A methodology for assessing the poverty-reducing impacts of Australia's international agricultural research

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

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Foreword

Around the globe, new quantitative, qualitative and mixed-method research approaches are emerging that can better highlight the contribution of agricultural research to poverty reduction. Recent support from the Australian Centre for International Agricultural Research (ACIAR) is also helping to develop innovations for the more effective analysis of issues such as multidimensional poverty, food security, gender equality and environmental sustainability.

There is now a considerable body of evidence to support the assertion that improving agricultural productivity can reduce extreme poverty among rural populations in the developing world. This was evident in a recent report commissioned by ACIAR into the role of agriculture in poverty reduction (ACIAR Impact Assessment Series Report No. 76; Grewal et al. 2012). However, while that study highlighted poverty experiences in five long-term research partner countries of ACIAR— China, India, Indonesia, South Africa and Vietnam—it did not investigate a direct link between ACIAR research and household-level changes in poverty.

To help guide investment in detailed poverty analysis, this report examines some recent advances in methods for assessing the impact of agricultural research on the wellbeing of the poor. Using the livelihoods

approach as a starting point, the authors have proposed a methodological process suitable for assessing the poverty-reducing impact of ACIAR research of any scale or scope. The methodology emphasises the importance of focusing on the tractable impacts of agricultural research on target groups; of understanding the vulnerability context and the rate, pattern and determinants of technology adoption by poor farmers; and of determining the impact of research on the wellbeing of socially differentiated groups. Elements of the process will guide ACIAR in decisions about which research projects to target for impact assessment.

In addition, the authors have laid out an integrated mixed-method approach to impact assessment, and have also introduced a number of qualitative and quantitative data collection and research methods. This work will provide ACIAR with new tools to guide procedures for assessing the impact of its research.

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Summary

In recent years, the International Agricultural Research Centres (IARCs) have focused more attention on assessing the poverty-reducing impacts of the research they undertake. There are pressing needs to accelerate this research and evaluation agenda—around the world, well over 1 billion people continue to live in extreme poverty, and 70% of them live in rural areas. Considerable evidence suggests that improving agricultural productivity can reduce extreme poverty in these rural populations. Agricultural research plays a significant role in increasing this productivity and thus contributing to poverty reduction. This report outlines a livelihoods-based methodology for assessing the poverty-reducing impacts of Australia's international agricultural research.

The Australian Centre for International Agricultural Research (ACIAR) has made efforts to assess the extent to which the research it funds addresses poverty criteria, and has funded methodological reviews in this area. These reviews adopted an income-poverty perspective and highlighted the many difficulties faced when assessing poverty using purely quantitative means. When considering the poverty-reducing impact of agricultural research, however, it is important to adopt a multidimensional conception of poverty, and to develop an approach that considers the myriad ways, not just income, that agricultural research contributes to poverty reduction—or, indeed, potentially exacerbates poverty. The sustainable livelihoods framework provides some guidance in this regard. The livelihoods approach introduced in this report acknowledges that poor people adopt many and varied strategies to meet their livelihood needs. These activities might include permanent or seasonal formal employment, exploitation of common property or wild resources, cultivation of gardens, livestock production or labour exchange, to name a few. This approach highlights the importance of ensuring that external processes and supports are compatible with the ongoing livelihood strategies of poor people if poverty reduction is to be sustained.

The sustainable livelihoods framework has five components: the vulnerability context; livelihood assets; transforming structures and processes; livelihoods strategies; and livelihoods outcomes. The vulnerability context encompasses those factors that are largely beyond the control of the poor. This context is influenced by transforming structures and processes, e.g. institutions, organisations, laws and processes, which together shape livelihoods. Within the vulnerability context are the livelihood assets. These assets, which are at the core of the framework, include the various 'capitals' (human, social, natural, financial and physical) that can be used by people to further their livelihood strategies. These strategies are the diverse portfolio of activities that poor people employ to meet their livelihood goals (e.g. farming, seasonal labour, migration). They result in livelihood outcomes such as increased income, sustainable use of the resource base etc. that in turn influence the livelihood assets base. Clearly agricultural research, technological change and the associated structures and processes affect the livelihoods of poor farmers, in many and varied ways.

When using the livelihoods approach as a research and evaluation framework in poverty impact assessment it is important to focus on the tractable impacts of the intervention under review. The all-encompassing nature of the livelihoods framework can make it somewhat difficult to operationalise in a practical way. As such, it is up to researchers with an understanding of livelihoods and systems thinking to adapt the framework to the phenomena under investigation, which is, in this case, the assessment of the poverty-reducing impact of agricultural research. This paper outlines how the framework should be adapted for this purpose.

The first phase of any research along these lines should focus on determining the intended poverty-reduction impacts of the agricultural research funded by ACIAR. This would involve analysing the original research design and enquiring into the poverty-reducing logic behind the project. This will help refine the impact assessment design and highlight the most tractable poverty-reducing impacts, which can then become the focus of the assessment. During this initial process, a number of questions should be asked about the target beneficiaries of the project, the nature of the agricultural research products, the potential direct and indirect poverty-reducing impacts of these products, and the time frames over which we may expect to see impact.

The second phase of research should assess the rate, pattern and determinants of adoption of agricultural research outputs. This is not just a simple matter of adoption versus non-adoption, but includes determining who adopted the technology, when they adopted it and for what purpose. This should be followed by an assessment of the impacts of agricultural research on wellbeing. This involves collecting data on the vulnerability context, livelihood assets and strategies, and the role of institutions in beneficiaries' lives. The assessment of wellbeing should seek to understand the most significant direct impacts of the agricultural research on poverty and how these direct impacts differ between subgroups.

A mixed-method approach utilising a suite of quantitative and qualitative tools should be used in this assessment. Suggested methods include: household surveys to understand the livelihood strategies employed by households; household demographics; macro-economic and political–economic assessments of the vulnerability context; and qualitative and participatory research to better understand the dynamics of decision-making within households. Research proposals should explicate how these methods will be sequenced and integrated to improve the validity of research findings.

The results of these poverty assessments should be used to further strengthen the programming of ACIAR funds and to contribute to the growing body of knowledge on the impact of agricultural research on poverty reduction.

1 Introduction

1.1 Methodological innovation in international agricultural research assessment

In recent years, the International Agricultural Research Centres (IARCs) have begun to focus more attention on assessing the poverty-reducing impacts of the research they undertake. Increasingly, it is recognised that ex-post and ex-ante impact assessments, while important, do not sufficiently account for the impact of agricultural research on the varied aspects of poverty. While such assessments often provide economic justification for research investments, they do not say much about the impact of research on multidimensional poverty, food security, gender equality or environmental sustainability. As a result, IARCs are moving towards developing new methodological tools that can better examine the complex relationship between agricultural research and poverty alleviation. This report outlines a methodology for assessing the poverty-reducing impacts of Australia's international agricultural research. The methodology proposed is multidisciplinary and based on the sustainable livelihoods framework.

The Consultative Group on International Agricultural Research – Standing Panel on Impact Assessment (CGIAR–SPIA) has recently reorientated its strategic direction, moving from a focus on ex-post impact assessments of agricultural research investments to a focus on how these investments are contributing to global development objectives, such as those enshrined in the Millennium Development Goals (MDGs). New research initiatives have been developed at the global level and much research is now underway on developing quantitative, qualitative and mixed-method approaches that can better highlight the impact of agricultural research on poverty reduction.[1]

The Australian Centre for International Agricultural Research (ACIAR) also seeks to increase its support of methodological innovations in this area. There are several drivers for this increase in support, including the need to better communicate to stakeholders how its research contributes to poverty reduction, the need to demonstrate more explicitly how its activities contribute to global development principles (such as those enshrined in the MDGs and the Paris Declaration on Aid Effectiveness) and the need to use impact assessment results to improve program performance.

1.2 Outline of the report

The substance of this report is in three sections. The next section begins with a general introduction to the scale of poverty worldwide and a discussion of the impacts of agricultural research on poverty. It then provides some background on recent advances in assessing the impact of agricultural research on poverty reduction, including an analysis of previous work funded by ACIAR. This analysis highlights some of the methodological difficulties faced by researchers when using purely quantitative techniques to assess the impact of agricultural research on poverty reduction, including the limitations of focusing on income poverty at the expense of the broader concept of multidimensional poverty. This section moves on to suggest that a livelihoods approach is complementary to a multidimensional conception of poverty and can be usefully employed in its assessment.

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[1]   See http://impact.cgiar.org/about

Section 3 introduces the sustainable livelihoods framework, discusses the components of the framework and highlights their interaction. This introduction seeks to familiarise readers with the livelihoods approach in a general way, providing a background for the discussion in Section 4. The introduction to the sustainable livelihoods framework is followed by a discussion of the impacts of agricultural research on poverty reduction, as considered through a livelihoods lens; these include both economic and non-economic impacts. The aim of this discussion is to examine the myriad ways in which agricultural research affects the livelihoods of poor people.

Using the above discussion as a starting point, Section 4 introduces a methodological process that can be used to assess the poverty-reducing impact of ACIAR research of any scale or scope. Some guidance on which ACIAR-funded research projects to target for impact assessment is also provided. The methodology emphasises the importance of focusing on the tractable impacts of agricultural research on target groups, and focuses in particular on understanding the vulnerability context; the rate, pattern and determinants of technology adoption by poor farmers; and the impact of research on the wellbeing of socially differentiated groups. In support of this process, an integrated mixed-method approach to impact assessment is suggested, and several qualitative and quantitative research methods are introduced.

2 Poverty reduction and agricultural research

This section provides some background to the extent of poverty in the developing world, the various ways in which poverty is conceived and the role of agricultural research in reducing poverty. It also includes an assessment of previous ACIAR-funded income-poverty studies and raises a number of technical issues concerning the trade-offs between adopting an income-poverty or a multidimensional conception of poverty for future impact assessments.

2.1 A review of poverty in the developing world

Tackling global poverty remains an enormous challenge—well over 1 billion people in developing countries around the world live in extreme poverty. There are various ways in which poverty can be measured. The most widely used poverty measure is the number of people living on less than US$1.25 per day.[2] According to accepted international thinking, people living below this income are considered to be living in extreme poverty. This is the poverty line used to assess progress towards the United Nations' MDGs. As a group, developing countries have made some impressive progress in reducing the number of people living in extreme poverty, as the most recent comparable global poverty statistics demonstrate (Table 1).

The number of people living in extreme poverty in all developing countries fell from 1.896 billion in 1981 to 1.377 billion in 2005, meaning that more than half

a billion people were pulled out of extreme poverty in 24 years. While this is obviously good news at an aggregate level, a closer inspection of the information in Table 1 suggests gains have been mixed. The decline in poverty in the developing world has been largely driven by gains in East Asia, particularly in China. The number of people living in extreme poverty in China fell by 627 million between 1981 and 2005, yet, in all other regions, extreme poverty was higher in 2005 than in 1981, despite falls between 2002 and 2005 in most cases. As welcome as the overall declines in poverty are, it needs to be remembered that one-fifth of the world's people were still living in extreme poverty in 2005.

The absolute number of people living in extreme poverty is greatest in South Asia. As shown in Table 1, 596 million people lived in extreme poverty in 2005, 456 million of them in India. The number of people living in extreme poverty in Sub-Saharan Africa in 2005 was 391 million. The proportion of people living in extreme poverty in Sub-Saharan Africa is, however, more than in any other region. In 2005, 50.9% of Sub-Saharan Africa's population lived in extreme poverty, compared with 40.3% in South Asia.

It also needs to be remembered that the most recent internationally comparable data are for 2005. It has been estimated that the surge in food and fuel prices during the mid to late 2000s pushed 130–155 million people into extreme poverty (World Bank 2009). It is also widely acknowledged that the global financial crisis slowed rates of poverty reduction in the developing world, making achievement of the MDGs by 2015 even more difficult than previously envisaged.

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[2] Adjusted for purchasing power parity (PPP), according to 2005 prices

Table 1. Numbers of people (millions) living below the US$1.25 and US$2.00 poverty lines in developing countries: breakdown by selected regions

Region	Year										Rural poor[d]	
	1981	1984	1987	1990	1993	1996	1999	2002	2005	2005 %[a]	2002	2002 %[b]
Number of people living on less than US$1.25 per day (2005 PPP[c])												
East Asia and the Pacific	1,071.5	947.3	822.4	873.3	845.3	622.3	635.1	506.8	316.2	16.8	223.2	93.2
of which China	835.1	719.9	585.7	683.2	632.7	442.8	446.7	363.2	207.7	15.9	175.0	97.8
Latin America and the Caribbean	42.0	52.3	52.3	42.9	41.8	52.2	54.8	58.4	46.1	8.2	26.6	41.0
South Asia	548.3	547.6	569.1	579.2	559.4	594.4	588.9	615.9	595.6	40.3	394.3	75.9
of which India	420.5	416.0	428.0	435.5	444.3	441.8	447.2	460.5	455.8	41.6	316.4	74.8
Sub-Saharan Africa	213.7	243.8	259.6	299.1	318.5	355.0	381.6	390.0	390.6	50.9	228.8	69.8
Developing country total[e]	1,896.2	1,808.2	1,720.0	1,813.4	1,794.9	1,656.2	1,696.2	1,603.1	1,376.7	30.6	882.77	75.8
Number of people living on less than US$2.00 per day (2005 PPP)												
East Asia and the Pacific	1,277.7	1,280.2	1,238.5	1,273.7	1,262.1	1,108.1	1,104.9	954.1	728.7	38.7		
of which China	972.1	963.3	907.1	960.8	926.3	792.2	770.2	654.9	473.7	36.3		
Latin America and the Caribbean	82.3	98.8	96.3	86.3	88.9	105.7	108.5	114.6	91.3	16.6		
South Asia	799.5	835.9	881.5	926.0	950.0	1,008.8	1,030.8	1,083.7	1,091.5	73.9		
of which India	608.9	635.6	669.0	701.6	735.0	757.1	782.8	813.1	827.7	75.6		
Sub-Saharan Africa	294.2	328.3	351.3	393.6	423.8	471.1	508.5	535.6	556.7	73.0		
Developing country total[e]	2,535.1	2,615.4	2,639.7	2,755.9	2,821.4	2,802.1	2,872.1	2,795.7	2,561.5	47.0		

Source of poverty data: Chen and Ravallion (2008) and Ravallion et al. (2007)

a   Number of poor as a percentage of the total population

b   The number of rural poor as a percentage of the total number of poor

c   Purchasing power parity

d   Based on the extreme income poverty line of US$1.08 PPP in 1993 prices, which is the equivalent of US$1.25 PPP in 2005 prices

e   Totals also include the relatively small numbers of people living below the poverty line in countries in the Middle East, North Africa, Eastern Europe and Central Asia

Another widely accepted measure of poverty is the number of people living below the US$2.00 per day PPP poverty line. In line with the US$1.25 measure, impressive gains have been made by East Asia and the Pacific, largely due to progress in China. Yet the total number of people living below US$2.00 was higher in 2005 than in 1981, despite reductions from 1993 onwards. In 2005, 2.562 billion people (47% all people in the developing world) lived in poverty, based on this measure.

An even closer look at poverty in developing countries reveals that it is largely a rural phenomenon. The most recent comparable international statistics on rural poverty are for 2002. These statistics are included in Table 1. Extreme poverty in China is almost entirely a rural phenomenon, with 98% of this country's extreme poor being rural inhabitants. For the other regions shown in Table 1 (except Latin America and the Caribbean), 70% or more of the extreme income-poor live in rural areas. Recognising that the extreme poor are typically not geographically mobile, these numbers make it abundantly clear that the global poverty-reduction challenge must start with lifting the incomes of the rural poor in developing countries. As the discussion below suggests, agricultural research and the technological advances that arise from agricultural research have an important role to play in lifting the incomes of the extreme poor.

2.2 The poverty-reducing impact of agricultural research

Considerable evidence supports the assertion that improving agricultural productivity can reduce extreme poverty among rural populations in the developing world. Recent evidence from a large cross-country econometric study (Christiaensen et al. 2011) points to the significant impact that growth in agricultural production can have on reducing poverty among the poorest of the poor. This research demonstrated that, irrespective of geographical setting, a 1% increase in agricultural per-capita gross domestic product (GDP) reduced the total US$1.00 per day poverty gap by at least five times more than a 1% increase in GDP in a non-agricultural sector. This, however, was not the case for the poor on $2.00 per day, who were better off if growth occurred in a non-agricultural sector. This re-emphasises the importance of continuing to focus on

agricultural productivity as a means to lift the world's poorest people out of poverty. Similar conclusions to the above were reached by Valdes and Foster (2010) whose analysis of cross-country studies suggests that, in developing countries, agriculture tends to have an impact on national growth and poverty reduction that is greater than its share of GDP.

Agricultural research plays a significant role in increasing agricultural productivity. On these grounds, one would expect that the former, through its impact on the latter, would also improve the circumstances of the extreme poor. There is a significant body of literature that points to the fundamental importance of agricultural research to poverty reduction throughout the developing world (see: David and Otsuka 1994; Kerr and Kolavalli 1999; de Janvry and Sadoulet 2001; Thirtle et al. 2003; Minten and Barrett 2008; Alene and Coulibaly 2009; Becerril and Abdulai 2010). These studies use statistical methods to analyse the link between agricultural research and poverty reduction at an aggregate level, typically focusing on one or two aspects of this relationship. While, as Adato and Meinzen-Dick (2003) observe, at least some of this literature tends to simplify the relationship between agricultural research and poverty reduction, and may miss the many important ways agricultural research and the technology stemming from it impact upon poor people's lives, the statistical methods employed provide many important insights.

A well-regarded econometric study in this statistical literature is that of Thirtle et al. (2003), who developed a causal change model based on the hypothesis that agricultural research and development (R&D) expenditure increases the added value of agriculture; this increase in added value in turn reduces income inequality, which, furthermore, reduces poverty. Based on the econometric application of this model to cross-country data, Thirtle et al. (2003) concluded that agricultural R&D 'raises agricultural value added sufficiently to give very satisfactory rates of return within the agriculture sector, in both Africa (22%) and Asia (31%), but much less so in LACs[3] (10%)'. Owing to the inequality-decreasing impacts of these increases in agricultural value, they suggest that every 1% increase in yields reduces the number of people living on less than $1.00 per day by 6 million in the sample of countries examined. In line with Christiaensen et al. (2011),

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3   Latin American and Caribbean countries

they put the view that productivity improvements in agriculture are more important to the extreme poor than improvements in other sectors.

Fan et al. (2005) conducted a broadly similar study that focused specifically on China. Respectively, some 15.9 million and 473.7 million Chinese live below the $1.25 and $2.00 per day poverty lines according to the most recent statistics provided in Chen and Ravallion (2008). Fan et al. (2005) found that each additional 10,000 yuan (approximately A$1,500) of agricultural R&D expenditure reduced the number of people living below the official poverty line in China by 6.79. These people will remain out of poverty in perpetuity provided no other events push them back, an interpretation that applies to all poverty impacts of agricultural research discussed below. This translates to A$221 in expenditure for every individual lifted out of poverty. China, along with India, is one of the few developing nations for which this type of analysis can be done, since the data required for rigorous econometric investigation are available. Results from the International Food Policy Research Institute (IFPRI), based on what appears to be a cross-country investigation, suggest that each additional US$23 lifts one person out of poverty (based on the $US1.00 a day poverty line) in South and South-East Asia (von Braun et al. 2008). These numbers are, for many reasons, including differences in the way additional expenditure is allocated and the poverty line in question, not comparable. They do, however, point to the important poverty-reducing impact of agricultural research.

Alene and Coulibaly (2009) also looked at cross-country data for 1980 to 2003 for a sample of Sub-Saharan African countries. Recall that, based on the most recent data outlined in Table 1, the proportion of people living in extreme poverty in Sub-Saharan Africa is greater than in any other region of the world, with almost five of every 10 people living below the US$1.25 poverty line in 2005. Using a reasonably complex simultaneous equation econometric model, not unlike that applied by Thirtle et al. (2003), Alene and Coulibaly first presented evidence that agricultural research contributes significantly to productivity growth in Sub-Saharan Africa. They then presented evidence that this growth raised per-capita incomes, which was shown, in turn, to have significant poverty-reducing effects. Based on these results, Alene and Coulibaly estimated that agricultural research reduces the number

of poor people living on less than US$1.00 per day by 2.3 million or 0.8% annually. With agricultural research expenditure amounting to approximately US$35 billion dollars between 1980 and 2003, this translates to one person pulled out of poverty for each US$630 in spending. While Alene and Coulibaly (2009) note that this reduction is not large enough to offset the poverty-increasing effects of population growth and environmental degradation, their econometric analysis points to the significant potential of agricultural R&D to reduce poverty in Sub-Saharan Africa. They argue that, on the basis of the results of their analysis, a doubling of annual research investments in Sub-Saharan Africa, from a level of US$1.67 billion in 2003, would reduce poverty in the region by 9% annually.

As the above brief review suggests, extreme poverty remains a largely rural phenomenon in all developing countries. While some significant advances in poverty reduction have been made, well over 1 billion people continue to live in extreme poverty. Agricultural research, and increases in agricultural productivity, have been shown to contribute significantly to poverty reduction throughout the world, and increased investments in this area will likely lead to further reductions in poverty worldwide.

2.3 A review of previous ACIAR studies on agricultural research and poverty reduction

A significant number of the extreme poor live in countries targeted by ACIAR programs, particularly those in South Asia, and many ACIAR research projects and programs have an explicit poverty-reducing aim. With this in mind, ACIAR now seeks to place increasing emphasis on assessing the poverty-reducing impact of the research it funds. ACIAR has invested some effort in assessing the poverty-reducing impact of Australian-funded research by funding four studies on agricultural research and poverty reduction; their results are reported in the papers by Menz et al. (1999), Pearce (2002), Bauer et al. (2003) and Corbishley and Pearce (2006), which are reviewed in this section.

Menz et al. (1999) describe the evolution of the poverty-alleviation focus within ACIAR, noting that the measurement of achievements in this outcome had been

minimal. They highlight various difficulties in assessing the poverty-reducing impacts of agricultural research, essentially arguing for an approach focused on the assessment of economic benefits that could be assumed or inferred but not directly quantified.

Pearce (2002) lays the groundwork for a move away from this approach by outlining a comprehensive framework for the direct quantitative assessment of poverty impacts. He reviews different definitions and measures of poverty, and discusses various alternative methods for quantifying the poverty-reducing impacts of agricultural research. Measures reviewed include the headcount ratio, which is the percentage of the population whose incomes are less than the chosen poverty line. Pearce correctly observes that a weakness of the poverty-line approach is that it fails to consider how far below the poverty line poor people are. As such, it can tell us only about the extent of poverty, not its depth. Pearce also notes that there are two types of poverty lines. The first is an absolute poverty line that reflects the amount of money required to purchase basic needs. The second is a relative poverty line, which is the average income of the poorest 25% of the population. It follows that an individual who is poor according to the second of these measures might not be poor according to the first. Pearce correctly comments that setting poverty lines is notoriously difficult in practice, and it is important to be aware of the problems associated with implementing this method of assessing poverty.

Pearce considers in some detail alternative methods for quantifying the impacts of agricultural research on poverty and whether ACIAR could usefully apply these methods to assess the poverty-reducing impact of the research it funds. Two broad categories of methods are identified: experimental methods and simulations. Experimental methods involve experimental group and control group comparisons. The experimental group is that which experiences the benefits of agricultural research and the control group is that which does not. Randomised trials, which are currently extremely popular in the development economics research community, fall into this category. Pearce argues against ACIAR adopting this type of method on two grounds. First, it is likely to be prohibitively expensive. Second, there is a perceived difficulty associated with finding a group of people who have not benefited indirectly, in one way or another, from the research.

Simulation methods are far more favourably reviewed. According to Pearce, these methods compare actual 'with research' poverty scenarios against simulated, counterfactual 'without research' poverty scenarios. By comparing these scenarios, the poverty impact of the research can be identified. Five simulation methods are reviewed. The first method is the application of econometric modelling techniques, as in the studies discussed above (e.g. Thirtle et al. 2003 and others). Pearce (2002, p. 25) argues that this method 'could be useful to ACIAR in several ways'. He seems to acknowledge that since the analysis is typically applied at a macro level it is not necessarily informative at the level of individual projects. He nevertheless asserts that elasticities from these analyses (which show the extent to which poverty is reduced owing to a one-unit increase in research expenditure) could be applied at the project level.

The second method involves constructing a market model of the agricultural commodity in question that provides predictions of price and cost changes owing to research. These changes are then combined with an existing household survey to assess the poverty-reducing impacts of the research. The third, fourth and fifth methods involve the application of economy-wide general equilibrium models. The outputs of these models are combined with household survey data to examine changes in poverty levels. Although it is not clear from Pearce's paper, it seems that these models are used to predict the economy-wide impacts of agricultural research (such as increases in income) and these increases are then applied to household-level data to determine poverty impacts. While Pearce (2002, p. 28) argues that such methods could be usefully applied by ACIAR, he does acknowledge that it would need to be done in the context of 'significant projects' and that, owing to the costs of constructing an economy-wide general equilibrium model, a pre-existing model would need to be applied.

Bauer et al. (2003) looked at the poverty-reducing impact of an ACIAR project that led to the successful introduction into Papua New Guinea of a biological control agent for the banana skipper, an introduced butterfly pest that was causing significant damage to that country's banana crops. The methods applied in this study were relatively simple and involved combining information on the estimated effects of the control agent on banana production, consumption and prices with that

on poverty from the 1996 Papua New Guinea Household Survey to estimate the poverty-reducing impact of the introduction of the control agent. On the basis of this comparison it was estimated that between 1,500 and 6,000 subsistence banana growers (owing to increased banana consumption) and approximately 28,000 urban banana consumers (owing to lower prices) would have been pulled out of poverty through this research alone.

Corbishley and Pearce (2006) applied a similar approach to assessing the poverty-reducing impacts of a project that looked at ways to control herbicide-resistant weeds in the Indian wheat belt. Haryana was one of two states that benefited most from this project. The project led to the introduction of zero-tillage technology as a means of controlling the weeds. Farmers in Haryana were surveyed each year by a group at the Haryana Agricultural University. The 2004 survey was extended so that additional information could be obtained on farmers' incomes, to enable measurement of post-project poverty levels. This type of assessment is known as the 'before and after' method; in this case comparing poverty levels before the introduction of the zero-tillage technology with those after it had been introduced. When using this method, any decline in poverty is attributed to the technology and thus also to the ACIAR research that led to its introduction. Corbishley and Pearce found that the research had no impact on poverty, as there were no people living below the Haryana state poverty line before the introduction of the technology in question.

It is interesting that Bauer et al. (2003) and Corbishley and Pearce (2006) applied none of the methods favourably reviewed by Pearce (2002). A model could possibly have been constructed for the purpose of both evaluations, but given the cost of doing so it would probably have been beyond ACIAR's available funding and inconsistent with the scale of the agricultural research projects. In the case of Papua New Guinea, data availability would have also been a major problem. This reflects a more general problem with the Pearce framework: owing to cost and data limitations, such models either do not exist or cannot be developed. This will most definitely be the case in many countries within which ACIAR operates. Owing to lack of data, informative, empirically rigorous models certainly cannot be built for East Timor and most Pacific countries. There is also an issue of applying information obtained from economy-wide models to local contexts.

It is well known that relationships that might exist at the national level cannot necessarily be assumed to exist at the local level. The former, observed from economic models, are essentially those which apply on average across a country.

The previous comments do not imply that Pearce was wrong to favourably review the abovementioned models, as in principle they can overcome the problems associated with other methods, including the 'before and after' method used by Corbishley and Pearce (2006). This method has been heavily criticised for assuming that all other drivers of the variable in question remain unchanged (McGillivray 1999). If there had actually been poverty in Haryana, it could well have declined for reasons unrelated to the new technology. Since the 'before and after' method of analysis is blind to such changes, the observed declines could be wrongly attributed to the new technology. In this case the method would overstate the poverty-reducing impact of the agricultural research in question. What is required is information on the level of poverty that would had persisted had the technology not been introduced. The models reviewed by Pearce (2002) can come very close to providing this information by controlling for the impacts of poverty drivers other than the technology. Where Pearce's recommendations fall down, however, is in their practical application.

It seems clear that, on the basis of the studies just discussed, ACIAR has made strenuous efforts to align its evaluations to a poverty-reduction criterion but the methodologies suggested in these studies are either cost prohibitive or the data to implement them are unavailable. Further, the poverty research path that ACIAR has followed thus far has been characterised by a narrow 'income' poverty conceptualisation that lags behind state-of-the-art international thinking. This income-poverty focus also limits the types of methodologies that can be used to investigate poverty.

In the international literature, poverty is broadly defined as the lack of something of special importance (Gasper 2007). From a quality-of-life perspective, this clearly includes income. But it is not confined to income, a point that has long been recognised in the research and policy communities. The World Bank (Coudouel et al. 2002), for example, acknowledges that:

> Although poverty has been traditionally measured in monetary terms, it has many other dimensions.

Poverty is not only associated with insufficient money or consumption but also with insufficient outcomes with respect to health, nutrition, and literacy, and with deficient social relations, insecurity, and low self-esteem and powerlessness.

The concept of multidimensional poverty recognises that there is more to being in poverty than having a low income, but it also recognises that absence of income poverty does not guarantee the absence of other forms of poverty. Put differently, a person or household can be non-poor in terms of income but poor in terms of other poverty dimensions. Improvements in income will not guarantee improvements in these other quality-of-life dimensions and vice versa.

The United Nations Development Programme (UNDP) has implemented a focus on multidimensional poverty with its 1997 introduction of the Multidimensional Poverty Index (MPI). The current version of the MPI recognises three quality-of-life dimensions that are considered important to all people in all societies. These dimensions are health, education and material living standards. Household achievements in these dimensions are measured using 10 equally weighted indicators (UNDP 2010). Thresholds in each of these indicators are used to determine whether a household is poor with respect to any of them. These thresholds have a status equivalent to income poverty lines.

The health thresholds include having at least one household member who is malnourished and having had one or more children die. The education thresholds are having no household member who has completed 5 years of schooling and having at least one school-age child (up to 8th grade) who is not attending school. The standard-of-living thresholds relate to not having electricity, not having access to clean drinking water, not having access to adequate sanitation, using 'dirty' cooking fuel (dung, wood or charcoal), having a home with a dirt floor, owning no car, truck or similar motorised vehicle, and owning at most one of these assets: bicycle, motorcycle, radio, refrigerator, telephone or television (UNDP 2010).

A household is given a score for each threshold it does not meet. If a household's score is three or greater it is deemed to be multidimensionally poor. For example, it will be given this score if it fails to meet two of any of the health and education thresholds, all of the standard-of-living thresholds or three of the standard-of-living thresholds and one of the health or education thresholds. According to the MPI, the incidence and depth of poverty is significantly greater in Sub-Saharan Africa than elsewhere in the world, although the greatest number of people who are multidimensionally poor reside in South Asia (Alkire and Santos 2010).

We can, of course, debate the choice of quality-of-life dimensions and their weights, along with the choice of indicators and thresholds in each. But what remains clear is that if we accept that there is more to life than income, and that achievements in all aspects of life are not exactly mirrored by income, we must acknowledge that poverty is multidimensional and that focusing on income levels alone gives us partial and possibly misleading information about it. If this is accepted, then a logical step in the evolution of ACIAR's approach to poverty assessment is to embrace the multidimensionality of poverty and support innovative methodologies that can assess the impact of its research on multidimensional poverty, rather than on income alone.

It is clear from the above discussion that poverty is complex and multidimensional, and that the measurement of it cannot be reduced to a consideration of income. Furthermore, it is clear that a poverty impact evaluation that adopts a multidimensional poverty perspective cannot use the types of empirical methods adopted by Fan et al. (2003) and Thirtle et al. (2002), or those suggested by Pearce (2002). It is also clear from the above discussion that the income-poverty methods adopted by the authors mentioned above are prohibitively expensive, the data required for the models entailed are largely unavailable in many of the countries where ACIAR operates, and there are problems with scale (e.g. conflating national outcomes and local outcomes).

The question then arises: how can poverty, in all its multidimensionality, be measured? And how can the impact of agricultural research on poverty be assessed? One conceptual framework that incorporates a multidimensional perspective of poverty, and employs both quantitative and qualitative methods to explore it, is the sustainable livelihoods framework, which focuses on household-level poverty and livelihood strategies, and therefore has much in common with the UNDP MPI approach discussed above. We suggest that this framework, used in a focused and purposive way, can be usefully employed to assess the poverty-reducing impact of ACIAR's research.

3 The sustainable livelihoods framework

The discussion in Section 2 highlighted the importance of adopting a multidimensional approach to poverty; that is, an approach that does not reduce the concept of poverty to income alone. When considering the poverty-reducing impact of agricultural research, it is similarly important to adopt a multidimensional approach that considers the myriad ways, not just income, that agricultural research contributes to poverty reduction—or, indeed, potentially exacerbates poverty. The sustainable livelihoods framework can provide some guidance in this regard. This section introduces this framework, in very general terms, and discusses the many ways in which agricultural research impacts upon poverty. This section is not a methodology per se, but simply an introduction to livelihoods thinking in the broadest sense. It provides the background required to understand the livelihoods-influenced methodology presented in Section 4.

This section begins with an introduction to the sustainable livelihoods framework, and then moves on to describe in detail the various components of the framework and the interaction between components. This is followed by a discussion of the various ways in which agricultural research affects poverty, using the language and insights of the livelihoods approach.

3.1 An introduction to the sustainable livelihoods framework

In the early 2000s, the Consultative Group on International Agricultural Research (CGIAR) funded a large multicountry study that adopted a livelihoods approach to investigate the variable impacts that agricultural research has on poverty in developing countries (see Adato and Meinzen-Dick 2002). The initial report and subsequent publications from this study have been instrumental in expanding our knowledge of how agricultural research impacts upon the poor. The original work funded by CGIAR also demonstrated how important it is to adopt a multidisciplinary approach to poverty assessment. This is important because the effects of agricultural research on poverty cannot be reduced entirely to questions of economics and productivity, even though these are of significant importance.

The sustainable livelihoods framework has become an increasingly popular way to conceptualise the full suite of economic activities undertaken by the poor. This people-centred approach arose in the late 1990s in response to emerging frustration with more traditional models of rural development, which failed, according to some, to adequately countenance the multiple dimensions of rural poverty and the complexity of rural livelihoods (Carney 1999). The livelihoods approach reorientates rural development first and foremost towards a consideration of the complexity of poor people's lives; it promotes a more holistic understanding of how the poor use the full suite of assets available to them and the various structures and processes that influence the presence of assets (see Carney 1998; Ashley and Carney 1999; Carney et al. 1999).

The livelihoods approach acknowledges that poor people adopt many and varied strategies to meet their needs. These activities might include permanent or seasonal formal employment, exploitation of common property or wild resources, cultivation of gardens,

livestock production or labour exchange, to name a few. This approach highlights the importance of ensuring that external processes and supports are compatible with the ongoing livelihood strategies of poor people if poverty reduction is to be sustained.

The sustainable livelihoods framework is outlined in Figure 1. It is important to understand at the outset that it is not a rigid framework; it simply provides a checklist of important factors that affect the livelihoods of poor people and describes the relationship between those factors (DFID 2001). As such, it is a heuristic device that can be used when planning development activities or assessing the impact of activities, such as agricultural research, on the lives of poor people. If it is to be used for this latter purpose, however, then clear guidance needs to be given on its practical application. This guidance is provided in Section 4.

As Figure 1 suggests, the sustainable livelihoods framework is not linear, but a complex systems-like framework with feedback mechanisms influencing the various elements. The sustainable livelihoods framework has five components: the vulnerability context, livelihood assets, transforming structures and processes, livelihood strategies and livelihood outcomes. The vulnerability context encompasses those factors that are largely outside the control of the poor. This context is influenced by transforming structures and processes, such as laws, policies, institutions and

organisations, which together shape livelihoods. Within the vulnerability context are the livelihood assets that are at the core of the framework, these assets including the various 'capitals' (human, social, natural, financial and physical) that can be used by people to further their livelihood strategies. These assets can influence transforming structures and processes and, in turn, be influenced by them. The livelihood strategies themselves are the diverse portfolio of activities that poor people employ to meet their livelihood goals (e.g. farming, seasonal labour, migration). These strategies result in livelihood outcomes such as increased income, sustainable use of the resource base etc., which, in turn, influence the livelihood assets base. From examining the framework it is clear that there are myriad ways in which agricultural research, technological change and the associated structures and processes can affect the livelihoods of poor farmers. The components of the framework are discussed in more detail below.

3.1.1 The vulnerability context

The vulnerability context is the totality of influences that shape and constrain the livelihood strategies available to the poor. In most cases, poor people have limited or no control over the vulnerability context within which they are embedded. The aim of poverty reduction strategies should be to ameliorate the vulnerability context by building up the asset base, which will, in turn, improve

Figure 1. Sustainable livelihoods framework. Source: DFID (2001)
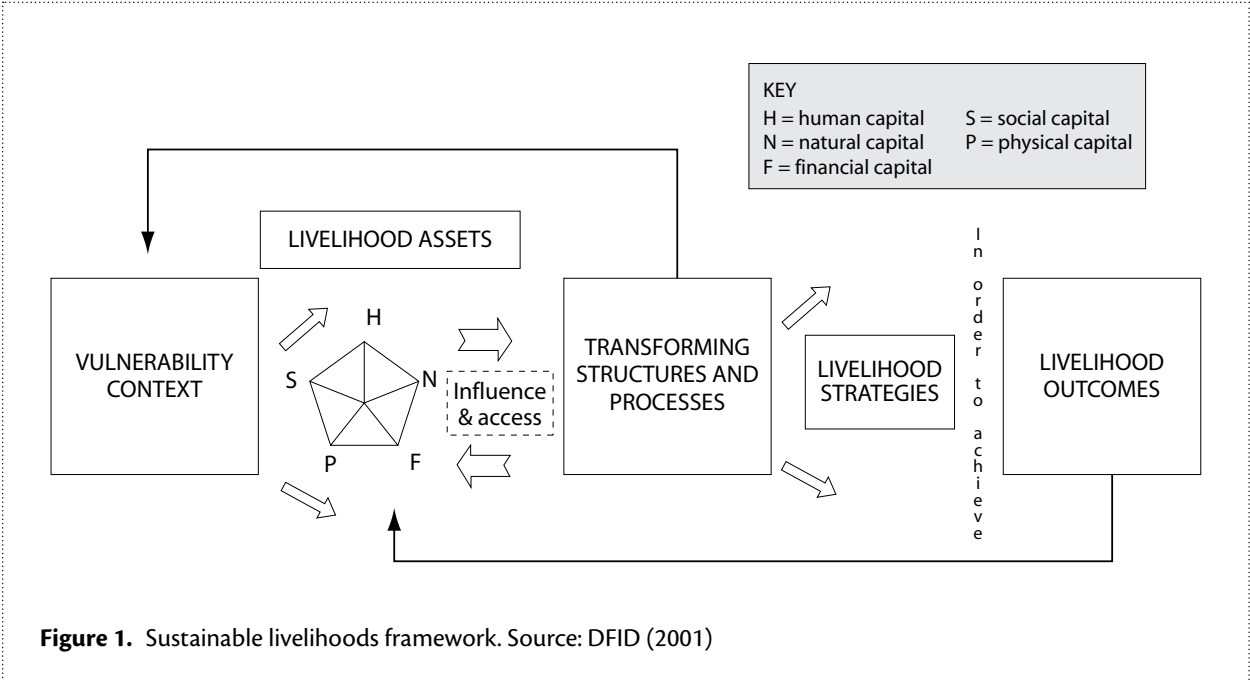
the resilience and adaptability of livelihood strategies (DFID 2001). The following definition (Hirby 2004) provides an insight into the nature of vulnerability:

> Vulnerability can be seen as a state of high exposure to certain risks and uncertainties, in combination with a reduced ability to protect or defend oneself against those risks and uncertainties and cope with their negative consequences. It exists at all levels and dimensions of society and forms an integral part of the human condition, affecting both individuals and society as a whole.

The vulnerability context is affected by shocks, seasonality and trends, each of which is discussed below:

Shocks

Shocks of various kinds can have devastating effects on the lives of poor people, who are often unable to cope with them. These shocks may include natural shocks (such as tropical cyclones and floods) that can directly destroy assets and force people to abandon livelihood strategies, or they may include human health shocks, economic shocks, conflict and crop/livestock shocks. The recent food and fuel crisis is an example of parallel shocks that had profound effects on the lives of the poor and vulnerable in the developing world. It has been estimated that the surge in food and fuel prices during the mid to late 2000s pushed between 130 and 155 million people into extreme poverty (World Bank 2009). Similarly, the recent global financial crisis had significant impacts on economic growth, employment and informal sector opportunities for poor people across the developing world, and combined to increase the vulnerability of the poor.

Seasonality

Seasonality is another important element of the vulnerability context. This might include seasonal changes in food prices, shifts in employment opportunities during the year and shifts in food availability, which can be most acute in the preharvest stage. Assessing the vulnerability of households to seasonal poverty is an important component of the sustainable livelihoods framework. This is because seasonal poverty can have crippling effects on the health of poor people and their capacity to accumulate assets (Longhurst et al. 1986). Vulnerability can be reduced

by strengthening the coping mechanisms of the poor to adapt to seasonality. While seasonal shifts in prices and food can cause significant problems for poor people, they can also provide opportunities for farming households to optimise income by exploiting price fluctuations (although the livelihood benefits of this depend on whether the household is a net producer or consumer of food).

Trends

Trends are also important contributors to the vulnerability context, although they are invariably more predictable than shocks and may be less acute. Trends that may have significant impacts on the lives of poor people include population trends (e.g. rural–urban migration), resource trends and associated conflicts (e.g. mining versus agriculture), national and international economic trends (e.g. globalisation), political trends and technological trends (e.g. biotechnology). The vulnerability of people is measured by the extent to which they are adversely affected by these trends, but there are also opportunities to lift people out of poverty and reduce vulnerability by exploiting beneficial trends.

3.1.2 Livelihood assets

The next component of the sustainable livelihoods framework is livelihood assets. The sustainable livelihoods framework is founded on the conception that people require a complex set of assets to achieve livelihood outcomes. These assets interact to provide people with the basic elements they need to meet their livelihood goals. The sustainable livelihoods framework highlights the importance of understanding how and why people use assets in the way they do and how the stock of assets changes over time. Those people whose assets are in continual decline are considered the most marginalised and vulnerable, while those whose suite of assets is increasing are incrementally improving their wellbeing.

There are five types of assets or 'capitals'. It is important to understand these assets, as this provides a solid foundation upon which to base our understanding of the complicated livelihood strategies adopted by poor people. A discussion of each of these 'capitals' follows.

Human capital

Human capital underlies the utilisation of all the other 'capitals'. It is the skills, knowledge, health and ability to labour that enables people to pursue livelihood strategies. Human capital is important because it is the basic asset required to make use of the social, natural, physical and financial capital at one's disposal. It is therefore a necessary but not sufficient condition for poverty reduction. Human capital can be invested in, and can have significant impact on, the wellbeing of poor people; for example, across the world better educated people invariably have higher incomes than those with less education (Becker 2008). But human capital also has its own intrinsic value, particularly if one adopts a multidimensional conception of poverty, which sees a deficit in education or health as a form of poverty.

The accumulation of human capital is the goal of many development projects, as demonstrated by the significant amount of money spent by donors on health and education interventions in developing countries. Aside from the accumulation of foundational forms of human capital (for example, through schooling), there is also a need to ensure that knowledge generation (such as that which leads to changes in agricultural practices) builds on an understanding of current livelihood strategies and complements the local knowledge of poor people.

Human capital, particularly as it is manifested in education and health outcomes, is an important component (alongside income) of the multidimensional conception of poverty, and any analysis of poverty using a multidimensional approach should incorporate an assessment of human capital.

Social capital

According to Pretty (2002, p. 48) social capital 'captures the idea that social bonds and social norms are important for attaining sustainable livelihoods'. Within the agriculture and natural resource management sectors, social capital is seen as vitally important because it facilitates the collective management of resources. From catchment management, to irrigation users groups, to crop protection and integrated pest management, more productive and sustainable solutions to agricultural management issues are believed to derive from participation in a group (Pretty and Ward 2001; Pretty 2002). Suggested further benefits include enhancing social learning, facilitating innovation and the cross-fertilisation of ideas, and promoting better partnerships between all actors within the agricultural sector (Pretty 2002).

To understand the various ways in which social capital facilitates individual and collective action, it is useful to conceive of it as having three connecting strands: bonding, bridging and bracing. Bonding social capital refers to the strong ties that exist between 'those like us' (Woolcock 1998); for instance, family members, neighbours, close friends and business associates. Bonding social capital connects people who share similar demographic and ethnic characteristics; it can be conceived of as the glue that binds a group together. These bonds are held together by norms of trust and reciprocity and are characterised by horizontal association; i.e. they are non-hierarchical. Bonding social capital is particularly important to those with limited access to resources and who have minimal extra-group linkages. But problems can arise when too much emphasis is placed on bonding social capital (e.g. downward-levelling norms, antisocial behaviour). While primary groups and networks are important for wellbeing, they also 'reinforce pre-existing social stratification, prevent mobility of excluded groups, minorities of poor people, and become the bases of corruption and co-option of power by the dominant social groups' (Narayan 1999, p. 13).

According to Narayan (1999), societal wellbeing and collective good are facilitated by the development of crosscutting ties or bridging social capital and a move away from exclusive loyalty to primary social groups. Bridging social capital is characterised by weak ties that connect people from different ethnic, geographical and occupational backgrounds. The importance of crosscutting ties has been emphasised by Granovetter (1973) whose now familiar aphorism 'the strength of weak ties' draws attention to the importance of expanding ties beyond the primary network to access richer resources and achieve social and economic mobility. This is particularly important if one considers the dynamic changes that are taking place in the rural economy, with increased mobility broadening livelihood strategies.

Another type of social capital is bracing social capital (Rydin and Holman 2004). This relates to the instrumental and targeted use of social capital

resources to achieve a particular development end. The engineering metaphor has been adopted to emphasise the strengthening of connections between groups. These groups may be of any scale, the connections may be vertical or horizontal, and they may be from any sector of society. As opposed to bridging social capital, which also links groups through networks, bracing social capital emphasises the development and sharing of common norms to solve problems. The goal of bracing social capital is to build the capacity to act.

Natural capital

Natural capital is the totality of natural resources and ecological processes and services from which all human livelihoods derive. This form of capital is critical to the functioning of the Earth's life-support system. The stock of natural capital includes all the Earth's ecosystems and its atmosphere; from this stock flow a plethora of ecosystem services that combine with manufactured and human capital to produce human welfare (Costanza et al. 1997).

Natural capital is critical to the livelihoods of poor people. Shocks that destroy natural capital (floods, fires etc.) can devastate the livelihoods of poor farmers, while ongoing unsustainable agricultural, forestry or fisheries practices can undermine the resource base and increase vulnerability. Changes in the atmosphere, such as those occasioned by increases in greenhouse gas concentrations, can also have significant impacts on the livelihoods of poor people, who are the most vulnerable to climate change. It is clear that climate change will have profound impacts on agricultural systems worldwide and particularly on the livelihoods of poor people (Campbell 2009).

Physical capital

Physical capital is an important component of the livelihood asset portfolio as it provides the basic infrastructure and producer goods required to meet livelihood outcomes (DFID 2001). There are certain types of infrastructure that are essential for sustainable livelihoods, these including access to water and sanitation services, and access to affordable transport, shelter and energy. A lack of access to these services can have significant ramifications for multidimensional poverty. For example, inadequate access to transport may hinder income generation or preclude access to education and health services, while a lack of access

to energy and water can have an adverse impact on human health and require significant investment in nonproductive activities.

Physical capital also interacts with other forms of capital to shape and constrain livelihood outcomes. For example, in remote communities with limited agricultural infrastructure, access to physical capital such as irrigation services may be facilitated only through bonding social capital; i.e. through a history of participation in a group (see Carpenter (2005) for examples from the Philippines). This can have ramifications for migrants and people from outside the primary group. Furthermore, the insufficient provision of producer goods can constrain the productive capacity of individuals and the optimisation of their human capital. The lack of access to physical capital such as schools also has significant impacts on the development of human capital.

Financial capital

Within the livelihoods framework, financial capital refers to both the stock and flow of financial resources available to pursue livelihood strategies (DFID 2001). On the stock side this includes savings, credit or liquid assets such as livestock; and on the flow side it may include income, remittances or other regular cash inflows such as cash transfers or pensions. Financial capital is the most fluid and easily convertible form of capital asset. However, a lack of financial capital is, more than shortage of any other capital, predeterminative of chronic poverty (Dowling and Chin-Fang 2009). Within the context of the livelihoods approach, access to financial capital cannot be divorced from the broader social axes that shape and constrain people's lives. Class, gender, ethnicity and age all act to influence the livelihood options available to people.

3.1.3 Transforming structures and processes

Transforming structures and processes refer to those institutions, organisations, policies and laws that act at multiple levels to shape and constrain livelihoods. This is the most complicated aspect of the livelihood framework because of its significant influence on all its other elements. Structures and processes encompass the broader social, cultural and political–economic environment within which livelihoods are constructed. These conditions can determine access to livelihood

assets, the terms of exchange between different assets and the returns to any particular livelihood strategy (DFID 2001).

Within the livelihoods framework, 'structures' refers to those public- and private-sector bodies that create laws, implement policy, purchase goods, trade and provide a multitude of services for people. Public bodies include international governance structures (e.g. World Trade Organization), governments at multiple levels and legislative bodies. The private side includes civil society, private enterprises and non-government organisations (NGOs) at multiple scales. Processes are the suite of policies, legislation, cultural norms, institutions and power relations that govern the interaction between structures and individuals. These processes may be formal and their likely impact on the poor relatively easy to discriminate (e.g. laws pertaining to the use of intellectual property), or they may be informal, culturally specific norms.

This is obviously a very complicated area; the livelihoods framework merely provides some guidance as to what these structures and processes are and how they interact with other aspects of the framework. From an analytical perspective, it is necessary to focus on those structures and processes that have the most significant impact on the individuals and communities that are the focus of any intervention or research study. To do this, one needs to look beyond the structures and processes themselves and ask questions about the effects of these on the lives of particular groups of people.

3.1.4 Livelihood strategies

'Livelihood strategies' is an all-encompassing term used to describe the full suite of activities that people deploy to meet their livelihood goals; they might include productive activities, investments, reproduction etc. (DFID 2001). The sustainable livelihoods framework focuses attention on the way householders combine activities over space and time to meet livelihood outcomes. For example, people might move away from the primary household to exploit seasonal peaks in employment or they might receive remittances from family members living overseas.

The activities that the rural poor undertake to meet livelihood outcomes cannot be singularly classified. While 'farming' or 'fishing' or other natural-resource-based activities may be important for income and

employment, classifying people as 'farmers' or 'fishermen' does not sufficiently encompass the wide range of productive activities undertaken by poor people in rural areas of the developing world, and may lead to misguided assumptions about what is important to their livelihoods. The livelihoods approach does not seek to categorise people; instead, it seeks to understand the factors that lie behind the choice of livelihood strategies (e.g. asset base, structures and processes etc.) to reinforce positive aspects while constraining negative influences (DFID 2001).

One thing that is becoming clear as we reflect on the lives of the rural poor is the increasing complexity of livelihood strategies and the declining role that natural-resource-based productive activities play in people's lives. There are major transformations taking place across rural areas in the developing world that are leading to pronounced shifts in economic activity. These trends and processes have been summarised by Rigg (2006, p. 183) as follows:

- Occupations and livelihoods in the countryside are diversifying.

- Occupational multiplicity is becoming more common and more pronounced.

- The balance of household income is shifting from farm to non-farm.

- Livelihoods and poverty are becoming delinked from land (and from farming).

- Lives are becoming more mobile and livelihoods correspondingly delocalised.

- Remittances are playing a growing role in rural household incomes.

- The average age of farmers is rising.

- Cultural and social changes are being implicated in livelihood modifications, and in new ways.

Rigg's review of a multitude of economic studies from throughout the developing world highlights the important role that new, non-farm-based economic opportunities are playing in the lives of poor rural people in the developing world. These new opportunities are associated with significant cultural and social change and increased mobility, which are, in his view, driving forces behind a trend away from farm-based productive activities. These observations point to the importance of understanding how livelihood

strategies are affected by trends in the vulnerability context, and again reinforce the importance of non-categorisation and focusing on the factors that drive livelihood strategies in certain contexts.

3.1.5 Livelihood outcomes

Livelihood outcomes are the end result of livelihood strategies. These are many and varied and may include an increase in income, a reduction in multidimensional poverty, a reduction in vulnerability, improved food security or the sustainable use of natural resources, to name a few. There can clearly be conflicts between different livelihood outcomes, such as when a desire to increase income affects the sustainability of the natural resource base, or when different members of a household prioritise some outcomes over others (e.g. income over reduced vulnerability).

As indicated in Figure 1, livelihood outcomes can produce feedback effects on livelihood assets. For example, a person may adopt a livelihood strategy whereby they reinvest income (a livelihood outcome) into physical capital (a livelihood asset) with a view to improving future livelihood outcomes, and this may be the catalyst for a positive cycle of feedbacks that may contribute to a reduction in poverty. Alternatively, livelihood outcomes can interact with assets in more negative ways, such as when the sustainability of the natural resource base (or natural capital) is undermined by unsound agricultural practices. This may catalyse a feedback effect that could increase vulnerability and contribute to a descent into further poverty. An important aspect of the livelihoods framework is the understanding of positive and negative feedback cycles between the various framework elements.

3.2 The impact of agricultural research on poverty reduction: considered through a livelihood lens

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One of the valuable contributions of the livelihoods approach to understanding poverty is that it explicitly recognises the differential livelihood assets and strategies of the poor. People who may be classified under the same income-poverty level can have vastly different ways of achieving their livelihood outcomes,

and the impact of technology adoption can vary quite markedly depending on the livelihoods assets available to them and their socioeconomic circumstances. This insight has been confirmed in two major reviews of the benefits of agricultural technology adoption (Kerr and Kolavalli 1999; Hazell and Haddad 2001) that suggest that the benefits arising from technology adoption depend more on the socioeconomic and agroecological circumstances within which they are adopted than the technology itself. This highlights the importance of understanding these circumstances when seeking to assess the impact of agricultural research on poverty reduction. Simple measures of income poverty cannot differentiate between poor people in these important areas and, while these measures are necessary, they are not sufficient when it comes to understanding the impact of agricultural research on poverty.

A 2003 IFPRI study (see Meinzen-Dick et al. 2003) that was also influenced by the livelihoods approach highlighted the importance of assessing the differential impact of agricultural research on poverty. This study has had a significant influence on the evolution of the methodology described in Section 4. According to Meinzen-Dick et al. (2003, p. 8), agricultural research and technology development interacts with livelihoods in three important ways:

- by increasing or decreasing **vulnerability**, through changes in diversity of crops grown, resistance to climate and pests, variability of output, changes in seasonality, or dependence on markets

- by changing the **asset base** of physical capital (equipment), natural capital (soil fertility or water control), human capital (knowledge of management practices), and social capital (through farmer research groups, community nurseries, or collective action for watershed management)

- by interacting with **policies, institutions and processes** that also affect poverty outcomes. The processes by which technology is developed, water rights are allocated, and marketing and extension services are organised affect the types of technologies that are developed and how they are promulgated and accessed.

Their large multicountry study looked at the impacts of the products of agricultural research on diverse groups of poor farmers from Bangladesh, China, India, Kenya,

Mexico and Zimbabwe. Using the livelihood framework as an underlying conceptual framework, this research assessed the direct and indirect effects of technology adoption on different groups of farmers. These impacts varied depending on factors such as asset endowments, socioeconomic status, gender and age. Impacts included positive and negative productivity effects, increases and decreases in yield stability, improvements in human capital, increases in women's empowerment and social capital formation. Indirect impacts included increases in labour demand, land leasing and non-agricultural employment, as well as an increase in so-called 'scientific practices' by farmers. While the vast majority of the beneficial impacts were in the area of productivity improvement, there was a wide range of other positive and negative effects that arose from the research, which highlighted the complex interaction between agricultural research and livelihoods. The following discussion draws on the insights from this IFPRI research to discuss the interaction between agricultural research and livelihoods with regard to the vulnerability context, the asset base, and policies, institutions and processes.

The importance of understanding the vulnerability context, both objectively and subjectively (i.e. as conceived through the eyes of farmers), was a key finding of the IFPRI research. The provision of new technology can have negative and positive influences on vulnerability. For example, it can help improve the productivity, stability and sustainability of agriculture through, for instance, the development of pest-resistant crop varieties, improvements in access to water or increases in yield. These improvements may reduce the vulnerability of poor farmers, and could, depending on other circumstances, lead to a reduction in poverty. However, new technologies can, in certain instances, also increase the vulnerability of households, and potentially exacerbate poverty. This may occur when inappropriate technologies are introduced, or where human capital (e.g. the skills and knowledge to optimise the benefits of agricultural research) is lacking. Agricultural research targets specific problems and seeks to benefit (typically large) rural communities, but if one adopts a livelihoods perspective it is clear that the asset base and livelihoods strategies of individual households can vary quite markedly within a target population, and so too can the impact of agricultural research.

Take, for example, the use of new crop varieties in suboptimal conditions. The use of new varieties in these circumstances can reduce productivity, increase the instability of production, reduce income and increase debt (Carpenter 2005), thus increasing the vulnerability of households and exacerbating poverty. While this negative impact is occasioned by the use of the products of research (in this case germplasm) in suboptimal conditions, and while their use in this way may not have been the goal of researchers, the fact is that high-yielding crop varieties, especially those propagated by seed, have the capacity to swiftly move through the landscape (Carpenter 2010) and this can have negative impacts when they are used in marginal environments and when other circumstances are present (e.g. lack of access to inputs, usurious local credit markets, land tenure issues etc.).

Agricultural research and the introduction of new technology also play an important role in shaping the livelihood asset base (i.e. the various capitals available to farmers to construct livelihoods strategies). For example, the introduction of new technology (e.g. hand tractors), or the promotion of more efficient irrigation practices, can improve access to, and the efficiency of, physical capital. These changes can have variable impacts across poor communities, as they interact with the other capitals to forge modified livelihood strategies (e.g. they may offset traditional labour exchange relations, thereby modifying local social capital, or they may require greater access to finance, thus changing the financial capital asset base).

By introducing new practices, agricultural research can have negative or positive impacts on natural capital (e.g. soil ecology, pest–predator interactions etc.). This may occur through the promotion of intensive practices in suboptimal environments, which may undermine the natural resource base thus affecting the sustainability of production; or through the introduction of sustainable practices that improve the natural resource base. The reduction in agricultural biodiversity occasioned by the introduction of new agricultural practices can have significant impacts at the field, farm and landscape level (Altieri and Roge 2010).

Aside from directly affecting the asset base (either positively or negatively), the products of agricultural research are in some respects also mediated through livelihood assets. For example, access to the products

of agricultural research may, in some circumstances, be available only through local networks or participation in a group. Participation in a group is a form of social capital, and access to social capital can be differential across households, so it can play an important role in facilitating or constraining access to the products of agricultural research. As the discussion above has suggested, human capital (i.e. skills and knowledge) plays a fundamentally important role in the utilisation of new technology and the forging of livelihoods strategies, so it is also an important element of the livelihood asset base.

The role of policies, institutions and processes is also an important locus of interaction between agricultural livelihoods and research. Agricultural research is undertaken within public or private structures and the products of this research are promoted and disseminated through legislation, policies, and formal and informal institutional processes. At the international level, such processes might include legislation like Trade-Related Intellectual Property Rights under the World Trade Organization, which seeks to protect the rights of breeders of new crop varieties, while at the national level it might include policies that promote these varieties (for example, through subsidies), and at the local level it might include the informal 'rules of the game' where farmers exchange seed annually.

Policies, institutions and processes are important because they mediate access to the products of agricultural research and influence how these products are used. Take, for example, the important role that private and public extension plays in the dissemination of agricultural technology, or the role that subsidies can play in influencing farmer behaviour. It is important to understand how these important policies, institutions and processes shape and constrain access to agricultural technology in particular circumstances and by different groups of people.

The above discussion has highlighted how adopting a livelihoods approach to determining the impacts of agricultural research on poverty is a complicated and nuanced enterprise that has to account for a broad range of phenomena; it is significantly more complicated than a focus on income poverty. The following section will introduce a focused and practical methodology for assessing the poverty-reducing impact of agricultural research, drawing on the important observations of the IFPRI study (i.e. the importance of understanding vulnerability, assets and institutions) but also highlighting the need to focus specifically on the agricultural technology being promoted, and on the rate, pattern and determinants of technology adoption.

4 A methodology for assessing the impact of agricultural research on poverty reduction

One of the problems with the livelihoods approach, as is evident from the preceding discussion, is that it is very general and all-encompassing, and includes within its scope everything from the minutiae of economic activity at the household level to large-scale political and economic processes. While all these various dimensions are important and reflective of the complexity of human-ecological systems, this complexity poses problems for those who seek to use the framework as a tool to assess the poverty-reducing impact of agricultural research.

In this section, some methodological guidance is provided on how to undertake livelihood-orientated research on the impact of agricultural research on poverty reduction. In order to set the context, this section begins with a discussion of the types of research investments funded by ACIAR; this discussion highlights the diversity of these investments and the significant variability in their scope and scale. Second, a methodological process is introduced that can guide researchers who seek to assess the poverty-reducing impact of ACIAR's agricultural research investments, regardless of their scope or scale. This methodology highlights the importance of focusing on the outputs of agricultural research[4]; the intended direct and indirect effects on poverty of that research; the rate, pattern and determinants of technology adoption; and the impact of adoption on wellbeing. Third, some methodological justification for an integrated approach to livelihoods

research is presented. This includes a discussion of the importance of sequencing quantitative and qualitative methods of data collection. Lastly, the quantitative and qualitative methods of data collection and analysis briefly outlined in the process section are further explained. This is not a prescriptive or exhaustive list of methods, and the exact mix of methods may require modification depending on the focus of the impact assessment. The aim of this methodological section is to provide researchers with a process and a suite of techniques that can be used to determine the tractable impacts of ACIAR's agricultural research on poverty reduction, noting that, due to resource constraints, all-encompassing assessments that include all components of the sustainable livelihoods framework will not be possible.

4.1 ACIAR's research investments

ACIAR funds a broad range of agricultural research in four research clusters: economics, crops, natural resource management, and livestock and fisheries, under which there are 13 discrete research programs. The economics research projects (specifically agribusiness and agricultural development policy) focus on the broader enabling environment within which actual production is embedded (e.g. policy and value-chain issues), while the crops research projects focus more on improving productivity at the farm level through germplasm and plant improvement, and through the

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4   This refers primarily to the technologies produced by agricultural research, which include management practices, physical technologies and germplasm.

introduction of new technology. Some projects also focus on landscape-level issues such as soil management and access to water. As such, some ACIAR projects focus more on what is, in livelihoods parlance, referred to as transforming structures and processes (e.g. transforming policies and public and private institutions to improve the returns to agriculture), while some focus more on modifying the livelihood asset base, through the introduction of new physical technologies or improvements in natural capital. The policy- and institution-focused programs may have more of an indirect impact on poverty reduction (at the household level) than those programs that focus on improving productivity or promoting sustainability at the farm and landscape level.

Aside from the varying scope of the research projects, there are also important scale differences. Some projects, such as the 'Seeds of Life' crop improvement program in East Timor, seek to have national-level effects through the widespread distribution of germplasm; while some projects have a much more local scale, such as those programs that focus on controlling pests of particular plant species in certain locations (e.g. the integrated pest management projects under the Pacific Crops research program). Some projects—such as the abovementioned 'Seeds of Life'—are significant in both scope and scale, in that they seek to improve many related aspects of agricultural production at the national level (in this case, developing new germplasm, formally and informally producing and distributing improved germplasm, and strengthening the capacity of the Ministry of Agriculture in the area of seed management). If we think back to the components of the livelihoods framework then we can see that a project like this is operating in multiple components of the framework, in that it is seeking to expand the natural capital asset base (e.g. through the production of germplasm), to modify the social capital asset base (e.g. through the informal distribution of seed) and to transform structures and processes (e.g. private and public agricultural service providers and associated policies).

Due to their scale, scope and financial size, projects like 'Seeds of Life' are more suited to a livelihoods-focused poverty reduction assessment than smaller local projects. This is because there is more likelihood that a project of this scale has made a significant contribution to poverty reduction that can be assessed, and because of economies of scale at the level of research funding. From an impact

assessment perspective, it makes more sense to invest research funds into assessing what are likely to be larger scale poverty impacts. This does not mean that smaller projects cannot be assessed, but some consideration may need to be given to amalgamating small projects into a research-program-focused evaluation, or one that focuses on a range of ACIAR investments in a particular region over time.[5] The methodological process described below can be used for small projects, clusters of small projects, or large projects.

In summary, ACIAR funds a broad range of research projects that vary considerably in scope and scale. Some will have direct impacts on poverty reduction; some will have more of an indirect impact by influencing policy or improving capacity within counterpart governments. Some projects will have widespread impacts; some will have more localised impacts. It makes sense from an efficiency perspective to focus poverty impact assessment on those projects that seek to have large-scale poverty-reducing outcomes, or to amalgamate smaller projects into clusters of regional projects. A methodology for assessing project outcomes is presented in the next section.

4.2 A process for assessing the poverty-reducing impact of ACIAR's agricultural research

The following section outlines a methodological process for assessing the poverty-reducing impact of the agricultural research funded by ACIAR. The conceptual basis for this is the sustainable livelihoods framework introduced in Section 3. The steps in the process are based on insights arising from the Meinzen-Dick et al. (2003) study, which, as far as the authors of this paper are aware, is so far the only large-scale attempt to use the livelihoods framework to assess the poverty-reducing impact of agricultural research. This methodological process comprises three phases: determining the intended poverty-reducing impact of the agricultural research, determining the rate and pattern of adoption of research outputs by targeted beneficiaries, and assessing changes in wellbeing.

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5   For example, the agribusiness projects (AGB/2008/002 and AGB/2009/053) underway in north-western Vietnam, or other projects that have a regional focus.

4.2.1 Phase 1: Determine the intended poverty reduction impacts of the agricultural research

Any assessment of the poverty-reducing impact of an agricultural research project should be preceded by an analysis of the original research design and an enquiry into the poverty-reducing logic behind the project. If the project did not have an explicit poverty-reducing logic then this should be developed in concert with the research proponents during a scoping study, or inferred from the research proposal. This will help refine the impact assessment design and highlight the most tractable poverty-reducing impacts, which can then become the focus of the impact assessment. During this initial process, answers should be provided to the following questions:

■ Who were the target beneficiaries of the project?

■ What agricultural research products were developed as part of the project?

■ What were the perceived direct and indirect poverty-reducing impacts of the agricultural research undertaken? (There will most likely be numerous answers to this question; if so, the answers should be listed in order of perceived importance.)

■ Over what time frame (short, medium or long term) was it envisaged that these poverty-reducing impacts would occur? (This should be mapped against the abovementioned perceived impacts, in a matrix with short, medium or long term against each perceived impact. A definition of 'short', 'medium' and 'long' should be agreed to with the research proponents or inferred from the original design.)

Research reports should then be reviewed to determine the extent to which the project followed the original design. The information gathered as part of this process could then be compiled into a brief theory of change that outlines how the outputs of the research project sought to reduce poverty over time. This theory of change can then be used to guide the next phase of the impact assessment.

4.2.2 Phase 2: Assess the rate, pattern and determinants of agricultural research outputs

One of the key insights of the Meinzen-Dick et al. (2003) study was the need to focus on the rate, pattern and

determinants of technology adoption. This research found that the impact of technology adoption on poverty is influenced significantly by the rate and pattern of adoption. This is not just a simple matter of adoption versus non-adoption, but includes determining who adopted the technology, when they adopted it and for what purpose. Meinzen-Dick et al. (2003) suggest that the pattern of adoption can affect the distribution of benefits and costs.

The adoption of technology modifies the livelihood assets available to farmers and therefore has a direct influence on the livelihood strategies available to households. It is through the modification of livelihood strategies that poverty-reducing outcomes will arise. As the discussion in Section 3 suggested, the distribution of livelihood assets between households (in this case the beneficiaries of agricultural research) is likely to be differential prior to the adoption of any new technology. As a result, some households may be more vulnerable than others. The perceived and actual vulnerability of households will have a strong influence on the adoption of technology and on risk aversion. The influence that policies, institutions and processes plays in people's lives, particularly in terms of the dissemination of the products of research, will also differ, and this will influence the livelihood strategies undertaken, as discussed in Section 3.

The Meinzen-Dick et al. study found that the three main factors that influenced the rate and pattern of technology adoption were (Meinzen-Dick et al. 2003, p. 22):

■ whether the technologies were anticipated by potential adopters to increase or decrease farmer vulnerability

■ whether farmers had the requisite assets to make adoption worthwhile

■ the role that policies, institutions and processes play in technology dissemination.

To determine the rate and pattern of technology adoption, it is important therefore to focus on these three factors: vulnerability, assets and technology dissemination. Some guidelines on how to conduct research in these areas that remains focused and tractable are described below.

Research in this area should include an objective assessment of vulnerability by the research team, and some qualitative research on subjective perceptions of vulnerability with a purposive sample of potential beneficiaries.

Using the information on target beneficiaries and agricultural research outputs gathered during Phase 1 of the research (i.e. the theory of change), a brief study on vulnerability should be undertaken. This should use the livelihoods conception of vulnerability as a starting point (i.e. a focus on shocks, trends and seasonality). This will provide some important context within which to understand the rate and pattern of technology adoption. This inquiry should provide answers to the following questions:

- *Did any shocks affect the targeted beneficiaries during or immediately before the research project?* This may include an assessment of the presence and impact of any economic shocks (e.g. food and fuel crisis), natural shocks (e.g. cyclones) or conflict shocks (e.g. civil strife). This information can be gathered largely through secondary data sources and through interviews with key informants, and could be gathered during a scoping study. Some macro-economic techniques that can be used to assess vulnerability are discussed in Section 4.4.

- *What trends most affected the targeted beneficiaries during the research project?* This should focus on the particular communities targeted by the research project and may include an analysis of migration patterns; economic trends, such as major shifts in employment; or major shifts in the distribution of resources within a country. This information can also be gathered through secondary data sources and through interviews with key informants and country experts, and could be gathered during a scoping study. This would include a brief political–economic analysis along the lines discussed in Section 4.4.

- *What seasonality issues affected the targeted beneficiaries during the research project?* This could focus on the particular commodity, or suite of commodities that was the focus of the agricultural research in the first instance (e.g. maize, rice etc.), and could assess changes in food prices over the course of the research project, or look at supply and demand issues. It could also link with the research conducted under *trends* and ascertain if any employment shifts (e.g. the opening of new mines or other activities) are creating seasonal employment opportunities that are being taken up by people in the targeted communities. This research can be undertaken relatively simply through desk-based research and interviews with key in-country informants and country experts.

If the agricultural research project under investigation was large-scale, with geographically dispersed and distinctly heterogeneous beneficiaries, then it may be necessary to determine whether any shocks, trends and seasonality issues have differentially affected subgroups. This will help inform which groups should be the target of more intensive quantitative and qualitative research.

Aside from the focus on the objective assessment of the vulnerability context, it is also important to seek, from the targeted beneficiaries, a subjective assessment of vulnerability. This will involve purposively sampling households and communities in targeted areas and undertaking qualitative research using participatory research techniques. These techniques should elucidate the shocks, trends and seasonality issues from the farmers' perspective. Some participatory techniques that can be used to undertake this task are recommended in Section 4.4.

Understanding the asset base and livelihood strategies

Using the information gathered during Phase 1, and having developed an understanding of the vulnerability context, the research should then move on to collecting data on the livelihood assets available to different groups of target beneficiaries and how these assets are deployed to formulate livelihood strategies. Poor people will typically have fewer assets than the non-poor, and the presence and absence of assets will determine the rate and pattern of technology adoption. Therefore, this is a fundamentally important phase in the impact assessment process.

The collection of livelihood data should be undertaken at the household level using a customised household livelihoods survey instrument and through other data-collection methods, such as focus-group discussions, longitudinal household case studies and key informant interviews (see Section 4.4 for more details of these

methods). The household survey data should collect basic demographic data, details on livelihood asset availability and details of particular livelihood strategies, including the use of the products of the agricultural research being assessed. Table 2 includes details of the types of information that should be collected using a livelihoods-based survey instrument. This survey can be customised to reflect the local realities of beneficiaries using the information collected during Phase 1 of the research and the assessment of vulnerability. Specific questions should be asked about the mode of agricultural production that was the target of the agricultural research (e.g. rice farming, maize farming, vegetable production etc.), or a combination of modes of production if the research was multifaceted. The survey instrument would need to be modified depending on the scope of the agricultural research.

The number of households surveyed would depend on the scale of the original research project and the resources available for the impact assessment study; attempts should be made to survey a representative sample of the population of beneficiaries. These methodological issues should be resolved during a scoping study, after a target project for impact assessment has been identified. The survey data on livelihoods would

provide some good information on what the livelihood assets of different groups of beneficiaries are and how they are deployed to undertake livelihood strategies; however, these data will not say too much about *why* farmers deploy their assets in the way they do to meet livelihood outcomes. The qualitative data arising from key informant interviews, longitudinal household case studies, focus groups, and participatory rural appraisal forums will shed light on this *why* question.

Determining technology dissemination pathways

The mode of technology dissemination will strongly influence the knowledge of, and access to, the products of agricultural research. The research from Meinzen-Dick et al. (2003) highlighted a number of factors that influence technology dissemination and, ultimately, technology adoption. These included trust in mediating institutions (such as government agencies), membership in formal community-based organisations, the presence of widespread informal social networks and the direct participation of farmers in the technology development process. The participation of farmers in the selection and breeding of new plant varieties has been shown to be a particularly important way to enhance dissemination (Carpenter 2010).

Table 2. An outline of required household livelihoods survey data

Demographic data	Household composition, including gender, ages, years of schooling and details of the head of the household
Livelihoods assets	**Natural capital**: land area (total size plus parcels), quality of land (rainfed, irrigated), quality of access to water, land tenure
	Financial capital: household income from different sources, sources of credit and savings
	Physical capital: ownership of, or access to, agricultural machinery; presence or absence of irrigation
	Social capital: membership of local organisations (e.g. farmer groups) and local agriculture-based institutions (e.g. labour exchange institutions, rotating credit and savings associations)
	Human capital: formal education, agricultural training, household labour force availability and health details
Livelihoods strategies	**Details of seasonal agricultural production:** questions would be specific to the mode or modes of production that were the target of the agricultural research, and other forms of agricultural production that may not have been the focus of that research. Include details of the timing of agricultural tasks, the use of the products of research, yields from the different modes of production, average productivity, historical stability of production, revenue from agriculture as a whole and revenue from the different modes of production.
	Details of other non-agricultural household strategies: questions detailing the relative importance of non-farm livelihood strategies (e.g. off-farm employment, seasonal labour, remittances, short-term migration)

The dissemination of the products of agricultural research is mediated through institutions, and affected by various policies and processes. It is these institutions, policies and processes that should be the target of this aspect of the research. The formal and informal institutions that are important to people's lives can be identified under the 'social capital' assets component of the livelihood survey mentioned above, and more data on these institutions can be collected using methods such as Venn diagramming, key informant interviews and focus-group discussions. Attention should be given to developing, as much as possible with the resources and time available, an understanding of local culture and the power relations within which formal and informal institutions are embedded, as this will provide important context for understanding the role of institutions in people's lives. This research should be augmented by an analysis of the relevant government agricultural extension policies, and government and non-government programs that focus on agricultural technology dissemination within the target communities.

4.2.3 Phase 3: Assess the impacts of agricultural research on wellbeing

Once the information on vulnerability, livelihood assets and strategies, and the role of institutions has been collected, these data should be analysed to assess the impact of agricultural research on the wellbeing of targeted beneficiaries, which is the principal task of the impact assessment. This assessment should be guided by the four key evaluation questions listed in Table 3.

Depending on the characteristics of the targeted community and the scope of the original research project, it may be necessary to disaggregate the beneficiaries into subgroups in order to answer these questions. The criteria used to disaggregate beneficiaries will arise from the analysis of the research data and may include absolute income levels, households headed by men or by women, asset levels (such as size of land), sociocultural grouping

etc. This review will include the statistical analysis of household survey data (and any other data that are amenable to statistical interpretation) and the qualitative analysis of all the qualitative data collected.

The assessment of direct impacts should focus on those who adopted the agricultural research technology and would include wellbeing effects such as improvements in productivity, increases in income, improvements in soil fertility, social capital formation and human capital development. In line with the livelihoods approach, an attempt should be made to discuss the aggregate impact on poverty that the agricultural research has had, instead of focusing on one aspect of livelihoods, such as income poverty or productivity, for example.

This assessment of indirect impact would look primarily at the positive and negative impacts of the agricultural research on those not directly targeted by it; this analysis may include assessing increases in employment, decreases in food prices, increases in the availability of improved germplasm, increases in land leasing opportunities and increases in non-agricultural employment. This analysis may also include identifying negative effects such as increases in environmental pollution or prices. The importance of this aspect of any impact assessment will be determined to some extent by the scale of the agricultural research undertaken and the resources available. It may be the case that many of these impacts cannot be corroborated with quantitative data, in which case efforts should be made to assess the indirect impact of agricultural research with non-adopters through qualitative methods.

The above three-phased process would require some customisation depending on the scope and scale of the agricultural research project being assessed, but it could be used as a generic process for most of ACIAR's research investments.

Table 3. Key evaluation questions

1.	What were the most significant direct impacts of the agricultural research on poverty?
2.	How did the direct impacts of the agricultural research differ between subgroups?
3.	What livelihood components influenced the differential impact of agricultural research?
4.	What were the most significant indirect impacts of the agricultural research?

4.3 Mixed-method integrative research

As the methodological process introduced above suggests, a livelihoods-orientated study into the impact of agricultural research on poverty reduction cannot be undertaken using quantitative methods alone, as these methods do not sufficiently address sociocultural and institutional issues, nor can they sufficiently explain the diverse livelihood strategies deployed by beneficiaries. A mixture of quantitative and qualitative methods, drawing on a number of disciplines, would be required to sufficiently manage the complexity (Murray 2001; Adato and Meinzen-Dick 2002; Place et al. 2007). This type of research, known as integrative research, is introduced in this section, which also explains how an integrative approach can be used to improve the explanatory power and rigour of livelihoods-orientated poverty research. This theoretical discussion provides higher level methodological justification for the process outlined above.

The so-called 'paradigm debate' (Creswell 2007), which pitched quantitative (so-called hard approaches) against qualitative (so-called soft approaches), is now considered by most researchers to be 'past its use-by date' (Walter 2006, p. 19). The dichotomy between these two approaches, which often rested on notions of perceived rigour (Harriss 2002), has been disabused as researchers become more convinced of their complementarity, and of the fact that both quantitative and qualitative techniques can be inappropriately applied and therefore lacking in rigour (White 2002). Quantitative and qualitative methods are now widely seen as different but equally valid methods of enquiry that, when used together, can improve explanatory power and rigour particularly in development and poverty research (see White (2002) for a thorough explanation of this issue).

Many authors now see qualitative and quantitative data collection and analysis as residing on a spectrum of research techniques mutually reinforcing each other and working together to investigate complex problems. Poverty, which is a very complex problem, is a case in point. Quantitative methods frequently aim to produce poverty data that can be aggregated and analysed to describe and predict relationships often over quite large populations, the aim being to achieve breadth in coverage and analysis. This may be very important when seeking to identify something like the income poverty line in a developing country, and to predict what impact a policy might have on 'poor' people across a wide region. We know from our previous discussions, however, that poverty is multidimensional and that the 'poor' are a socially differentiated group, with varying access to livelihoods assets. The contextual nature of qualitative research, which sacrifices breadth to explore issues in depth, allows for a deeper, more dynamic analysis of poverty that can help explain the 'missing middle' between interventions and impacts (Garbarino and Holland 2009), something that is often absent from quantitative analysis.

Qualitative research is used in three situations: where a detailed understanding of a complex issue is required; when we want to empower individuals to share their stories and participate in the research (participatory research); or when it is important to understand the context and settings in which a problem or an issue is experienced (Creswell 2007). An example may be to measure the different dimensions of poverty, particularly those that are not readily quantified but which poor people themselves identify as important, such as dignity, respect, security and power (Garbarino and Holland 2009).

Qualitative data collection methods typically use open-ended questions to collect non-numerical data, such as words, text or images, often from key informant interviews and focus group discussions (Creswell 2007). In contrast to quantitative methods, qualitative methods are used with a small group of participants and the results are not generalisable to a larger population (Creswell and Plano Clark 2007). Instead the focus is on generating an in-depth understanding, with a focus on meanings, perceptions and understandings (Walter 2006).

Many studies that combine quantitative and qualitative methods go beyond mixing methods and seek to integrate different disciplinary perspectives; this is known as integrative research. Integrative research is not just the mixing of different types of data collection and analysis; it also involves the integration of the conceptual frameworks of more than one discipline to engender a deeper and broader understanding of the situation under study (Bamberger 2000). Integrative research has risen rapidly in environmental science and public environmental policy since the mid 1990s

(van Kerkhoff 2005). It can be regarded as 'utility-focused research that connects research activity across a number of boundaries' (van Kerkhoff 2005, p. 453). Integrative research is centred around a particular problem (rather than around a disciplinary framework), which brings multiple disciplines together, blending perspectives to allow analysis across scales, and bridging barriers that have separated traditional modes of inquiry (van Kerkhoff 2005).

There are numerous ways of integrating different but complementary data. They may involve, for example, integrating economic and gender analysis to understand how development interventions differentially impact upon women and men (Bamberger 2000). Integrative research can also integrate analysis at different levels; for example, survey methods with an economic, quantitative perspective can provide estimates of individual, household and community-level welfare but may be less useful for analysing social processes and institutions, a perspective that may be served by a sociological, qualitative exploration (Bamberger 2000). Integrative research can reveal the perspectives of individuals, households, communities, regions and institutions. 'Understanding these … levels is usually

important in analysing why projects have succeeded or failed or for understanding the factors that determine the level and distribution of outcomes and impacts' (Bamberger 2000, p. 154).

Qualitative and quantitative methods and data can be combined through the processes of integrating and sequencing. The integration of methods (as discussed above) helps improve measurement, while the sequencing of information helps strengthen analysis and explanatory power. These approaches, and examples of how they are used, are introduced in Table 4.

4.4 Suggested research methods

Following on from the above discussion of the integrated research approach, this section provides more details of the methods of data collection and analysis that could be used to assess the poverty-reducing impact of ACIAR's agricultural research. Many of these methods were briefly discussed in Section 4.2.

Table 4. Approaches to combining quantitative and qualitative research methods

Approach	Definition	Examples
Integrating methods	An iterative relationship between qualitative and quantitative methods is undertaken at various steps throughout the design and fieldwork phases with a view to improving measurement.	• The results of surveys are used to select a qualitative research sample. • A survey highlights priority issues to be investigated through qualitative research. • Qualitative research uncovers knowledge gaps that need to be filled through surveys (helps refine survey tools). • Qualitative research identifies what is highly contextual information and to which the application of standardised quantitative methods is therefore not appropriate. • Results from quantitative and qualitative studies help define population subgroup sampling frames.
Sequencing analysis	This allows for examining, explaining, confirming, refuting and enriching information from one approach with that from another with the aim of improving analysis.	• A qualitative study generates 'working hypotheses' that can be further examined through quantitative research with predefined questions. • Qualitative research helps explain the relationships, trends and patterns emerging from survey data. • Qualitative data triangulates (verifies or refutes) survey results. • Qualitative research enriches analysis of relationships, trends and patterns emerging from the survey data through new learning.

Sources: Carvalho and White (1997); Garbarino and Holland (2009)

4.4.1 Methods of data collection

Household livelihoods survey

This form of data collection can be used in Phase 2 of the research process. Household surveys provide the most important and widely used method of obtaining demographic, social and economic information for individuals and households in developing countries. Many decisions are made at the household level and, as such, household-level surveys are required to identify livelihood strategies and examine the prevalence, causes and effects of poverty in its many different forms. Targeted surveys that focus on the livelihoods of specific population subgroups can be used for the poverty-reducing research funded by ACIAR and would provide very important insights into the impact of agricultural research on poverty reduction. Table 2 outlined the type of data that should be collected using a household livelihoods survey instrument.

Well-designed household surveys can yield far richer information on livelihoods and living standards than macro-economic data and can provide policy recommendations that are generalisable to the broader population. Data from household surveys are a useful complement to qualitative information obtained from focus groups and key informant interviews. It is important to use qualitative methods of enquiry to help appropriately target household surveys. The most appropriate form of integration between household surveys and other data-collection methods will depend on the program under review and, in particular, the scale of the research project. The integration of methods should be explained clearly in any research proposal. Household surveys should also be pre-tested and piloted in-country before deployment, and the training of enumerators should take place to ensure data collection is consistent across research locations.

Key informant interviews

This mode of data collection can be used through all phases of the research process. Key informants are those people who are willing and able to provide in-depth insights into important aspects of the research. This might include insights into the intended poverty-reducing impact of the agricultural research (in Phase 1), insights into the vulnerability context of poor farmers (in Phase 2) or insights into the relative importance of different mediating institutions (in Phase 2). When assessing the impact of agricultural research on poverty reduction, selected people might include early adopters, community elders, government extension workers, national and international policy officers, agricultural researchers, NGO workers or private-sector employees (Adato and Meinzen-Dick 2002). Interviews with key informants are usually semi-structured and, aside from collecting a wide range of data, can be used to test and validate research insights and to triangulate other data. This technique can also be used to collect data that can be analysed using quantitative techniques.

Key informant interviews can help researchers learn more about local contexts, and can provide important information that may help in the design of sampling frames for quantitative research. They are therefore an important part of the integrative approach. Key informants are usually identified using a 'snowball' technique[6], and the effort should be made to identify exactly who is 'key' to the research study. Key informant interviews are usually digitally recorded and transcripts analysed using sophisticated qualitative data analysis software that allows researchers to code for particular themes arising across interviews. There are ethical and methodological issues associated with the recording and translation of qualitative data that should be considered by researchers when designing qualitative research and these issues should be spelt out in research plans.

Household case studies

This method of data collection will be an important component of Phase 2 of the research, as it will help researchers understand some of the 'why' questions emerging from the livelihood household surveys. In-depth household case studies will help researchers develop an understanding of the livelihood strategies adopted by socially differentiated groups and how the products of agricultural research are used by these groups. It is important to identify different types of households within communities to select for in-depth case studies. Participatory wellbeing ranking (see discussion under Participatory Rural Appraisal below) and household livelihoods survey data can be used to identify different subgroups of beneficiaries for in-depth case studies.

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6   A technique for finding research subjects. It can be used to identify potential beneficiaries or to provide the names of key informants for the study. One subject gives the researcher the name of another subject who, in turn, provides the name of a third, and so on (Vogt 1999).

Focus group discussions

This method of data collection can be used in Phase 2 of the research process outlined in Section 4.2.2. Its use will help researchers understand more about the choices of similar groups of farmers. Focus groups typically bring together people of similar social status (e.g. all small farmers, all extension workers, all researchers etc.) to explore their views on important themes emerging in the research. Focus groups need to be tactfully and professionally facilitated by experienced people who understand the local language and sociocultural context. It is particularly important to ensure focus groups are not coopted by powerful local interests. In some contexts, it may be the case that socially marginalised people will not feel comfortable participating in focus groups along with their fellow community members and, if this is the case, then alternative forms of engagement need to be explored.

Participatory Rural Appraisal (PRA) techniques

These techniques will be an important part of Phase 2 of the research process, in numerous areas including the subjective determination of vulnerability (e.g. asking farmers to provide information about the shocks, trends and seasonality issues that affect them), determining the importance of particular institutions in people's lives, and understanding poor peoples' agricultural production practices more generally. Participatory techniques have been used extensively throughout the developing world since the mid 1990s by researchers and NGO workers who seek to understand more about the livelihoods of rural people. The key to these techniques is for researchers to take a back seat and allow local people to analyse their own livelihoods using a vast array of techniques, including (Chambers 2007):

- participatory analysis of secondary data such as photos and maps

- participatory modelling and mapping of social structures, demography, health, natural resource endowments and infrastructure

- transect walks through communities to identify the properties of local agroecosystems

- time lines of trends and changes over time, including social and ecological histories, land use changes, natural shocks, conflicts and changes in physical infrastructure

- seasonal calendars that map out agricultural practices during the various seasons of the year and emphasise critical points in the agricultural calendar (such as when harvests occur or labour is required etc.)

- institutional mapping or Venn diagrams that chart the formal and informal institutions that exist in a particular community and rank their importance to livelihoods

- participatory wellbeing ranking, which involves local people identifying aspects of wellbeing and ill-being as conceived locally, and using innovative techniques to rank different groups and households based on the presence or absence of locally conceived wellbeing indicators. These indicators may include things like: presence of productive assets, food security, sending children to school, access to medical services, financial capital, powerlessness, number of dependants etc.

4.4.2 Methods of data analysis

Quantitative analysis of poverty data

This analysis can be used in Phase 3 of the research process—namely in the assessment of the impacts of agricultural research on the wellbeing of poor people. As mentioned in Section 4.2, there is a need to assess the impact of agricultural research on the wellbeing of the different groups of poor people identified during the earlier phases of the research (if, in fact, these groups are distinct). Given the nature of the variables involved, the econometric and computable general equilibrium analysis outlined in Section 2 cannot readily be applied in a multidimensional poverty/livelihoods context. This is not to say that the data collected in livelihood household surveys cannot be analysed in a rigorous quantitative manner. Precisely how this analysis would be undertaken is specific to the particular context, but the first step would be to develop an index similar to the UNDP MPI, but with a greater or more explicit livelihoods focus. This index would then be used to determine which households are multidimensionally poor, using the same approach adopted by the UNDP. This methodology has been the subject of intensive development and peer review and, as such, there is logic in adopting it.

The second step would be to look at simple correlations between this index and possible causal factors, for which data will have been collected in household surveys. These causal factors would include the direct benefits of productivity improvements or related impacts of the agricultural research in question. The correlation analysis would look at both the value of the index (that is, the multidimensional poverty scores it assigns each household), as well as simple binary outcomes (in poverty, not in poverty) with the view to developing certain stylised facts. Each fact portrays a statistical relationship between a potential determinant of poverty and poverty itself. Unlike the modelling mentioned above, the objective of this exercise is not to establish or prove causality, but simply to look for possible relationships that require further investigation. This is left up to the qualitative investigation and reflects the self-reinforcing and iterative approach of integrated investigation.

Macro-economic analysis

This form of analysis can be used in the assessment of the vulnerability context (Phase 2 of the research). It will be important to provide some insights into the 'big picture'; namely how the macro-economic environment shapes what is observed at the household level, i.e. economic shocks or trends. Most households, in one way or another, are linked to the macro-economy of the country in which they reside and they are therefore susceptible to economy-wide shocks. These shocks can be either beneficial or harmful and include changes in commodity prices, inflation, costs of obtaining credit and so on. If we are to understand the vulnerability contexts of the people surveyed, then this information is a requirement. A macro-economic analysis is therefore needed to identify and monitor relevant economy-wide changes to better understand the vulnerability context. This analysis should be targeted towards identifying those factors that are most likely to affect the vulnerability of the beneficiaries of the agricultural research.

Agroecosystems analysis

This analysis can be used during Phase 2 of the research, particularly in the assessment of changes in the natural capital asset base and the sustainability implications of technology adoption. This analysis draws on systems theory and agroecological principles to analyse agricultural systems at various scales from plant to landscape (see Conway 1985, 1987). This is particularly important when assessing the sustainability implications of agricultural research and associated technology dissemination. This analysis can also be used to assess the impact of any shocks that may have affected the natural capital base, thereby increasing vulnerability. It is important that any assessment of the poverty-reducing impact of agricultural research include a consideration of the sustainability implications of agricultural research and associated technology dissemination, whether or not improved sustainability was a research aim. This is because the sustainable utilisation of the natural resource base is of critical importance for millions of resource-poor farmers. The data used in agroecosystem analysis can be collected through PRA techniques, secondary agricultural research, on-farm data collection, household case studies and key informant interviews.

Political–economic analysis

Political–economic analysis focuses on how power and resources are distributed through a society and the conditions that give rise to observed patterns of distribution. As suggested in Section 4.2, it may be necessary to conduct some political–economic analysis as part of assessing vulnerability context and this should be done alongside the macro-economic analysis described above. Sources for political–economic analysis may include existing academic research, donor agency research, reviews of official documents (such as policies, laws and regulations), as well as interviews with key informants within decision-making institutions. Political–economic research is clearly very complicated and could consume significant resources. It is therefore imperative that any studies into the impact of agricultural research on poverty reduction explain what level of analysis will be conducted, how it will be conducted and why. Much of this will be determined by the nature of the research question itself and the scale of the program under review.

Gender analysis

It is important that any assessment of the poverty-reducing impact of agricultural research takes into account the differential impact technological change can have on the livelihoods of women and men as distinct groups. The livelihoods of men and women are influenced significantly by their different roles within a family, their varying responsibilities and their access

to resources. A gender perspective should be integrated into all quantitative and qualitative methods used to explore livelihoods. This may include the collection of sex-disaggregated data through quantitative surveys, seeking to provide information on the differences between men and women in various livelihood aspects, as well as the qualitative exploration of why these disparities exist. A number of qualitative methods can be used to explore the *why* question, including modifications of the PRA techniques mentioned above. Data-collection techniques for gender analysis include:

- gender-disaggregated focus group discussions

- key informant interviews with female early adopters

- seasonal calendars that assess the different workloads of men and women and explore the division of labour by gender across the year

- gender-disaggregated wellbeing ranking, which uncovers the differences between how men and women perceive wellbeing

- daily activity schedules that identify the hourly division of labour by gender

- resource analysis, which maps access and control over private, community and public resources by gender

- decision-making matrixes that seek to understand agricultural decision-making practices by gender.

There are myriad gender analysis tools that can be deployed by the poverty researcher. The way in which a gender perspective will be mainstreamed into any poverty research funded by ACIAR will need to be explained fully in a detailed research proposal once some preliminary assessment of gender issues pertinent to the scope of the research has been undertaken. At a very minimum it should involve the use of the PRA-like tools mentioned above, but in some circumstances it may include the use of more sophisticated quantitative techniques such as the collection of gender-disaggregated survey data.

5 Conclusion

Agricultural research agencies such as ACIAR are increasingly interested in assessing the poverty-reducing impacts of the research they fund. Most recent studies in this area have focused on assessing the impact of agricultural research on income poverty. This is problematic for numerous reasons, not the least of which is the significant resources involved in this form of analysis, and the lack of data in many countries, including many of the countries targeted by ACIAR research. Added to this are the problems associated with focusing on income poverty, a concept that does not sufficiently encompass the many ways in which agricultural research impacts upon the lives of poor people. This notion of poverty has largely been surpassed in the poverty literature by the concept of multidimensional poverty.

This paper has introduced a livelihoods-orientated methodology that can be used to assess the multidimensional poverty-reducing impacts of ACIAR's research investments. This methodology draws on the results of other large livelihoods research projects and the sustainable livelihoods literature and presents a practical and efficient way to assess the tractable outcomes of the agricultural research funded by ACIAR. The methodology emphasises the importance of understanding the vulnerability context; the rate, pattern and determinants of technology adoption by poor farmers; and the impact of agricultural research on the wellbeing of socially differentiated groups. An integrated mixed-method approach to impact assessment is suggested, and a number of qualitative and quantitative research methods are introduced. The use of this methodology in a practical sense by ACIAR will need to be preceded by an analysis of impact assessment requirements and will, of course, be subject to the availability of resources. Recognising this, the next step is to implement and test this framework by undertaking a policy analysis of a significant research initiative funded and/or managed by ACIAR.

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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	AS1/1983/034, AS1/1987/017 and AS1/1993/222
2	George P.S. 1998.	Increased efficiency of straw utilisation by cattle and buffalo	AS1/1982/003, AS2/1986/001 and AS2/1988/017
3	Centre for International Economics 1998.	Establishment of a protected area in Vanuatu	ANRE/1990/020
4	Watson A.S. 1998.	Raw wool production and marketing in China	ADP/1988/011
5	Collins D.J. and Collins B.A. 1998.	Fruit fly in Malaysia and Thailand 1985–1993	CS2/1983/043 and CS2/1989/019
6	Ryan J.G. 1998.	Pigeonpea improvement	CS1/1982/001 and CS1/1985/067
7	Centre for International Economics 1998.	Reducing fish losses due to epizootic ulcerative syndrome—an ex ante evaluation	FIS/1991/030
8	McKenney D.W. 1998.	Australian tree species selection in China	FST/1984/057 and FST/1988/048
9	ACIL Consulting 1998.	Sulfur test KCL–40 and growth of the Australian canola industry	PN/1983/028 and PN/1988/004
10	AACM International 1998.	Conservation tillage and controlled traffic	LWR2/1992/009
11	Chudleigh P. 1998.	Postharvest R&D concerning tropical fruits	PHT/1983/056 and PHT/1988/044
12	Waterhouse D., Dillon B. and Vincent D. 1999.	Biological control of the banana skipper in Papua New Guinea	CS2/1988/002-C
13	Chudleigh P. 1999.	Breeding and quality analysis of rapeseed	CS1/1984/069 and CS1/1988/039
14	McLeod R., Isvilanonda S. and Wattanutchariya S. 1999.	Improved drying of high moisture grains	PHT/1983/008, PHT/1986/008 and PHT/1990/008
15	Chudleigh P. 1999.	Use and management of grain protectants in China and Australia	PHT/1990/035
16	McLeod R. 2001.	Control of footrot in small ruminants of Nepal	AS2/1991/017 and AS2/1996/021
17	Tisdell C. and Wilson C. 2001.	Breeding and feeding pigs in Australia and Vietnam	AS2/1994/023
18	Vincent D. and Quirke D. 2002.	Controlling *Phalaris minor* in the Indian rice–wheat belt	CS1/1996/013
19	Pearce D. 2002.	Measuring the poverty impact of ACIAR projects— a broad framework	
20	Warner R. and Bauer M. 2002.	*Mama Lus Frut* scheme: an assessment of poverty reduction	ASEM/1999/084
21	McLeod R. 2003.	Improved methods in diagnosis, epidemiology, and information management of foot-and-mouth disease in Southeast Asia	AS1/1983/067, AS1/1988/035, AS1/1992/004 and AS1/1994/038
22	Bauer M., Pearce D. and Vincent D. 2003.	Saving a staple crop: impact of biological control of the banana skipper on poverty reduction in Papua New Guinea	CS2/1988/002-C
23	McLeod R. 2003.	Improved methods for the diagnosis and control of bluetongue in small ruminants in Asia and the epidemiology and control of bovine ephemeral fever in China	AS1/1984/055, AS2/1990/011 and AS2/1993/001
24	Palis F.G., Sumalde Z.M. and Hossain M. 2004.	Assessment of the rodent control projects in Vietnam funded by ACIAR and AUSAID: adoption and impact	AS1/1998/036

No.	Author(s) and year of publication	Title	ACIAR project numbers
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	ADP/1997/021 and ANRE1/1992/028
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/1984/057, FST/1987/036, FST/1988/048, FST/1990/044, FST/1994/025, 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 and 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	AS2/1990/028, AS2/1994/017, AS2/1994/018, AS2/1999/060, CS1/1990/012, CS1/1994/968, FST/1993/016 and PHT/1990/051
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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	LWR1/1998/034 and LWR2/1994/004
44	Gordon J. and Chadwick K. 2007.	Impact assessment of capacity building and training: assessment framework and two case studies	CS1/1982/001, CS1/1985/067, LWR2/1994/004 and LWR2/1998/034
45	Turnbull J.W. 2007.	Development of sustainable forestry plantations in China: a review	
46	Monck M. and Pearce D. 2007.	Mite pests of honey bees in the Asia–Pacific region	AS2/1990/028, AS2/1994/017, AS2/1994/018 and AS2/1999/060

No.	Author(s) and year of publication	Title	ACIAR project numbers
47	Fisher H. and Gordon J. 2007.	Improved Australian tree species for Vietnam	FST/1993/118 and FST/1998/096
48	Longmore C., Gordon J. and Bantilan M.C. 2007.	Assessment of capacity building: overcoming production constraints to sorghum in rainfed environments in India and Australia	CS1/1994/968
49	Fisher H. and Gordon J. 2007.	Minimising impacts of fungal disease of eucalypts in South-East Asia	FST/1994/041
50	Monck M. and Pearce D. 2007.	Improved trade in mangoes from the Philippines, Thailand and Australia	CS1/1990/012 and PHT/1990/051
51	Corbishley J. and Pearce D. 2007.	Growing trees on salt-affected land	FST/1993/016
52	Fisher H. and Gordon J. 2008.	Breeding and feeding pigs in Vietnam: assessment of capacity building and an update on impacts	AS2/1994/023
53	Monck M. and Pearce D. 2008.	The impact of increasing efficiency and productivity of ruminants in India by the use of protected-nutrient technology	AH/1997/115
54	Monck M. and Pearce D. 2008.	Impact of improved management of white grubs in peanut-cropping systems	CS2/1994/050
55	Martin G. 2008.	ACIAR fisheries projects in Indonesia: review and impact assessment	FIS/1997/022, FIS/1997/125, FIS/2000/061, FIS/2001/079, FIS/2002/074, FIS/2002/076, FIS/2005/169 and FIS/2006/144
56	Lindner B. and McLeod P. 2008.	A review and impact assessment of ACIAR's fruit-fly research partnerships—1984 to 2007	CP/1997/079, CP/2001/027, CP/2002/086, CP/2007/002, CP/2007/187, CS2/1983/043, CS2/1989/019, CS2/1989/020, CS2/1994/003, CS2/1994/115, CS2/1996/225, CS2/1997/101, CS2/1998/005, CS2/2003/036, PHT/1990/051, PHT/1993/87 and PHT/1994/133
57	Montes N.D., Zapata Jr N.R., Alo A.M.P. and Mullen J.D. 2008.	Management of internal parasites in goats in the Philippines	AS1/1997/133
58	Davis J., Gordon J., Pearce D. and Templeton D. 2008.	Guidelines for assessing the impacts of ACIAR's research activities	
59	Chupungco A., Dumayas E. and Mullen J. 2008.	Two-stage grain drying in the Philippines	PHT/1983/008, PHT/1986/008 and PHT/1990/008
60	Centre for International Economics 2009.	ACIAR Database for Impact Assessments (ADIA): an outline of the database structure and a guide to its operation	
61	Fisher H. and Pearce D. 2009.	Salinity reduction in tannery effluents in India and Australia	AS1/2001/005
62	Francisco S.R., Mangabat M.C., Mataia A.B., Acda M.A., Kagaoan C.V., Laguna J.P., Ramos M., Garabiag K.A., Paguia F.L. and Mullen J.D. 2009.	Integrated management of insect pests of stored grain in the Philippines	PHT/1983/009, PHT/1983/011, PHT/1986/009 and PHT/1990/009
63	Harding M., Tingsong Jiang and Pearce D. 2009.	Analysis of ACIAR's returns on investment: appropriateness, efficiency and effectiveness	
64	Mullen J.D. 2010.	Reform of domestic grain markets in China: a reassessment of the contribution of ACIAR-funded economic policy research	ADP/1997/021 and ANRE1/1992/028

No.	Author(s) and year of publication	Title	ACIAR project numbers
65	Martin G. 2010.	ACIAR investment in research on forages in Indonesia	AS2/2000/103, AS2/2000/124, AS2/2001/125, LPS/2004/005, SMAR/2006/061 and SMAR/2006/096
66	Harris D.N. 2010.	Extending low-cost fish farming in Thailand: an ACIAR–World Vision collaborative program	PLIA/2000/165
67	Fisher H. 2010.	The biology, socioeconomics and management of the barramundi fishery in Papua New Guinea's Western Province	FIS/1998/024
68	McClintock A. and Griffith G. 2010.	Benefit–cost meta-analysis of investment in the International Agricultural Research Centres	
69	Pearce D. 2010.	Lessons learned from past ACIAR impact assessments, adoption studies and experience	
70	Harris D.N. 2011.	Extending low-chill fruit in northern Thailand: an ACIAR–World Vision collaborative project	PLIA/2000/165
71	Lindner R. 2011.	The economic impact in Indonesia and Australia from ACIAR's investment in plantation forestry research, 1987–2009	FST/1986/013, FST/1990/043, FST/1993/118, FST/1995/110, FST/1995/124, FST/1996/182, FST/1997/035, FST/1998/096, FST/2000/122, FST/2000/123, FST/2003/048 and FST/2004/058
72	Lindner R. 2011.	Frameworks for assessing policy research and ACIAR's investment in policy-oriented projects in Indonesia	ADP/1994/049, ADP/2000/100, ADP/2000/126, AGB/2000/072, AGB/2004/028, ANRE1/1990/038, ANRE1/1993/023, ANRE1/1993/705, EFS/1983/062 and EFS/1988/022
73	Fisher H. 2011.	Forestry in Papua New Guinea: a review of ACIAR's program	FST/1994/033, FST/1995/123, FST/1998/118, FST/2002/010, FST/2004/050, FST/2004/055, FST/2004/061, FST/2006/048, FST/2006/088, FST/2006/120, FST/2007/078 and FST/2009/012
74	Brennan J.P. and Malabayabas A. 2011.	International Rice Research Institute's contribution to rice varietal yield improvement in South-East Asia	
75	Harris D.N. 2011.	Extending rice crop yield improvements in Lao PDR: an ACIAR–World Vision collaborative project	CIM/1999/048, CS1/1995/100 and PLIA/2000/165
76	Grewal B., Grunfeld H. and Sheehan P. 2011.	The contribution of agricultural growth to poverty reduction	
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