project expenditure on capacity building

The Crawford Fund training cost of A$6,723 represents 0.58% of project costs considered relevant to the evaluation of the capacity building.

Net benefits attributable to capacity building

Using the values estimated above, Table 22 shows how the analysis estimated the NPV of A$82,837 for the benefits attributable to the capacity building, a BCR of 13.32 and an IRR of 28%.

Conclusions

In summary, the following conclusions can be drawn from the capacity-building evaluation:

- The GIS training funded by a Crawford Fund award filled a clear gap in the broader ACIAR projects.
- GIS skills were necessary for the successful outcome of the project and were not available elsewhere at the time.
- The second project employed the GIS skills acquired from the training, but not the first project. The capacity-building evaluation therefore estimated the benefits of the second project only (as at 1998 in 2005 dollars).

Table 20. Estimated benefits of ACIAR project LWR1/1998/034

Year	Dan Haoi	Cu Chi	Total benefits
	A$'000 (nominal)		
1998	0	0	0
1999	0	0	0
2000	0	0	0
2001	0	0	0
2002	0	0	0
2003	56	149	205
2004	104	268	372
2005	156	343	499
2006	208	1,352	1,560
2007	260	1,675	1,935
2008	313	1,675	1,988
2009	313	1,675	1,988
2010	313	1,675	1,988
2011	313	1,675	1,988
2012	313	1,675	1,988
2013	313	1,675	1,988
2014	313	1,675	1,988
2015	313	1,675	1,988
2016	313	1,675	1,988
2017	313	1,675	1,988
2018	313	1,675	1,988
2019	313	1,675	1,988
2020	313	1,675	1,988
2021	313	1,675	1,988
2022	313	1,675	1,988
2023	313	1,675	1,988
2024	313	1,675	1,988
2025	313	1,675	1,988
2026	313	1,675	1,988
2027	313	1,675	1,988
Total	**5,481**	**37,287**	**44,331**

Source: Harris (2006).

Table 21. Distribution of ACIAR project expenditures

Year	Expenditures on project 1		
	A$ (nominal)	A$ (1998)	Present value A$ (1998)
1994–95	137,000	145,708	177,110
1995–96	137,000	143,266	165,848
1996–97	137,000	139,814	154,145
1997–98	137,000	137,874	144,767
1998–99	137,000	137,000	137,000
Project 1 totals	**685,000**	**703,663**	**778,871**
Expenditures relevant to the capacity-building evaluation A$ (nominal)			
1998–99	(778,871 x 20% = 155,774) + 179,000 =		334,774
1999–2000			179,000
2000–01			179,000
2001–02			179,000
2002–03			179,000
Overall total			**$1,050,774**

Source: Harris (2006), CIE calculation.

- GIS skills were a necessary input to the project but not sufficient on their own to achieve the benefits associated with the project. Therefore, a cost-share approach was employed to estimate the benefits attributable to the capacity building. The cost of the GIS training was estimated at A$6,723, representing 0.58% of the overall project costs relevant to the capacity-building evaluation.
- Capacity building resulted in an estimated gross benefit of A$89,560—a 0.58% share of the A$15.5 million in benefits estimated for the second project. The net benefits of the capacity building were A$82,837, giving a BCR of 13.32 and an IRR of 28%.
- No benefits attributable to the Crawford Fund training arising subsequent to the completion of the ACIAR projects were identified. This was due to the non-participation of the Crawford Fund awardee in the second stage of the tracer study, which sought to obtain information about the continued use of the skills acquired and their organisational impacts. This does not imply that these benefits did not arise, or that the training failed to contribute to the stock of GIS knowledge at the organisational and national levels, but rather that there is no evidence to date to justify such claims within the scope of this study.

Table 22. Estimated net benefits attributable to capacity building

	Computation	Estimated present value A$ (2005)
Overall project costs		1,162,082
Costs of capacity building		6,723
Percentage cost of capacity building	6,723/1,089,000	0.58%
Overall project benefits		15,480,917
Benefits of capacity building	15,480,917 x 0.58%	89,560
Net benefits	89,560 – 6,723	82,837
BCR	89,560/6,723	13.3
IRR	Iterative process computed by Excel	28%

Source: Harris (2006), CIE calculation.

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

8 Lessons learned from the case studies

Testing the framework

The framework can be applied to provide quantitative estimates

The case studies demonstrate the successful practical application of the framework under differing circumstances. In both cases, it was possible to use a benefit–cost analysis (BCA) methodology to provide a quantitative estimate of the net benefits attributable to capacity-building activities.

In general, BCA will be possible when:

- impacts can be measured
- pathways can be identified
- attribution can be made.

However, BCAs are often difficult because:

- impacts are often diffuse—that is, they are not linked to specific technical or policy outputs and hence outcomes
- a critical mass of capacity, as well as stock of knowledge, is often a precondition for achieving outputs that track to impacts, and the activity being evaluated may have added to, but not achieved, this critical mass
- contribution of the capacity-building component may not be recognised or be taken for granted by the training participant
- capacity building is often the step before an output that tracks to impact, so impact is contingent on additional investments occurring.

Establishing causal links

The successful application of the framework relies on establishing the causal links between each level of output. Demonstrating these links tends to become progressively more difficult as we move from the output quality of the capacity building to the net benefits. This is due to:

- elapsed time between the levels of results
- other investments contributing to capacity built and overall impacts
- the importance of the institutional environment for capacity to be utilised
- the critical interaction with the enabling environment that makes possible impacts resulting from utilisation of new capacity.

The case studies clearly show that qualitative techniques add value to the process of establishing the links. Often these are subjective judgments made by the people involved in the project and the application of the outputs. Econometric modelling can demonstrate correlations between capacity-building investments and outcomes. However, to improve the robustness of the analysis additional evidence that traces the links from the capacity built to the outcomes is desirable.

Future application of the framework

Lessons

The following lessons are of particular relevance to future applications of the framework for undertaking BCAs of capacity-building projects:

Selecting projects for evaluation

In selecting projects:

- change in practice, products, or policy that the capacity building is associated with must be amenable to evaluation (quantification)
- the participants in the capacity building, or at a minimum their managers, should be willing to participate in the evaluation
- the capacity-building activity, whether formal training courses or learning by doing, must be separable from previous investments in capacity by the individual or organisation.

Collecting data for the evaluation

Baseline data such as initial levels of education and experience can usually be accurately collected at the time of the evaluation. Less easy to measure are changes in attitudes and, in some cases, knowledge and skills. Measures of these more-subjective attributes should ideally be made at the initiation of the capacity-building activity. The following are some of the issues to be aware of:

- Investment (costs) in capacity building are usually not separated from total investment in a project, particularly for learning by doing.
- Organisational change resulting from utilisation of new capacity is hard to measure, and measurements will be largely subjective.
- It is only formal courses that are usually recognised as capacity building, so greater effort is required to identify the 'learning by doing' capacity built.
- Triangulation of the utilisation of new capacity and attribution is desirable.
- Capacity building is a continuous rather than a discrete process. Thus, in assessing capacity built it can be useful to ask participants how long it would have taken them to attain their new level of ability without the capacity-building activity (or if at all).
  - This has the potential to provide a rule of thumb about the capacity-building outcomes of 'learning by doing' through collaborative activities.
  - The rule of thumb would also provide a benchmark for expectations from capacity-building outcomes.

Analysis of impact

The analysis of the impact of capacity-building activities requires two main steps. The first is assessing the contribution of the capacity building to the outputs that lead to changes in products, practice and policy. The second is assessing the net benefit flows from these changes in products, policy and practice. The second step is normally the challenge for BCAs. The first step is additional. The following are issues that may arise in undertaking this step:

- Participants trained may not recognise value of the skills gained. This can arise where the new skills fill a gap and make possible the successful completion of the project, but the participant is unaware of the contribution this made to overall project impacts. This is most likely to occur when the training participant is not fully integrated into the project team as a whole.
- Learning by doing has joint outputs—capacity and technical outputs that add to the stock of knowledge—and separating their impact may not be possible.
- The need for critical mass in knowledge, in staff capabilities and in organisational attitudes, mean that observed outputs are often the result of a much greater investment, and a decision is required on how these prior investment should be treated.
- When technical outputs fail, the capacity-building outputs may still deliver. However, these impacts might be more diffuse and hence difficult to measure.

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

Looking forward

The framework is designed to be a living document. The analytical framework provides guidance in identifying the links between the capacity-building investments and the impact. While it has four main pathways, there may be others that can be added over time. There are a few rules of thumb that have merged in the analysis of the literature. These help (with due caution) to provide estimates where no other data are available. They also provide a useful check on the estimates made from data collected. Over time, the rules of thumb should be tested and improved, and with enough evaluations new ones may emerge.

There is a well-held belief that building the knowledge base and skills and capabilities of people is essential for promoting development, adoption of technology and productivity growth. The literature review found that most studies support this belief, but also pointed to the difficulties in empirically demonstrating the impact of capacity building. The easiest demonstration is at the individual level, where people gaining skills and knowledge can command a higher income, and at the highly aggregate level where the quantum of skills and knowledge in the population predicts the income level of the population. Applying quantitative techniques to capacity-building investments presents many empirical challenges. But it is important to persevere in trying to quantify the impacts in order to understand the relative benefits of the capacity-building investments in larger projects, with the aim of finding the optimal balance. For stand-alone capacity-building activities, quantification will add to the knowledge of what works well and why. The process of trying to quantify the benefits of capacity-building activities also adds value in forcing a clear articulation of why the investment is made and what is expected to change as a result. The simple process of thinking through capacity built, how capacity is utilised and what the impact of this has been or will be will raise the quality of these investments in the future and allow better recognition of the value added by capacity building in the future.

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

Appendix 1
Evaluation tools and methods

This appendix describes a selection of evaluation tools and methods referred to in chapter 3. The selection is by no means exhaustive and approaches should be selected on the basis of their appropriateness to the evaluation question being addressed, cost of utilisation and administrative feasibility.

Quantitative approaches

Benefit–cost analysis

BCAs require the following six steps. The actual methodology used to estimate the benefits can vary widely, and is discussed after the steps.

1. Describe the logic or results basis of how the investment has led to observed or expected impacts—changes in practice and behaviour. This requires identifying the pathway to adoption—that is, what needs to happen for capacity built to lead to impacts.

2. Identify and measure (over time) all the inputs going into delivering the activities to be evaluated and contributing to the changes in practice and behaviour (costs of the capacity-building activity and other investments made, which can include implementation costs).

3. Identify what would have happened in the absence of the investment (the counterfactual that provides the baseline). This includes taking into account the alternative uses of resources. Capacity-building activities may simply bring forward the impacts by reducing the time to acquiring capacity.

4. Measure or estimate the change from the baseline in capacity built, capacity utilised and impact. As well as intended impacts, there may be unintended impacts, either positive or negative. These measures are often changes in consumption and production inputs, outputs and their costs/prices. But they could include changes in the natural resource base quality or quantity, individual and community health or wellbeing, or exposure to risk or uncertainty.

5. Assign values to the direct and flow-on impacts. This requires taking into account the chain of events that is set off as resources are reallocated and consumer and producer behaviour adjusts to the first-round changes.

6. Discount the time series of inputs (costs) and the values of the impacts (benefits) over time, to reflect the time preference of beneficiaries (or the cost of capital). This is required to sum the values across the years in which costs are incurred and benefits arise.

Each of these steps contains a concept that is central for a high-quality BCA. Step 6 is straightforward application of the actuarial formula to estimate present values and ratios. While important for BCAs, it is not this step that is the distinguishing characteristic. Good impact analysis will follow steps 1–4. It is step 5, which moves beyond first round impacts to take into account dynamic adjustments to changes, that characterises the BCA approach. It is this step that usually requires more complex modelling.

Econometric approach

ACIAR's Impact Assessment Series No. 25 (Brennan and Quade 2004)

The authors took advantage of existing data and highly relevant prior evaluations of R&D outcomes to produce quantitative estimates of the net benefits, BCR and IRR of two closely related projects. The steps taken in the Brennan and Quade (2004) impact assessment are as follows:

Inputs:

- There was long-term (10–12 months) hands-on training of three Indian and four Pakistani plant pathologists in Australia at the University of Sydney.
- There were short-term visits by several senior scientists from India and Pakistan to familiarise themselves with the project.
- Several brief visits were made to India and Pakistan by Australian scientists.

The overall cost to ACIAR of these inputs was approximately A$1.6 million in 2003 dollars over the two projects concerned.

Outputs—capacity built:

- A group of rust pathologists with training in advanced knowledge about rust diseases was created.
- Human capacity was estimated as the sum of the years that pathologists spent in study and years of experience (measured as 'full-time equivalents' (FTEs)). India had 20.2 FTE scientists working on rust resistance, representing a total human capital of 326 years, and Pakistan had 18.1 FTE scientists representing a total human capacity of 270 years. Human capital intensity of production was estimated as the human capital years divided by the production area being influenced by that human capital. This was considered to better facilitate comparisons between production areas of different sizes.
- The change in human capacity of each individual was measured as the sum of training undertaken and years experience, where a training course is equivalent to one-half or full-time year experience. In other words, each round of training increased the capacity of each trainee by 5 years. The training has a 'life' of 10 years in terms of improving the human capacity of that individual.

Outcomes—capacity utilised:

- Increased total R&D capacity in rust disease in India and Pakistan was assumed to have led to advice on changes in varieties and practice to better manage disease. *This step was not demonstrated in the evaluation.*

Impacts—value added by capacity utilised:

- Improved resistance was measured as the reduction in yield losses expected in the years following the training. The following steps were used to estimate this fall:
  - Wheat pathologists scored the incidence and potential (uncontrolled) and present severity of the disease in each of the target areas on a scale of 1–5. It is important to note that these estimates, although they are the opinions of experts, are nevertheless subjective.
  - Experienced plant pathologists were then consulted in order to convert these qualitative scores into quantitative estimates of yield loss associated with each level of disease incidence and severity. This also enabled the maximum productivity improvement (potential output in complete absence of the disease) to be derived.

Benefits—quantified gains:

- Values of potential and present yield losses in the different production areas were calculated using representative yields and prices. The extent to which existing controls were successful was calculated by combining the estimated potential and present yield losses and expressing the result as a percentage of potential losses, in order to provide a measure of the success of current R&D capacity in relation to disease resistance.
- The relationship between human capital for combating rust resistance and outcomes for wheat rust resistance was estimated using these values for the different production areas by means of an existing model that relates different levels of R&D capacity with different productivity outcomes. The

minimum productivity improvement (assuming no increase in human capital) was set at 50% of the maximum possible output, in order to take into consideration R&D spillovers from other areas.

- Productivity gains expected to arise as a result of the training were estimated by regressing the change in output arising from improved resistance on the level of human capital available in each of the regions.
- Capacity-building projects evaluated provided substantial economic return on the funds expended:
  - net benefits were estimated at A$53.9 million
  - BCR was 17.3
  - IRR was 51%.

Qualitative approaches

Case studies

Case studies are a structured and detailed investigation of an organisation. They are designed to analyse the context and the processes involved in capacity building, as well as the results. The questions asked and methods used generally differ from case to case, so they cannot be considered strictly comparable. Because case studies are in-depth investigations, they can make good use of any combination of different evaluation tools, including direct observations and reviewing existing documents.

Direct observations

This tool is particularly useful in assessing capacity utilised. It highlights the potential value of enlisting external experts to observe an organisation's activities and facilities, and how they are utilised from a capacity-building perspective. Internal staff and managers are often so familiar with the organisational environment that they no longer notice good or bad aspects of the organisation. An outsider with knowledge of similar organisations might see these immediately. This tool can be particularly effective when combined with self-assessment.

Review of existing documents

Archives, annual reports, budgets and minutes of meetings can be an indispensable source of information and a good starting point for discussion about capacity utilised and, in some cases, the impacts of capacity-building activities. They also provide a focus for the collection of additional information. If records are well kept and complete, they can provide essential quantitative information about inputs to capacity building, staffing issues, remuneration and working conditions, the utilisation of resources, and the overall performance of an organisation over time.

Most-significant change (MSC)

Davies (1996) formalised this dialogical, story-based approach to cope with the complexities of evaluating a rural savings and credit program in Bangladesh. It does not use any quantitative indicators and is also known as 'monitoring without indicators', the 'evolutionary approach to organisational learning', 'the narrative approach' and the 'story approach'. Dart and Davies (2003) describe the primary purpose of the approach in evaluation as being to improve the program by focusing the direction of work towards explicitly valued directions. It also contributes to the evaluation by means of values inquiry and the provision of information about unexpected and most-successful client outcomes. The underlying mechanism is a form of continuous values inquiry whereby designated groups of stakeholders search for significant program outcomes, then deliberate on the value of these outcomes.

Following Dart and Davies (2003), the MSC method comprises seven key steps:

1. the selection of domains of change to be monitored
2. the reporting period
3. the participants
4. phrasing the question
5. the structure of participation
6. feedback
7. verification.

First, the people managing the MSC process identify the domains of change they think need to be evaluated. Selected stakeholders identify broad domains, such as 'changes in people's lives' which, in contrast to performance indicators, are not precisely defined. The domains are defined later by the actual users.

Second, stories of significant change are collected from those most directly involved, such as beneficiaries, clients and field staff. They are asked to respond to the question: 'During the last month, in your opinion, what was the most significant change that took place in the program?' The respondents allocate their stories to a domain category and report why they consider the change described to be significant. A proforma can be developed to help collect the stories by recording standard information, including:

- the story title
- the domain in which the change took place
- the name of the respondent
- the region
- date of narration
- where and when the event happened.

The proforma may also be used to guide the respondents with a few open-ended question such as:

- What happened?
- Why do you think this is a significant change?
- What difference did it already/will it make in the future?

The stories are then analysed and moved upwards through the levels of authority in the program concerned. Each level reviews the stories sent to it by the level below and selects the single most-significant account of change within each of the domains. As the 'winning' stories are sent up the hierarchical levels, the number of stories is reduced through a systematic and transparent process. The criteria used to select the stories are recorded and fed back to all interested stakeholders so that each round of story collection and selection is informed by feedback from previous rounds. The organisation is effectively recording and adjusting the direction of its attention and the criteria used for valuing events.

At the end of the year, a document is produced containing all the stories chosen by the uppermost organisational level over that period and giving the reasons for their selection. The donors are asked to assess the stories, selecting those that most fully represent their intended outcomes and recording the reasons for their choice.

The winning stories are then verified by visiting the sites of their occurrence, in order to check that the accounts are honest and accurate, and to gather more detailed information. If conducted some time after the event, the visit provides the opportunity to observe any further developments since the story was first documented.

The MSC approach also includes the option of including quantitative information when an account of change is first described, and quantifying the extent to which the most significant changes identified in one location have taken place in other locations. Another optional step is to monitor the monitoring system by observing who participated, how their contributions affected the contents and the frequency of reports relating to different types of changes.

Interviews

Interviews can be used to obtain more detailed information on aspects of the capacity-building activity that the results of a survey indicate are of significance to outputs, outcomes and impacts. Interviewees can be selected on the basis of their responses to survey questions, an affiliation with important interest groups or expert knowledge. Different types of interview methods can be used to elicit different kinds of information.

Self-assessment workshops

Self-assessment workshops provide an extremely useful means of gathering and analysing information from organisational capacity-building initiatives and interpreting results. They also help to build awareness and commitment to the evaluation, and support the validation and enrichment of information, conclusions and recommendations. High-level facilitation skills and the proficient utilisation of tools for group analysis, synthesis of findings and reporting of results are essential for the successful implementation of these workshops.

Key informant interviews

Key informant interviews are generally in-depth, face-to-face discussions with individuals selected on the basis of their affiliation with certain interest groups, or because they are regarded as particularly experienced, insightful or well informed. This tool enables evaluation specialists to capture the views and expectations of stakeholders, such as staff members, managers, clients and end users, concerning capacity-building efforts and changes in capacity and performance over time. These interviews with individuals who are part of the organisational supply chain can also provide important insights into why changes did or did not occur.

Group interviews

Group interviews lie somewhere on the continuum between key informant interviews and self-assessment workshops. If competently facilitated, group interviews can capture consensus views of relatively homogeneous groups. They are less appropriate with more heterogeneous groups or when certain individuals tend to dominate the conversation.

Personal histories

Personal histories are an effective tool when compiled from individuals with a deep and long-term knowledge of capacity-building processes. They are particularly useful when the evaluation covers a long period and/or documentation is limited. Personal histories can capture the perspective of key players concerning the history of an organisation, their own personal and professional development. They can also help identify factors that may have promoted or hindered the development of an organisation's capacity.

Surveys

The questionnaire survey is probably the most frequently used tool for collecting information for evaluations. Surveys tend to be time- and resource-intensive, however, and require specialist skills for the preparation of the survey forms, sampling techniques, administration of the survey, management of databases for quantitative and qualitative information, statistical analysis and research. They may also require translation into a number of local languages, in which case the results then have to be processed in those languages and reconstituted into a single set of results.

Questionnaire surveys are an extremely useful tool in capacity-building evaluation. They can be used to identify the skills and knowledge staff members have gained as a result of training activities and what skills they have been able to use on the job.

Ideally, surveys are conducted:

- before training to establish baseline capacities
- on completion of training to assess capacity built
- post training and return to the work environment to collect information on capacity utilised
- some time after to assess the impact of the training.

These surveys should involve participants and their organisations. Tracer studies entail tracing previous participants in training in order to survey them on capacity built and utilised, and their perceptions of impact. Where participants have ended up is in itself an indicator of the impact of the training. Ideally, these people and organisations will be engaged regularly, but unless there is an ongoing relationship this can be costly.

Appendix 4 contains the survey questions used by Effective Development Group in conducting the tracer study for case study 2 in chapter 7.

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

Appendix 2 Examples of qualitative evaluation approaches

This appendix contains details of the approaches undertaken by USAID and DANIDA to qualitatively evaluate capacity building. These were outlined in chapter 3.

USAID Center for Information and Evaluation

Information template for impact assessment of training (Kumar and Nacht 1990)

- Capacity-building activity and trainees:
  - socioeconomic status
  - duration of training
  - education attained
  - participant satisfaction.
- Career advancement:
  - opportunities for new entrants
  - promotion/transfer to more challenging assignment shortly after training
  - effects of training on job placement
  - career choices
  - overall effects
  - private sector.
- Knowledge and skills utilisation:
  - nature of use
  - extent of use with regard to all jobs subsequent to training
  - barriers to use.
- Contributions to growth and functioning of the organisation:
  - case studies in different organisations were used incorporating field visits and in-depth interviews with trainees and their supervisors:
    - How many trainees are still in the organisation?
    - Leadership roles/promotion of training within organisation and/or society/ contribution to reforms?
    - Diffuse new skills and ideas/links with other organisations/ demonstration of potential to lead in research and/or administration; and
    - Was the training relevant to the goals of the organisation?
- Women:
  - the proportion of women trainees can be taken from records
  - are there cultural barriers? Expert opinions regarding the situation reported.
- Impact of training on psychological orientation:
  - self-confidence, broader outlook, new ways of dealing with people, scientific outlook, inquisitiveness
  - effects not just from training but from exposure to different culture/society.
- Gender comparison of career impacts:
  - gender breakdown of the above impacts.
- Third country training:
  - comparison with training in the US.

DANIDA's Capacity Development Outcome Evaluation (CDOE) method (Boersen and Therkildsen 2003)

Organise the evaluation process

- Consider and clarify process and participation aspects of the evaluation.
- Identify each target organisation(s) for Danish capacity development (CD) support (each one must be analysed separately).

Get the facts: what has changed?

- Identify changes at the output level, quantitatively and qualitatively, of the involved organisations or units targeted for CD support.
- Identify changes in outcomes for clients/users.
- Identify changes in external factors, which may have affected changes in capacity, outputs and outcomes.
- Identify changes in the capacity in the target organisation(s).
- Identify changes in the inputs/resources of the target organisation(s).
- Calculate and assess changes in the efficiency and effectiveness of the organisation(s), if feasible (cost/output ratio, relevance of output to envisaged outcomes).

Begin analysing: how have changes occurred?

- Identify, among the above factors, significant factors whose changes together explain changes in outputs.
- Identify all major intentional CD support activities from all domestic or international sources, which influence the significant factors, identified in step 9.
- Describe Danish CD support in the Sector Programme Support (SPS) and analyse its efficiency, and immediate effects.
- Identify the analytical and strategic basis for the Danish CD support through SPS and its process, leadership and commitment aspects.

Reach conclusions: why have changes occurred, what can be learned?

- Assess the extent to which capacity changes and changes in outputs in the target organisation(s) can be attributed to Danish CD support and what degree to other factors. Assess the effectiveness of the Danish support.
- Assess the technical, institutional and financial sustainability of the capacity and output changes.
- Extract lessons learned for partner organisation(s), donor(s) and key stakeholders.

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Appendix 3 Summary of ACIAR capacity-building evaluations

Table A3.1 provides an overview of ACIAR capacity-building evaluations taken from the Impact Assessment Series. It includes a brief description of the capacity building carried out as a part of the project and the method used or recommended as suitable to evaluate it.

Table A3.1. Summary of ACIAR capacity-building evaluations

IAS No.	Capacity-building activity	Evaluation method
1. Control of Newcastle disease in village chickens		
	• Develop training methods and provide training for people in developing countries to develop from seed stocks the I2 vaccine against Newcastle disease.	• No attempt was made to evaluate the benefits attributable to the training provided. • Since this is an example of integrated capacity building, it would be reasonable to attribute the overall benefits to the projects in proportion with the cost share of the training exercises.
3. Establishment of a protected area in Vanuatu		
	• Production of two simple 'how to' manuals and training courses for forestry officers and industry. • Training benefits associated with working on the project team.	• No explicit mention of the benefits attributable to training activities, although 'knowledge of alternative income sources' and 'awareness of trade-offs between logging and conservation' were cited as major project outputs. • The training benefits of working on the project team were assumed to offset the opportunity cost to the Department of Forestry incurred as a result of providing the project team with a full-time research officer.

Table A3.1. (continued)

IAS No.	Capacity-building activity	Evaluation method
6. Pigeonpea improvement		
	• Training of collaborating staff from the Indian Council for Agricultural Research (ICAR) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) to ensure the sustainability of research beyond the life of the two ACIAR projects concerned. • This included long-term visits to Australia, postgraduate training funded by AIDAB (AusAID)/ACIAR Fellowship and training on pest management in Indonesia and Thailand. • Australian and foreign postgraduate students and visiting exchange scientists were also provided with relevant training.	• The leader of the pigeonpea breeding program at ICRISAT in the 1980s claimed: '…the funds for research and training have resulted in the importance this crop now has'. • It was noted that the quantification of benefits arising from the various interactions, training programs and exchanges would be difficult, especially due to the rapid spillover of knowledge, experience and technologies, as well as the mobility of the personnel trained. • Attribution was further complicated by the fact that the University of Queensland (UQ) began work on pigeonpea in the early 1970s and that ICRISAT provided funding to UQ from 1978–1982 (both bodies mentioned were collaborators in the ACIAR pigeonpea projects under assessment here). • Attribution was attempted via a series of detailed and well-targeted questions asked of key collaborators and aimed at eliciting explicit links between the ACIAR projects and the overall outcomes/impacts observed and follow-on impacts of the projects elsewhere. The questions focused on: – the significance of breeding lines resulting from the ACIAR projects relative to those from other projects – the role the projects played in realising adoption rates and whether this could be quantified via existing data – the importance of the projects in stimulating/accessing funds for similar research elsewhere – the impact of long-term training at UQ on the scientists' subsequent approach and networking throughout Asia – how reasonable the experts thought it was to attribute the observed gains to the ACIAR projects and whether they thought this could be quantified – if and to what extent it was reasonable to claim that the projects contributed to the identification of disease immunities in subsequent projects – if there were any unexpected positive outcomes of the (follow-up) projects – if the disease resistance could be quantified for an economic assessment of the projects – if the research had led to the introduction of the crop in places where it was not previously important and whether this effect could be quantified – the impact of the various publications arising from the project – any other impacts the experts were able to express or quantify.

Table A3.1. (continued)

IAS No.	Capacity-building activity	Evaluation method
7. Reducing fish losses due to epizootic ulcerative syndrome—an ex ante evaluation		
	• The project included training and extension but no details about the type or the extent are provided in the IAS document.	
18. Controlling Phalaris minor in the Indian rice–wheat belt		
	• Eight Indian scientists received training at the University of Adelaide and the International Maize and Wheat Improvement Centre (CIMMYT). • Staff training was also undertaken in both Australia and Mexico.	• Capacity building/training was identified as a contributory component of the economic gains resulting from the project as a result of the increased capacity of Indian weed scientists with regard to: – monitoring and responding to future changes in the performance of the rice–wheat cropping system – developing holistic solutions to future weed-management problems that go beyond the use of herbicides – A value for the capacity-building activities was not computed, however, even though it was acknowledged that this value might well be significant.
24. Assessment of the rodent control projects in Vietnam funded by ACIAR and AusAID: adoption and impact		
	• The impact assessment included AusAID Capacity Building for Agriculture and Rural Development (CARD) in 2000 for the enhancement of capacity with regard to rodent management in the Mekong delta region using non-chemical methods. • This was carried out in order to extend community-based rodent-management approaches developed in ACIAR-funded projects through training the staff to develop the research and implementation capacity of Vietnamese agricultural researchers in this area and to develop a regional plan for implementation and monitoring of effective rodent management. • Under another project (World Vision/ ACIAR), CSIRO scientists trained local technical staff, who then conducted training for farmers in their district.	• Reference made to two benefit–cost ratio estimations: Brown, P. R., Tuan, N.P., Singleton, G.R., Ha, P.T.T., Hao, P.T., Tan, T.Q., Tuat, N.V., Jacobs, J. and Müller, W.J. 2004. Ecologically-based management of rodents in the real world: application to a mixed agro-ecosystem in Vietnam. Ecological Applications (submitted) and Tuan, L. A. 2003. Presentation on rodent control in Bac Binh District, Binh Thuan Province, Vietnam, at the ACIAR Review Rodent Meeting. Institute of Agricultural Sciences (IAS), Ho Chi Minh City, March 2003. • The training was considered necessary to teach farmers the importance of group action in rodent control. • The costs of the training activities were not included in the assessment. • No specific benefits were attributed to the capacity-building activities.

Table A3.1. (continued)

IAS No.	Capacity-building activity	Evaluation method
25. Genetics of and breeding for rust resistance in wheat in India and Pakistan		
	• Three Indian and four Pakistani scientists spent 10–12 months at the University of Sydney • Several senior scientists from India and Pakistan visited Australia for shorter times during the project. • Australian scientists involved in the projects also made several brief visits to India and Pakistan.	• The sum of years spent in study and years of experience was used as a measure of human capacity. The concept of full-time equivalents (FTE) was used in recognition of the scientists' work in other areas. This total figure was then divided by the millions of hectares under wheat cultivation to provide a measure of human capacity intensity. • It was assumed that each round of training lifted the capacity of each trainee by 5 years. • The increased capacity was mapped straight to impacts on disease control. • Improved resistance was measured on the basis of the decrease in yield losses expected following the training. This involved a number of steps using current estimated losses and a scoring system, based on expert opinion, to rate losses without any resistance and in the event of full resistance. • Productivity gains expected to arise from the training were estimated by regressing the change in output arising from improved resistance on the level of human capital in the different regions. • A minimum productivity improvement of 50% (and 80%) without any additional capacity was assumed to allow for R&D spillovers from other areas.
26. Impact assessment of ACIAR-funded projects on grain-market reform in China		
	• Chinese Ministry of Agriculture (MOA) staff were trained in survey techniques and IAS 26 asserts that 'assistance was presumably provided in preparing policy briefs'. • Capacity building in the Chinese Department of Policy Reform and Law in the MOA	• Capacity building was claimed to have had a strong impact on the outcomes of the project, but no attempt was made to provide it with a value. • It was not possible to assess the extent of capacity building at the MOA due to time limitations, but it was noted that the household survey program has not been continued after the projects. This could have been due to financial limitations, however, rather human capacity limitations. • A professor had been able to attract more funding, however, which was taken as a possible indication of enhanced capacity building in the MOA.

Table A3.1. (continued)

IAS No.	Capacity-building activity	Evaluation method
33. Research into conservation tillage for dryland cropping in Australia and China		
	• Training of Chinese scientists and the development of appropriate conservation tillage (CT) equipment for China. • Younger scientists worked for 3–5 months with the project team at the University of Queensland at Gatton, where they gained direct experience with scientific approaches and application of CT in Australia. • Financial assistance for three PhD students.	• The visitors were able to make useful contributions to the projects. • The visiting scientists each made significant contributions to the projects in China and all still work in CT and related areas. • Two professors trained during the projects have since been able to capture most of the government funds for CT research to date and their university is the main research centre for CT and actively teaches CT to meet demand for expertise in China. This has flowed on to other universities where previous students of these two professors are now teaching CT. • Various tiers of government are also providing CT training to extension staff and farmers in many districts. • Modifications have been successfully made to adapt equipment to local conditions

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

Appendix 4
Tracer study survey questions

Table A4.1 lists the questions included in the stage one questionnaire of the tracer study carried out by the Effective Development Group (EDG), which was used to inform case study 2 in chapter 7 of this report. Responses to the questions were recorded on a five-point Likert (1932) scale with an additional 'not relevant' answer. The level of the framework to which the questions relate provides the grouping structure.

Table A4.1. Questions from the stage one questionnaire of the EDG tracer study

Framework category	Question
Relevance of training	• The topic of award was directly related to my field of work at time of completion
Quality of training	• I was provided with adequate supporting material • My mentor was knowledgeable and provided lectures/information of a good quality • My mentor provided the assistance I needed to complete the award • I found the award difficult due to my level of English[a] • I found it easy to follow the content outlined during my award • Additional training on some content used during the award would have been useful before commencing the program[a] • I was able to utilise the technology needed to complete my award • Additional training on the use of technologies during the award would have been useful before commencing the program[a]
Capacity built	
Knowledge/ understanding	• The training increased my knowledge of international trends/activities • I better understand issues and principles in my field • The knowledge gained from the course enabled me to interpret government policy
Confidence	• The award gave me motivation to research further in the field • The award gave me the confidence to pursue other work opportunities • The award gave me the confidence to pursue other research opportunities

Table A4.1. (continued)

Framework category	Question
Capacity built (continued)	
Technical skills	• I increased my capacity to do research • I acquired laboratory analysis skills • I acquired new technical skills
Management skills	• I acquired new ways to approach work problems • I learned techniques for managing and organising people and projects • I learned new or improved ways to communicate with networks within my field of expertise (e.g. farmers, donors, research organisations, government).
Capacity utilised	
Relevance	• I was able to apply the knowledge/skills from the training to my work • I was able to continue to apply the knowledge/skills from the training to my work for a period after the training • I continue to use the knowledge/skills learnt from the training in my current employment • I increased my ability to continue to research in my subject area • I have pursued work opportunities in the field of the award
Efficiency	• I work more effectively and efficiently • I increased my competency and confidence in my work • The award enabled me to perform better at work • I was able to improve my research processes due to the training • The networks made during the training have enabled me to produce better research outputs • I was given the opportunity to train others in my organisation the skills/knowledge learnt during the award • My employer offered me work which used the new skills I acquired during the award • The quality of internal training programs has been improved • The organisation has increased its R&D outputs • There is an improved flow of information within the organisation
Innovation	• I initiated my own projects/work activities • The uptake of new/improved technology has increased in the organisation • The organisation is more innovative and prepared to fund new approaches
Effectiveness	• I increased my professional collaboration with organisations both nationally and internationally • I increased my professional collaboration with people both nationally and internationally • The networks made during the training have enabled me to produce better policy outputs • I have more opportunities to collaborate with international and national organisations • The quality of discussion about work has improved in my department/organisation • The policies developed by the organisation are more considered and well informed about potential impact • The award has improved the management processes of the organisation • The award has added to the quality of research our organisation produces

Table A4.1. (continued)

Framework category	Question
Impact	
Personal	• The award had no impact on my work situation[a] • The award enabled me to move to another position in my workplace • The award enabled me to move to another institution or private company • I was offered a promotion • I have changed my work situation for the better due to the training • The award motivated me to participate in other training activities • My new level of skill/knowledge was rewarded by my employer
Organisational	• The award had no impact on my organisation or the work it performs[a]
	• The organisation has changed significantly for the better due to the award
Client	• The adoption of new/improved technology by the organisation's clients (e.g. farmers or industry) has increased
Policy	• The knowledge gained from the course enabled me to influence government policy • The award increased the organisation's ability to influence and inform policy decisions made by government

[a] Reverse interpretation

Source: EDG (2006); CIE categorisation.

IMPACT ASSESSMENT SERIES

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

No.	Author(s) and year of publication	Title	ACIAR project numbers
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
25	Brennan, J.P. and Quade, K.J. (2004)	Genetics of and breeding for rust resistance in wheat in India and Pakistan	CS1/1983/037 and CS1/1988/014
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	
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	