

Policy Series 10

***Natural Resources Research:
Impact Assessment and Poverty***

Simon Henderson

(Social and Economic Development Department, NRI)

© The University of Greenwich 2001

The Natural Resources Institute (NRI) of the University of Greenwich is an internationally recognized centre of expertise in research and consultancy in the environment and natural resources sector. The Institute carries out research and development and training to promote efficient management and use of renewable natural resources in support of sustainable livelihoods.

Short extracts of this publication may be reproduced in any non-advertising, non-profit-making context provided that the source is acknowledged as follows:

HENDERSON, Simon (2000) *Natural Resources Research: Impact Assessment and Poverty*. Policy Series 10. Chatham, UK: Natural Resources Institute.

Permission for commercial reproduction should be sought from the Managing Editor, Natural Resources Institute, the University of Greenwich, Central Avenue, Chatham Maritime, Kent ME4 4TB, United Kingdom.

Production of this publication was funded by the United Kingdom's Department for International Development. However, the Department for International Development can accept no responsibility for any information provided or views expressed.

Price £5.00

Copies of this book can be obtained by writing to NRI Catalogue Services, CAB International, Wallingford, Oxon OX10 8DE, UK. When ordering, please quote **EP10**.

Natural Resources Institute

ISBN: 0 85954 529 6

University of Greenwich, a registered charity and company limited by guarantee, registered in England (Reg. No. 986729). Registered Office: 30 Park Row, Greenwich, London SE10 9LS.

CONTENTS

	Preface	iv
	Executive summary	1
1	Impact assessments of NR research and their limitations	4
	Evidence from impact assessment studies	4
	Limitations of impact assessment	7
	Conclusions	14
2	Predicting the poverty impact of NR research	15
	Factors influencing the poverty impact of NR research	15
	Problems in predicting the poverty impact of NR research	21
	Conclusions	24
3	Targeting of NR research to the poor	25
	The argument for targeting	25
	Problems in targeting NR research towards the poor	25
	Conclusions	31
4	Conclusions	32
	Recognizing the trade-offs	32
	Contribution of more holistic definitions of poverty	34
	Greater recognition of process	35
	The objectives of impact assessment studies themselves	35
	Bibliography	36
	Abbreviations	40
	Other titles in this series	41

PREFACE

This series is principally concerned with current policy issues of importance to developing countries but also covers those relevant to countries in transition. The focus is upon policies which affect the management of natural resources in support of sustainable livelihoods. Much of the series will be devoted to concerns affecting the livelihoods of poor people in rural areas, recognizing the linkages with non-natural resource-based livelihoods. It will also include the interests of the urban poor, where these are linked to the use of natural resources as part of livelihood strategies.

The series will take a holistic view and cover both the economic and social components affecting livelihoods, and associated factors notably with respect to health and education. The aim is to provide topical analyses which are based upon field research where appropriate, and which will inform development practitioners concerned with issues of poverty in development.

The series is timely, given the increasing focus upon poverty and poverty elimination in the agenda of the development community. It is also timely with respect to the growing body of recent work which seeks to replace earlier, simplistic structural adjustment programmes, with more flexible approaches to livelihoods, institutions and partnerships.

Policy analysis is often assumed to be the remit of social scientists alone. Whilst it is recognized that social science may play a pivotal role, interactions with other disciplines may also be critical in understanding and analysing policy issues of importance to the poor. The series therefore draws upon a wide range of social and natural scientific disciplines reflecting the resource base at the Natural Resources Institute.

EXECUTIVE SUMMARY

Concerns regarding the economic impact of natural resources (NR) research and its effects on the poor are not new (e.g. Griliches, 1958; Lipton and Longhurst, 1989). There has, however, been renewed interest in these issues, reflecting the combination of a number of recent trends.

- Tightening NR research budgets within the overall context of real and proportional declines in development assistance to developing countries' agricultural sectors since the early 1980s (von Braun *et al.*, 1993).
- Mixed performance in the fight against global poverty with little reduction in the total number of people living in absolute poverty, i.e. living below the 'dollar a day' poverty line. This in turn has encouraged many donors to re-examine how they 'do development' (Wolfensohn, 2000).
- Increasing pressure on development agencies and research organizations alike to account for their activities in terms of their achievements, as witnessed by the widespread application of objective-driven, performance-based management systems. The universal adoption by donors of the Organization for Economic Co-operation and Development/Development Assistance Committee (OECD/DAC) International Development Targets is noteworthy in this context.
- The explicit identification of poverty reduction as *the* overarching goal for the majority of donors.

Thus recent debates about the contribution of NR research to poverty reduction involve a broad range of parties motivated by multiple and often different interests.

This briefing paper does not attempt to argue the case for or against NR research as a means to achieving poverty reduction objectives. In part, this reflects the scope and remit of the paper: it also reflects the fact that much has already been written in recent times on this topic, however, in the main, it reflects the belief that the balance of available evidence demonstrates that NR research can benefit the poor. The latter comment is made despite the fact that examples of adverse impacts of NR technology on specific poor groups can also be found. Nevertheless, the benchmark (albeit extreme) case, of no international or national NR research in developing countries over the last 50 years, conjures up images of adversity in these countries on a substantially larger scale than currently exists.

As a starting point, therefore, this paper accepts the potential value of NR research in achieving poverty reduction objectives. However, in recognizing the demands placed on donors, it outlines the challenges faced when attempting to ensure and demonstrate the realization of this potential. These challenges arise from multiple, related factors that can be distinguished as follows:

- the partial nature of the linkages between NR research and poverty reduction;
- the complexity of the factors influencing the poverty impact of NR research;
- the partial nature of the guidance available to decision-makers seeking to enhance the poverty impact of NR research;
- the difficulties in predicting the poverty impact of NR research and in designing 'poverty-targeted' NR research.

Section 1 of the paper examines examples from the literature contributing to the 'NR research-and-poverty' debate. The findings support the view that NR research plays an important role in addressing certain aspects of poverty in developing countries. Nevertheless, there are weaknesses from

the perspective of an agency seeking to enhance the role of NR research in this regard. These weaknesses stem largely from the relative narrowness of the literature with respect to the type of NR research included in impact assessment studies, the definition of poverty commonly employed in such studies, and the objectives of the studies themselves.

With these weaknesses in mind, section 2 reflects on the factors that are likely to influence the poverty impact of NR research. In spite of widespread understanding of these at the generic level, the extent to which they shape research policy in practice is less certain. In this context, the paper considers factors that may explain the apparent difficulty in predicting the poverty impact of NR research.

This uncertainty has also contributed to calls in recent years for more explicit targeting of NR research towards the needs of the poor as a means of increasing the likelihood of poverty impact. Section 3 examines the options for targeting and associated challenges. The term 'pro-poor research' is deliberately avoided because of the counter argument that targeting may actually weaken NR research's ultimate contribution to poverty reduction.

Finally, section 4 examines the implications of the changing distribution of the poor, for example, between the urban and rural sectors, and the likelihood of trade-offs in terms of positive and negative impacts that arise from the multi-dimensional nature of poverty. More recently developed tools, including the sustainable livelihoods (SL) framework, may help to assess such issues but these require further development. Finally the need to recognize and address the scope for assessment of user satisfaction are discussed in the context of the need to strengthen local institutional capacity.

IMPACT ASSESSMENTS OF NR RESEARCH AND THEIR LIMITATIONS

EVIDENCE FROM IMPACT ASSESSMENT STUDIES

Questions surrounding the effectiveness of natural resources (NR) research and its contribution to poverty reduction have generated a significant body of literature. Examples in recent years include: Alston *et al.* (1998); Collinson and Tollens (1994); Cox *et al.* (1998); Dirven (1999); Fan *et al.* (1999); Hazell (1999); Kerr and Kolavalli (1999); Menz *et al.* (1999). This paper does not attempt to review in detail the results of such studies, but rather an attempt is made to summarize the areas of agreement and dispute over degrees of effectiveness, and highlight the reasons behind the different views.

What emerges from the literature is near universal agreement that the most significant achievement of NR research in developing countries has been its positive effect on agricultural productivity. In so far as the bulk of NR research has been targeted at this objective, this consensus can be considered confirmation of the success of NR research efforts. Alston *et al.* (1998) surveyed 294 studies (nearly the entire literature) to examine the rates of return to agricultural research. Omitting the highest and lowest extreme values, estimated annual rates of return averaged 73%. These results are extremely high by normal investment criteria.

However, while estimates of productivity gains and rates of return are important in terms of demonstrating the effectiveness of research investments, these results refer to some aggregate level of analysis (normally the nation) and do not distinguish between 'winners' and 'losers'. As a result, rate of return studies provide little indication of poverty impact.

In an extensive review, Kerr and Kolavalli (1999) examined available evidence to address this concern and distilled four major beneficial impacts of productivity gains for the poor:

- increased availability of food: for example, since 1961 total cereal production in developing countries has increased three-fold, primarily as a result of yield gains;
- lower and more stable food prices: of particular importance to the poor who necessarily spend a larger proportion of total budget on food and are subject to greater stress during 'lean' periods;
- increased agricultural employment: since 1961 agricultural employment in developing countries has grown by around 60% and country-specific studies cited in Kerr and Kolavalli (1999) lend support to the argument that new (crop) technologies are a significant explanatory factor;
- overall economic growth: increased agricultural productivity has contributed (albeit indirectly) to poverty alleviation through important multiplier linkages with the non-farm rural economy.

In spite of the positive contribution of research-induced productivity gains, Kerr and Kolavalli (1999) recognize that controversy remains regarding the poverty impact of NR research. This reflects in part the offsetting effect of population growth in developing countries. This has dampened and masked the overall poverty impact of productivity gains by:

- constraining growth in per capita food availability;
- counteracting downward pressure on prices (through an expansion of demand);
- increasing the size of the potential labour force (and contributing to unemployment and/or downward pressure on wages);
- swelling the absolute numbers of poor people.

Thus, while the proportion of people in developing and transition economies living on less than US\$ 1 per day fell from 28% to 24% during

1987–98, the absolute number remained roughly constant, at around 1.2 billion. Indeed, excluding China, the number actually rose by around 100 million during this period (Wolfensohn, 2000). From an analytical perspective, the offsetting effects of population growth clearly point to the need for estimation of the outcomes *in the absence* of research (i.e. counterfactual conditions) when assessing the impact of NR research. At the same time, it is no surprise that the very real implications of population growth have led many to ask whether more can be done to address poverty.

The controversy, however, also reflects contradictory experiences in particular circumstances when looking beyond the immediate impact of research-induced productivity gains. Kerr and Kolavalli (1999) note that in terms of income effects, evidence is available either to support or refute the conclusion that poor farm households have benefited from technological change and as such the income distribution effects between farms of different sizes/resource endowments are ambiguous. In terms of agro-ecological characteristics, there appears to be wider agreement that more favourable regions have realized a greater share of the benefits from improved NR technologies. But again, Kerr and Kolavalli (1999) point to evidence of the dynamism of agrarian society where producers and labourers in less-favourable regions adapt to changed circumstances and new opportunities. At the same time, Byerlee (2000) notes that, in absolute terms, more favourable regions may contain the largest concentrations of poverty within a country. These issues are reconsidered in sections 2 and 3.

It is hardly surprising that uncertainty increases as the analysis of NR research impact moves beyond immediate effects (e.g. increased production) to more indirect effects, such as income distribution, nutritional effects, gender disparities, etc. A key conclusion drawn by Kerr and Kolavalli (1999) in the face of this controversy is that the role of NR technology in alleviating poverty is both indirect and partial – technology alone cannot overcome poverty.

This conclusion is intuitively appealing given the fact that poor farmers (let alone the landless rural and urban poor), derive only part of their income from agricultural activities. However, it provides little immediate guidance for organizations that are responsible for funding or implementing NR

research within the framework of an overarching commitment to poverty reduction.

LIMITATIONS OF IMPACT ASSESSMENT

Impact assessment studies have made an important contribution to the debate regarding the poverty impact of NR research. Without empirical evidence there would be little on which to base discussions. That said, there are limitations on the extent to which such studies can provide definitive conclusions or guidance. These limitations are considered here under the following headings:

- methodological challenges;
- type of NR research assessed;
- type of 'poverty impact' assessed;
- objectives of impact assessment studies.

Methodological challenges

Assessing the poverty impact of NR research is an exacting task, requiring the estimation of research effectiveness in cost-benefit terms and the identification and quantification of the distribution of these costs and benefits between different members of society. The complexity of analysis required necessarily raises the question of the quality of results obtained. Clearly the quality of study methodology is important in this regard.

This briefing paper does not attempt a meta-evaluation of the impact assessment literature but instead considers a few key factors that, in addition to concerns about data availability and quality, complicate any analysis.

- Attribution problems: Alston and Pardey (2000) discuss specific methodological problems relating to attribution (i.e. the correct apportionment of effects between multiple causal factors, including research). A general conclusion they reach is that unrealistic or simplifying assumptions regarding attribution have most likely biased upwards estimates of impact in many studies.

- Counterfactual conditions: assessing the impact of any research requires comparison between conditions 'with' and 'without' the research rather than 'before' and 'after'. This is a challenge for all impact assessment studies because data regarding counterfactual conditions, by definition, do not exist, though it is particularly problematic for maintenance research.¹ Adequate treatment of the counterfactual issue may require sophisticated modelling/econometric analysis but such approaches impose additional demands in terms of the skills and data required.
- Timeframe: a review of experiences in agriculture (Davis *et al.*, 1987) identified actual research lags ranging from 3 to 17 years. To these can be added adoption lags and, in some cases of resources with longer production cycles (e.g. trees), benefit lags. Impact assessment efforts face a trade-off between certainty of results (which increases as time passes) and timeliness of results (which decreases over time), but premature assessment can lead to erroneous conclusions.
- Indirect effects: beyond the immediate effects on adopters, technological change can be expected to lead to indirect effects, but capturing these increases the complexity of any study. Examples include effects on labour, other input markets and consumers, but also environmental and social impacts. Such effects may only become apparent over time, be unanticipated and may be positive or negative. For example, the first high yielding rice variety widely distributed in Asia was highly susceptible to pests. This encouraged heavy reliance on pesticides that resulted in poisoning of farmers and the evolution of new, pesticide-resistant insect strains (Shiva, 1991, in Kerr and Kolavalli, 1999).

In a review of the state of knowledge, Hazell (1999) found that many studies fall short of acceptable analytical standards with respect to these factors. It can be assumed that this conclusion applies to studies that concluded both positively and negatively on the NR research-poverty impact debate. Such problems obviously have implications for the

¹ The benefits of maintenance research are largely in the form of 'losses avoided' and hence the major share of research-induced gains is realized in the context of counterfactual conditions. Maintenance research is a significant part of the total NR research effort; the International Center for the Improvement of Maize and Wheat (CIMMYT) has estimated that 50% of its wheat research has been devoted to keeping ahead of mutating pathogens (Collinson and Tollens, 1994).

reliability of results obtained. Ellis (1988) provides a succinct summary of the dangers posed by inadequate treatment of these factors in the context of the pessimism surrounding the impact of modern varieties in the 1970s. This pessimism derived in part from: “(a) premature conclusions drawn at an early stage of diffusion; (b) confusion of the intrinsic technical features of the varieties with their insertion into societies already rife with unequal land ownership, economic power and imperfect factors markets; (c) confusion of the impact of new varieties with the conceptually separate impact of tractorization; and (d) wrongly attributing to new varieties the effects of political decisions favouring irrigation in some areas rather than others, subsidized tractor purchase by large farms, and so on.”

The type of NR research assessed

The bulk of the NR research assessment literature focuses on agricultural research, and within this category the evaluation of genetic improvement (i.e. modern varietal) research predominates. This in part reflects the scale at which this form of research has been adopted and the balance of international and national research efforts: for example, around 20% of the research budget of the Consultative Group on International Agricultural Research (CGIAR) is devoted to crop improvement. Nevertheless, nearly 50% of the same budget is devoted to NR production systems development and management, policy improvement and environmental protection (Kerr and Kolavalli, 1999), and yet such research is poorly represented in the general literature.

The attention to modern varieties also reflects the fact that the outputs of such research are easier to trace, though this is not always the case (see, for example, López-Pereira and Morris, 1994). In general, the production objectives of much crop improvement research accords well with the efficiency-orientation of conventional economic analysis (i.e. more output per unit of input), the main analytical framework used in NR research impact assessments. However, other benefits of NR research may be more difficult to assess within this conceptual framework. Benefits such as improvements in the quality of the final good, or improved characteristics for processing, have received significantly less attention in the literature.

More generally, other categories of NR research such as NR management, environmental protection and policy research are inherently more difficult to assess from a production efficiency perspective. The

realization of long-term maintenance and sustainability objectives, for example, may not generate easily observable production gains; this in turn can lead to difficulties in isolating the influence of research from the multiple (non-research) factors that influence actual outcomes. Similarly, the outputs of much 'systems-based' NR research (e.g. agroforestry, soil conservation) may yield indirect effects over long timeframes with resulting benefits that may be public and/or non-market in nature. The challenge of identifying these effects over time, valuing and relating these to the research investment in many cases may be insurmountable.

That is not to conclude, however, that sophisticated evaluation techniques can never be applied to such research. In a relatively rare example, Pattanayak and Mercer (1996) applied production function analysis to assess the benefits of agroforestry/soil conservation research. Nevertheless, in spite of a large survey effort to obtain biological, social, economic and demographic data and in-depth weekly surveys of 37 households over a 12-month period, the strength of final conclusions is tempered by the fact that the results "do not account for several significant off-site and on-site benefits. In addition, all long run soil conservation benefits... may not have been realized in the short 10 year period since the initiation of the agroforestry project" [emphasis added].

The relatively narrow scope of the impact assessment literature inevitably raises two problems. The first relates to the representativeness of results while the second relates to their usefulness for decision-makers seeking to select the most effective (in poverty reduction terms) areas of NR research. The first problem can be addressed to a certain extent by aggregate analyses, which examine the impact of all (normally public) expenditure across the entire NR research portfolio. For example, Fan *et al.* (1999) assessed the impact on rural poverty of a wide range of government investments in India. The study found that investment in agricultural research and extension, although not specifically targeted to the rural poor, was second only to investment in rural roads in terms of its impact on rural poverty. In addition, the study found that R&D had the largest impact of any investment on productivity growth. However, the fact that such studies examine NR research in aggregate means that they largely fail to resolve the second problem, i.e. assisting selection between specific NR research options.

The type of 'poverty impact' assessed

The predominance of economic analysis in impact assessment studies also explains why changes in measures of income/consumption have provided the main standard for assessing poverty impact. However, reflecting the ongoing trend towards participatory, people-centred development, income/consumption indicators are now increasingly viewed as only partial measures of poverty. In the context of a renewed commitment to poverty reduction, many development agencies have in recent years been investing greater effort into understanding the condition of poverty and its different manifestations in order to improve diagnosis and solution-setting. As a result, more complex, multi-dimensional definitions have been developed (e.g. Asian Development Bank, 1999; Carney, 1998; UNDP, 1998).

Within these broader frameworks, income is viewed as one input (among many) to individuals' capabilities and functioning rather than a direct measure of well-being. This view is supported by research that has demonstrated only weak correlation between traditional measures of income/consumption and people's own subjective perception of poverty (e.g. Ravallion and Lokshin, 1999).

Assessments that focus on income/consumption, therefore, can shed little light on the impact of different NR research initiatives on non-monetary dimensions of poverty. For example, a case study evaluation of participatory forestry research funded by the Department for International Development (DFID), promoting the co-management of publicly owned reserves in Malawi, found that the research had positively affected participating communities' 'social capital' in terms of improved relationships with local forestry department staff and a greater sense of rights, responsibilities and ownership. Of course, the more intangible benefits of 'empowerment' and 'ownership' are also likely to reflect the anticipation of tangible benefit in the future. It is less clear, however, whether the full effects of such social impacts are captured in the benefits streams conventionally estimated in economic evaluation (Henderson, 2000).

In spite of the growing interest in more holistic definitions of poverty, research managers face a problem in that, as yet, no consistent definition of poverty or 'standard' has emerged for the purposes of impact

assessment. The fact that conventional money-metrics still predominate assessment criteria reflects:

- the fact that attempts to mainstream broader definitions are still ‘work-in-progress’;
- the clarity and relative ‘simplicity’ of income-based measures – hence their appeal to decision-makers;
- the context specific nature of more inclusive definitions of poverty;
- the indirect influence of NR research on many of the variables included in broader definitions;
- the further research required to understand better the cause-effect relationships between the different dimensions and variables included in broader definitions.

Maxwell (1999) identifies nine key options or ‘fault-lines’ in the debate about measuring poverty, including: individual or household level measures, monetary plus non-monetary components of poverty, objective or subjective perceptions of poverty, actual or potential poverty, and absolute or relative poverty. Of these, the last two are of particular relevance to the NR research impact literature.

‘Potential poverty’ relates to the concept of vulnerability, i.e. people may not be poor in terms of current income but may be vulnerable to shocks that can force them into poverty. The role of NR research in meeting the food demands of ever-growing populations can be considered particularly important in this context. Absolute or relative poverty is also an important issue because it underpins much of the controversy and criticism surrounding the achievements of NR research. Even where broad-based adoption of an improved technology occurs, differential rates of adoption can contribute to a worsening of relative poverty, where wealthier producers adopt earlier and more quickly and as a consequence capture a greater proportion of research-induced gains. In such cases, poor producers’ incomes may improve but income inequality may worsen. At one level, this is a normative debate about the nature of development and the purpose of development assistance. Evidence also exists, however, to support the view that widening levels of income inequality may be

deleterious to the achievement of widely held development objectives. This issue is considered further in section 3.

Practical constraints may mean continued reliance upon income/consumption-based measures. To the extent that these are accepted as a reasonable (albeit incomplete) proxy indicator of poverty then this may be adequate for given purposes. More fundamentally, however, it is important to recognize a distinction between indicators that describe levels of poverty and the causes of (and hence solutions to) poverty. In this respect, narrow measures inevitably can only inform decision-makers in a partial way, providing indirect guidance regarding the poverty 'pay-off' to different forms of NR research.

The objectives of impact assessment studies

A final reflection on the literature is reserved for the objectives of impact assessment studies themselves and the role that these play in explaining the limitations of the information arising from such studies.

Although not always explicit, impact assessments may be divided into two broad categories according to the (primary) objective of the study. For the first category, the aim is to identify the factors explaining the effectiveness (or otherwise) of an intervention in order to improve the likelihood of success in the future. Such factors may be research or non-research related and the results of such exercises are generally intended for managers/practitioners. For the second category, impact assessment is carried out largely for accountability/advocacy purposes and seeks to demonstrate successful achievements to a largely external audience. While these categories are not mutually exclusive and both still rely on the use of credible criteria and methods, the focus of effort in each is likely to differ.

The emphasis in the majority of impact assessment studies has been on the latter objective. As such, the 'learning' function of evaluation has to a certain extent been sacrificed as studies seek to validate previous decisions regarding allocation of research funds. Of course, increasing pressure on managers to demonstrate impact has contributed to this. However, what worked in the past may not necessarily provide a good guide to what will work in the future. This issue is considered further in section 2.

CONCLUSIONS

The overall weight of evidence points to the importance of the potential benefits of NR research for the poor. However, while a reasonable consensus may exist for such a broad conclusion, at the 'operational' level doubts regarding the poverty impact of particular NR research programmes appear to persist. These doubts reflect the real difficulties faced by funders and managers in determining what NR research will yield the greatest positive impact on poverty in any given set of circumstances.

The discussion above identified some characteristics of impact assessment studies that may limit the value of the available literature in resolving these doubts. Indeed, the fact that the literature itself exhibits such limitations suggests that implementing more assessments of the same ilk may do little to move the debate on. In this context, the next section considers the factors influencing the poverty impact of NR research and why it remains hard to predict the outcomes.

2

PREDICTING THE POVERTY IMPACT OF NR RESEARCH

FACTORS INFLUENCING THE POVERTY IMPACT OF NR RESEARCH

Conceptually, three main ‘routes’ have been identified through which the income effects of NR research are realized. These routes are not independent and gains achieved via one may be additional to or at the expense of gains in the others.

- **Production:** the extent to which producers’ incomes are affected by research-induced changes in the efficiency of production technologies.
- **Consumption:** the extent to which consumers’ (real) incomes are affected as a result of research-induced gains in the availability or quality of products.
- **Employment:** the extent to which the demand for labour and the wages received are affected by changes in production technologies.

Though useful, this basic framework has two major drawbacks in the current debate. First, it has no specific ‘poverty focus’. Thus, when considering the distribution of research-induced gains across producers, consumers and labourers, it is necessary to identify where the poor are located within these three categories. In certain cases, the poor may comprise all three categories, such as small-scale farmers engaged in subsistence production, and possible trade-offs between the gains and losses experienced by producers, consumers and labourers are internalized within the individual. In other circumstances, the poor may be

distinguishable as a particular category, for example, labourers on commercial farms producing export crops. In this case, differential income effects between categories (i.e. enterprise owners and labourers) are of interest. More generally, however, the poor will represent a (varying) proportion of the population within all three categories. Under these circumstances, determining poverty impact requires assessment of differential effects not only *between* the categories of producers, consumers and labourers but also *within* each categories (e.g. poor vs wealthy consumers).

Second, crucially the basic conceptual framework provides no insight into the factors determining the distribution of gains (and losses) arising from technological innovation. This paper considers these in summary form below, organized for illustrative purposes into three categories: market-related factors, technology-related factors and institutional factors (broadly defined).

Market-related factors

The market characteristics of the good or service affected by a new technology whether it is traded or not, the elasticities of supply and demand, the proportion of total output affected by the innovation, and so on have an important influence on the distribution of gains (and losses) arising from technological change. Conventionally, economic surplus models, based on a market supply and demand framework, have been used to examine welfare changes between consumers and producers.²

For example, productivity-enhancing research may increase supply of an NR commodity. In such a case, if the commodity is traded internationally and the producing country accounts for only a small proportion of world output, price will remain unchanged (i.e. demand is perfectly elastic), the resulting gains will be realized entirely by producers. If, on the other hand, the commodity is produced for domestic consumption only, increased production may lower the price of the commodity to the benefit of consumers. The effect on producers' income will depend on whether the unit production cost savings brought about by the new technology are sufficient to offset the effect of the fall in prices. Where this is not the case, producers may in theory be worse off following adoption of the

² The term 'producers' is commonly used to denote farmers, though strictly speaking it refers to the owners of the factors of production.

technology though the actual outcome depends on *inter alia* the elasticity of demand and the nature of the supply curve shift at the industry level.

Technology-related factors

New technologies can affect the use of inputs applied in the production process and as a result the income 'earned' by each input. Technological change is said to be 'neutral' where the relative proportion of inputs applied remains unchanged at constant factor prices following adoption of the new technology.³ The converse of this is 'biased' change, where the proportional use of an input declines relative to others. In the context of the NR research-poverty impact debate, the factor of production of greatest interest is labour.

Most technological advances in developing countries have been biased, being either labour-saving (e.g. new machinery) or land-saving/land-augmenting (e.g. modern varieties, new fertilizers). Research targeted specifically at the development of labour-augmenting technologies appears to be relatively limited in comparison, even though opportunities may in principle exist to replace other inputs (e.g. chemicals, machinery) with labour. In explaining this, conventional economic analysis highlights the importance of relative factor prices in determining the scope for such substitution. To this, however, can be added a number of other factors:

- the influence of the developed world's research agenda, which has traditionally focused on labour-saving technologies;
- in contrast to the use of other factors of production, employing hired labour is significantly more complicated and may involve relatively high transaction costs which are often ignored in conventional analysis;
- needs assessment exercises used in the identification of research opportunities may be based on an analysis of conditions at the level of the farm household. At this level labour may appear in short supply, despite wider levels of unemployment among the landless.

³ Strictly speaking, technological change at the industry level is termed neutral when the proportional change in the marginal product of each input is the same (Thirtle and Ruttan, in Colman and Young, 1989).

Given the fact that (directly) labour-augmenting technologies have not been widely developed, the labour effects of other forms of biased technological change are, therefore, indirect and hence less predictable. The fact that technologies are categorized as land augmenting or indeed 'labour-saving' does not of itself necessarily mean disadvantages for labour. While modern varieties strictly speaking are land-saving, they have often proved to be labour-using in the absence of associated increases in mechanization. More labour is required for cultivation, weeding, input application, harvesting and so on. In this sense, modern varieties have increased rural employment but because of population growth and increasing landlessness/rural unemployment in some countries, such effects have not necessarily resulted in an increase in real wages (see Colman and Young, 1989).

Similarly, while labour-saving technological change is of concern given that it implies a lower share of total income accruing to labour from the production process, simplistic conclusions should not be drawn. By lowering the marginal cost of production, labour-saving technologies provide producers with an incentive to increase total output and thus employ more of all inputs (including labour). Whether any initial displacement of labour is more than offset by greater labour usage arising from increased production requires case-specific assessment. Such uncertainty also cautions against simplistic generalizations regarding the labour effects of different categories of NR research. Not all mechanization is necessarily labour-saving (e.g. irrigation pumps); not all biological innovation is necessarily labour-using (e.g. herbicides) (Ellis, 1998).

While the nature of technological change may be important *a priori* in determining potential benefits for labour, how the technology interacts with factor markets where it is introduced is also key in determining outcomes in practice. For example, the introduction of a land-augmenting technology may increase the demand for labour, but the share of the additional income gained by labour will depend on its availability relative to land. Where land is abundant and labour scarce, employment income can be expected to rise. In the converse situation, however, land values/rents may rise faster than wages. Kerr and Kolavalli (1999) cite a number of case studies in Asia which demonstrated that, in spite of increased wages reflecting greater labour productivity, the greatest gains were capitalized into land values, i.e. landowners' wealth.

In addition to bias, there may be 'scale' issues associated with new technologies. Scale issues are encountered where a new technology is only efficient (in a cost-benefit sense) if used on large areas. In so far as farm size may be considered a (crude) indicator of producers' wealth, scale characteristics inherent in any new technology are important in the poverty debate. Concern in this regard most commonly centres on mechanization technologies (particularly tractors) though the qualifications discussed above should be borne in mind (or at least the issues of bias and scale and their respective effects should be clearly distinguished).

Many of NR research innovations and in particular modern varieties are described as 'scale neutral'. Scale neutrality is a technical term that refers to the divisibility of the technology along with associated inputs (fertilizer, water, etc.) across all ranges of output. Nevertheless, this concept warrants closer scrutiny in the poverty debate. Small, poorer farmers' capacity to adopt 'scale neutral' modern varieties may have been limited in practice by other factors associated with scale (e.g. degree of risk aversion, access to credit to purchase necessary inputs, etc.). While newer varieties targeted at drought resistance, responsiveness to organic inputs, and so on, appear more accessible to poor producers, it nevertheless should be recognized that scale problems may arise not directly from the nature of the technology *per se* but as a result of the institutional characteristics of the society where the new technology is introduced. These factors are discussed further below but as a means of neatly summarizing concerns about the issue of scale, the Association for Strengthening Agricultural Research in East and Central Africa (ASARECA) strategy document comments:

"The operative philosophy is that most improved agricultural technologies such as improved seeds/more productive animal breeds, animal/crop protection systems, etc., are 'scale-neutral'. Experiences in the ECA and in other regions show that resource-rich producers have always been the first to benefit from improved technologies, although they were not actually targeted as priority beneficiaries in the first place. There is no compelling reason to believe that this apparent inequity will not happen in the future resulting in continuing marginalization of small-scale farmers."

Institutional factors

The term 'institutional factors' includes here a broad range of social, legal, political and cultural factors. These condition the operation of factor and product markets, the social structures into which improved technologies are introduced and the formal and informal rules governing people's behaviour. As such, they play an important role in determining the impact of NR research and subsequent distribution of gains. The scope of this paper precludes a detailed description of these multiple factors and their myriad possible effects under alternative conditions. However, by way of illustration, the following factors could be included:

- initial distribution of income, and the social and economic context in which it exists;
- tenure arrangements governing access to natural capital;
- arrangements governing access to financial and support services (including extension);
- political influence of different interests in setting priorities for public investment;
- access to education and health services that affect people's ability to respond to opportunities;
- economic policies affecting the supply of inputs and pricing/marketing of outputs.

The importance of institutional factors is affirmed in numerous studies. For example, in reviewing evidence regarding the distributional effects of the Green Revolution, Freebairn (1995) concluded that differences in the findings of numerous studies in different locations reflected real variations, arising from differences in policies and institutions that conditioned farmers' ability to adopt the new technology. Lipton and Longhurst (1989) concluded that economic policies related to input supply and land tenure that favoured large farmers were the most common reasons explaining why these farmers were the early adopters of modern varieties gaining the majority of benefits and leaving many non-adopters or late adopters worse off.

Similarly, in the context of the role of new technologies in promoting greater agricultural commercialization, Hazell (1999) notes: “while commercialization by itself rarely has adverse consequences on household welfare, commercialization combined with the failures of institutions, policies or markets can be damaging. It is, therefore, essential that government policies facilitate the transition to commercialized agriculture in a manner that benefits the poor and does not simply replace subsistence-related production risks with new market and policy failure risks, which may be more devastating to the poor.”

While the importance of institutional factors is well recognized (at least in recent years), there is often uncertainty over likely impacts of NR research even where institutional components are noted. Part of the problem relates to the diversity and potential complexity of differing institutional contexts, especially when these reflect more complex social relations. A second factor may be that institutional components can often only be influenced at levels beyond that of the (research) project. This uncertainty and hence the problem of promoting poverty impacts is discussed below.

PROBLEMS IN PREDICTING THE POVERTY IMPACT OF NR RESEARCH

Conditions under which the impact of technology will provide benefits for the poor have been characterized by Hazell (1999) as follows: “for a yield-enhancing technology, the following conditions are required: (a) a scale-neutral technology package that can be profitably adopted on farms of all size; (b) an equitable distribution of land with secure ownership or tenancy rights; (c) efficient input, credit and product markets so that farms of all sizes have access to requisite modern farm inputs and receive similar prices for their products; (d) a mobile labour force that can migrate or diversify into the rural non-farm economy; and (e) policies that do not discriminate against small farms.”

In essence these conditions have close similarities with neo-classical requirements for perfect markets. Hence, in practice it is hardly likely that all, if indeed any will apply.

A major weakness of conventional economic tools is that the array and variability of institutional and social relationships that condition the effects of NR research lie largely outside the framework of analysis. Standard

economic surplus models have been extended to incorporate features such as government pricing policies (see Alston *et al.*, 1995), analyses are rarely disaggregated sufficiently to account for the specific circumstances faced by the poor (who may, for example, face different prices for inputs, including credit, incur different transaction costs associated with both marketing and in accessing extension advice, and so on). Other factors, such as social relationships and norms, may be excluded from analysis. As Ellis (1988) concludes: “Since the roots of political and economic power in the material base of the productive economy are exogenous to [neo-classical economic] theory, they fall outside its capacity to handle or predict.”

Similarly the focus of conventional economic impact assessment is on the *products* of research and subsequent effects. Research *process* – how the research objectives were identified, how the research was conducted, and so on – lies outside the analytical framework. Consequently, the results of the majority of studies provide little or no guidance on this issue for the purposes of improving the planning and implementation of research in the future.

Beyond the limitations of existing analytical frameworks, prediction is also made difficult by the dynamism inherent in both the livelihood strategies of the poor and the social and economic systems in which they function. For example, the simple assumption that self-employed farming represents the major livelihood option for all or most poor rural households is at odds with more recent evidence of greater dynamism and diversification in rural livelihoods (e.g. see Parilla, 1995). As such, it is recognized that a given innovation can impact on only a part of the poor’s natural capital assets, which in turn are but a component of their overall livelihoods. The importance of non-farm economic activity in rural areas is emphasized by the figures in Table 1.

Table 1 Share of non-farm income and employment in total rural income and employment

Region	Non-farm income (%)	Non-farm employment (%)
Africa	42	n.a.
East and southern Africa	45	n.a.
West Africa	36	n.a.
Asia	32	44
East Asia	35	44
South Asia	29	43
Latin America	40	25

Source: Reardon *et al.* (1998) in Berdegue *et al.* (1999).

The importance of relationships between the farm and non-farm sectors in rural areas is emphasized by Hazell (1999) who found that growth in agricultural productivity can be associated with large multiplier effects, with between US\$ 0.5 and US\$ 1 of additional value-added created in the local non-farm economy for each dollar of additional value-added created in agriculture.

Similarly, migration is now widely recognized as an important livelihood strategy for certain poor groups. Thus, while first-round effects of technological change may contribute to widening disparities between 'favourable' (e.g. irrigated, reliable rain-fed) and marginal regions, migration and remittances may lead to second round effects that result in the benefits of new technologies being more broadly shared.

Of course, dynamism is also a feature of the research process itself, even within relatively narrow fields such as the improvement of a particular crop. Much of the early Green Revolution research focused on rice and maize and their production response to purchased inputs. Now many more characteristics (e.g. drought tolerance, wind resistance, shorter growing cycles) have been targeted by research and these, on the face of it at least, appear more 'poor friendly'. At the same time NR research has targeted an ever-growing range of crops including sorghum, millets, root crops and pulses. The changing nature of NR research itself cautions against simplistic conclusions about the potential poverty impact of 'NR research'.

Finally, broader emerging trends increase uncertainty surrounding the future and hence impinge on analysts' capacity to predict. In the face of these developments, looking back using the results of *ex post* impact assessments may not be a particularly good guide to outcomes in the future. Globalization, combined with trends in market liberalization and the development of new biotechnologies suggest major changes in the basis of comparative advantage in the future, with decreasing emphasis on geographical location and natural endowments, and increasing emphasis on technology (including information) and human skills. This is likely to result in greater spill-over effects of NR research both via market mechanisms and through technology-transfer.

At the same time, increased privatization of research globally is to some extent working against these trends, most notably in the area of

intellectual property rights for plant genetic materials. In the early 1980s most crop and seed development in the US was under public research. However, with the advent of legislation enabling the private sector to profit from public research, the proportion of public sector patents in biotechnology sold under exclusive licence to the private sector rose from 6% in 1981 to more than 40% by 1990 (UNDP, 1999). NR research effort in developing countries will have to respond to these trends as they develop. Whether this response is pro-active or reactive will depend on levels of capacity, but in the case of communication technologies already research appears to be trailing behind.

CONCLUSIONS

Conventionally the impacts of NR research upon the poor (and others) can be examined through effects on production, consumption and employment. Diversity of impacts is growing as research agenda themselves have broadened to incorporate a growing array of crops and cropping characteristics. Key issues arise with respect to the distributional impacts of research which are influenced by market factors. Equally the nature of technologies, which are generally labour-saving and land-saving/augmenting, may have variable impacts on the poor, especially where second and third round effects are taken into account. Institutional factors are likely to further complicate the nature of impacts arising from innovations.

Predicting the poverty impacts of NR research technologies is, therefore, complex, and difficulties are compounded both by the complexity of institutional and social environments, and by the diversity of livelihood strategies pursued by the poor. Recent policy and macro level change, for example, the impacts of liberalization and the trend towards globalization, further exacerbate the scope of the challenge and mean that past experience and hence results of *ex post* impact assessments may not provide an effective guide to potential future outcomes. Given these conclusions, the next section considers the positions that have been taken in response, with particular attention to the growing calls for explicit targeting of NR research to the poor.

3

TARGETING OF NR RESEARCH TO THE POOR**THE ARGUMENT FOR TARGETING**

The discussions in the preceding sections support the widely cited view that NR research is itself a blunt instrument for addressing poverty given its indirect and partial effects. Certainly the problems posed in predicting the poverty impact of NR research imply difficulties in wielding it with precision in the fight against poverty. There appears to be fairly widespread agreement on these points, at least in terms of the ways in which NR research is designed and implemented at present. However, the conclusions drawn from these analyses differ considerably.

In the face of such uncertainty, it is argued that national economic efficiency should be the overriding objective of NR research. It is held that as a tool to pursue distributional objectives, NR research is not only less effective than more appropriate policy instruments, but its use for this purpose would entail an opportunity cost in terms of efficiency losses. Instead, maximizing the contribution of NR research to economic growth is expected to better serve poverty reduction objectives because: (a) the additional value generated as a result could be redistributed to the poor in more efficient ways; and (b) sustained economic growth offers the most viable means of reducing poverty.

In contrast, the refocusing of donors' efforts on poverty reduction in recent years has provided impetus to calls for greater targeting of the poor by NR research. Advocates of this stance question whether in reality NR research is any blunter than alternative instruments available to policy-makers. Given the lack of feasible options (e.g. the weak tax base in many

developing countries and political problems in explicit wealth redistribution), they conclude that public spending on NR research has an important redistributive role to play and should be seen as one of among a multi-pronged approach. In short, they argue that through institutional and policy changes, the blunt instrument can be 'sharpened'.

This approach also questions the feasibility of relying on economic growth to achieve poverty reduction. Whilst there is general acceptance that where there is broad-based participation in economic growth and widespread access to basic social services, the efficiency argument can provide an effective route to improving the living standards of the poor, there are a number of concerns in this regard.

- While there appears to be a relationship between general economic growth and improved income levels for the poor, the relationship is not direct with many other factors influencing outcomes. There are examples where general economic growth has been associated with greater *inequality*, for example, periods of growth in 1980s and 1990s in Kenya, Nigeria and Tanzania and recently in India (DFID, 1999).
- Relative poverty may increase (i.e. the distribution of income may become more unequal) even though the poor experience absolute improvements in income; this situation in turn may reinforce relative poverty by strengthening unequal power relations (Kerr and Kolavalli, 1999).
- The greater degree of inequality to start with, the weaker the likely effect of general growth on poverty reduction (DFID, 1999).
- Whilst second and third round effects arising from economic growth may lead to a raised share for the poor, this raises questions over the lags associated with the process, especially where the poor start from such a low base. Such concerns point to the need for more finely tuned approaches to targeting the poor.

PROBLEMS IN TARGETING NR RESEARCH TOWARDS THE POOR

Technological advances in database and information systems combined with recent efforts to generate a wider range of information about poverty

in developing countries provide better means than existed in the past to assist targeting. Nevertheless, in spite of improvements in the information base on which planners can draw and greater understanding of the conditioning factors, targeting itself is by no means a simple process and is not without potential pitfalls.

The nature of research and the new technologies it generates mean that it is more difficult to target NR research than other forms of public spending for the poor (e.g. subsidized health, education, housing, etc.). Certainly the most focused of targeting methods, means-testing, is unlikely to be feasible at the supply side of NR research even ignoring typical data limitations in developing countries. Because of this, alternatives have to be considered, i.e. targeting on the basis of geographical, commodity/resource, indicator-based and demand-led criteria.

Geographical-based targeting

Byerlee (2000) reports that there is strong evidence to suggest that agro-climatic characteristics dominate technology adoption patterns. In so far as poverty (at least in a rural context) is associated with marginal production environments, geographical targeting might be relatively effective. Bigman and Loevinsohn (1999) present an example of the potential usefulness of this approach to targeting. However, Byerlee also highlights:

- the difficulty in ensuring that investment in research remains efficient, given that research pay-offs are likely to be lower in harsh agro-climatic conditions;
- unless regional disparities are high, the effectiveness of geographical targeting may be low;
- the fact that in absolute number terms, relatively favoured areas may be associated with the largest concentration of poverty.

For those that advocate an overriding 'pro-poor' orientation for research, the first bullet point above certainly raises the question whether funders would find acceptable a low or zero rate of return on *their* investment in the case where a new technology proves profitable (and sustainable) for poor end-users.

Commodity/resource-based targeting

Where a commodity is of interest only to the poor, this can be seen as a form of 'self-targeting'. However, the number of products that are of interest solely to the poor is small, as is their scale and the scope for improving them technically may be limited. As such, the scope for overall poverty reduction is likely to be limited, especially compared with major food staples that all use (Cox *et al.*, 1998). An alternative approach is to target a commodity that is known to be of importance to the poor but not exclusively so. However, bearing in mind the linkages discussed in section 2, it is clear that the possibility for 'leakage' of research benefits to the non-poor increases significantly in such circumstances. In either case, commodity-specific targeting requires clarity and transparency when setting research objectives given the fact that preferences may differ significantly between different producers of a particular commodity (e.g. preference for hybrid or open-pollinated varieties).

Alternatively, NR research might target a resource (e.g. common pool resource), that is known to be of great importance to the poor who rely on it. However, improvements in management of common resources may quickly attract the attention of elites who try to control access. Again, it is difficult to avoid leakage and to retain a poverty focus under such circumstances. Reviews of common property resources in forestry in Latin America and South Asia and micro-watersheds in India support this conclusion (Cox *et al.*, 1998). Finally, commodity-specific targeting may potentially ignore the dynamism inherent in the livelihood strategies of the poor and their capacity to respond to new opportunities. That is, it may risk provision of new opportunities to the poor by focusing on attempts to bring about (marginal) improvements in existing economic activities.

Indicator-based targeting

The effectiveness of targeting depends on how closely the criteria used reflect the variables of real interest. Poverty may not be commodity or region-specific and may be better defined in terms of socio-economic variables (e.g. farm-size, access to land, dependency ratio, gender, etc.). Recognition of this has led to the use of indicators to better locate the poor as the intended beneficiaries of support programmes. The idea being that having done so, technology development can focus on constraints

and characteristics most relevant to these groups (e.g. scarce financial capital, risk aversion, use of labour in 'slack' periods, etc.)

However, in comparison with broader geographical targeting or self-targeting through commodity-specific research, indicator-based targeting entails high administrative costs. As such, van de Walle (1995) notes that it is advisable to use indicators that are easily observed and difficult to manipulate or bias (such as gender and old-age, compared with employment or nutritional status). At the same time it has to be accepted that the correlation between easily observable indicators and poverty is often far from exact, in spite of increased understanding about the poor in developing countries. Poverty indicators at the level of the individual may be most appropriate but most data are often only available at household level though the implicit assumption about intra-household equality may not be realistic. Use of a combination of indicators can improve specificity (e.g. the Grameen Bank credit scheme screens on female gender, landlessness and rural residence), but in practice the number of indicators that can be used may be limited for practical reasons.

More generally, van de Walle (1995) notes that the fact that a programme is well targeted does not ensure that it is a cost-effective way to reduce poverty, since the extra costs incurred by targeting and the political-economy responses may actually worsen the final distribution of living standards when compared with untargeted programmes. In short, the ability of a policy to concentrate benefits on the poor and its impact on poverty though often confused are *not* equivalent. Determining the effectiveness of such an approach requires careful and complex evaluation that considers:

- costs of targeting;
- real benefits to the poor net of any adoption costs including where alternative sources of income are displaced (e.g. inter-household charity);
- the costs to poor and non-poor introduced by shifting resources from non-targeted research programmes.

Demand-led targeting

Approaches discussed above focus on the supply side of NR research. Alternative means are provided by demand-led targeting, based on the principle of empowering intended end-users to articulate their research needs and influence the selection of research objectives. Since the 1970s, participatory approaches have been a feature of research identification and implementation in response to the concern that even where the research programme identifies the poor as intended beneficiaries, supply-side planning and prioritization fails to adequately address the constraints affecting this group. Almost all research institutions or their funders now require some evidence of demand to justify research programmes. In so far as the institutional environment will enable the poor to articulate demand then this mechanism may be seen as further assisting targeting.

More recently, competitive funding mechanisms have been used to further the implementation of demand-led research, but it may not be straightforward. Even if broad research priorities are already set, a major problem still remains at the micro-level in ensuring that the poor are represented and have an adequate voice in the priority-setting processes. This may require investment of resources to develop appropriate mechanisms, for example, the Competitive Fund of Colombia's National Technology Transfer Program (PRONATTA) which has successfully stimulated the development, adaptation and validation of technologies designed for smallholders, including 'up-scaled' indigenous technologies. As part of the programme, resources were explicitly committed for the development of the demand-side among intended beneficiaries (Berdegué *et al.*, 1999).

There are other examples of more 'advanced' competitive resource allocation mechanisms, where funds are provided directly to users who in turn contract technical expertise to execute the desired research. While in certain regions, such as Latin America, such approaches appear to be feasible, the issue of representation of the poor still remains a central concern. In the case of Africa, the role that farmers' organizations can play in redirecting agricultural research "has been overstated". Many of these formal organizations tend to be weak and would need to be substantially strengthened before they can play an effective leadership role in agricultural R&D (Berdegué *et al.*, 1999).

From the perspective of donor agencies, it is often a case of demand being articulated by collaborating institutions. However, there is a need to consider the nature of such bodies and the extent to which they can genuinely articulate the needs of the poor. A combined approach, linking with PPAs and donors' country programmes (and poverty profiles included therein) may be required, together with funds to help mobilize representation for the poor. Similarly, a greater role for the poor in research prioritization through demand-led approaches may imply a greater role for the same group in evaluating the success of research. In this regard, indicators of 'success' as defined by the poor themselves may not align neatly with higher order objectives/indicators driving donors' efforts (e.g. the International Development Targets).

CONCLUSIONS

Concern with demonstrating progress against poverty will for many donors (understandably) translate into a desire to support initiatives directly targeted at the poor. The view that efficiency-orientated research represents the most effective means (ultimately) of addressing poverty certainly demands a greater 'leap of faith' than say poverty-focused participatory research, even accepting differences in the potential scale of research effects. However, the practical limitations and administrative requirements associated with targeting argues against the application of 'simplistic' screening approaches. In practice, targeting should be viewed as a tool but not an objective in its own right.

Even where efficiency concerns drive priority setting at the macro-level, there are likely to be significant opportunities to target research efforts at the micro-level by clearly distinguishing between different end-users' constraints and interests (Byerlee, 2000). In addition, there are still opportunities to realize both efficiency and equity objectives. Byerlee (2000) found this to be the case in terms of institutional innovations to improve overall research system performance. Reforms to land tenure arrangements and rural finance policy represent broader examples where NR research can contribute (DFID, 1999).

4

CONCLUSIONS

RECOGNIZING THE TRADE-OFFS

This paper has not sought to argue the case for or against NR research as a means to achieving poverty reduction targets. On the balance of available evidence, it is reasonable to conclude that NR research has made, and can make, an important contribution to poverty reduction. These concluding remarks, therefore, relate to issues which can be tackled in order to make future assessments more explicit and effective in highlighting poverty issues.

It is necessary to recognize the current context in which NR research operates. The research base in developing countries is decidedly weak, especially outside Asia (see Table 2). In the 1990s, the proportion of public funding for R&D in science and technology has fallen around the world, to be replaced by private industry; R&D has also shifted away from developing countries. Their share in the global total dropped from 6% in the mid-1980s to 4% in the mid-1990s. This trend has been particularly strong in agriculture and biotechnology (UNDP, 1999).

Table 2 Researchers/R&D personnel per 10 000 active persons (1991)

Region	No.
Japan	78
US	69
EU	40
India and China	26 (estimated)
Non-Asian developing countries	<0.5

Source: Scientific and Technological Research EC Communication, 25 April 1997.

Trends towards privatization raise concerns that the research agenda will increasingly reflect commercial objectives rather than those based upon the needs of the poor. This may strengthen the case for donor funding of NR research focused towards the poor, but given limited resources and the diversity and complexity of poverty itself one can expect examples of 'win-win' NR technologies to be relatively rare. Funders and implementers of research will inevitably be faced with choices and trade-offs, at multiple levels. The previous discussion about the debate between growth-orientated and targeted research provides one such example.

However, choices may also be faced between different categories of the poor. There is a tendency in the literature to talk of the poor as either a homogeneous mass or a specific group (such as 'poor farmers'). But even at a relatively crude level, it is clear that the interests of poor urban consumers and poor rural producers are not entirely consistent. While the majority of the world's poor will continue to live in rural areas over the next 20 years and people in rural areas are expected to remain on average poorer, beyond the year 2020, the majority of the population in all regions of the developing world will be living in the urban areas, even in Africa and Asia. Correlated with this is a decline in the percentage of the population relying on agriculture: beyond the year 2010, more than two-thirds of the world's population will be non-agricultural (Berdegúe *et al.*, 1999). While some commentators argue for clearer and narrower focus for internationally supported NR research, for example, persistently poor rural populations (Scherr and Haug, 1999), development agencies are concerned with the fight against poverty in its broadest sense and may ask what NR research can do for the non-rural poor.

Trade-offs continue to be encountered even within a given category of the poor because of the multi-dimensional nature of poverty. For example, greater integration of small farmers into markets through the promotion/ adoption of modern varieties implies a trade-off between higher-case income and less security in subsistence production as they risk becoming prey to the unequal exercise of power in imperfect markets. Similarly, Kerr and Kolavalli (1999) report work by Alauddin and Tisdell (1991) which found that despite the importance of modern varieties of rice in maintaining per capita output in Bangladesh, the average citizen consumed a narrower, less nutritious diet in 1984 than in 1967. Thus, valid concerns regarding adverse nutritional impacts of modern varieties (because of their tendency to replace more diverse traditional agricultural

systems) have to be set against the consequent increase in food availability. In Bangladesh, for example, this is a significant achievement given the real doubts at independence in 1971 about the prospects of avoiding starvation.

More explicit recognition of such trade-offs in research design and implementation would assist in the clarification of research objectives and thus could be expected to contribute to more effective research in the future. Similarly, through an iterative process, implementation of the research cycle in the light of an appreciation of such trade-offs can be expected to contribute to a better understanding of poverty itself.

CONTRIBUTION OF MORE HOLISTIC DEFINITIONS OF POVERTY

Efforts generally to collect more detailed data regarding poverty levels in developing countries are important in informing the debate. Country level poverty assessments, by providing a better understanding of who are the poor, are likely to inform understanding of trade-offs and choices. More specifically, use of conceptual tools such as the Sustainable Livelihoods (SL) framework being developed by the United Nations Development Programme (UNDP) and DFID among others offers the prospect of more detailed understanding of the causes of poverty and options for NR research. By recognizing the multiple dimensions of livelihoods, the SL approach provides a framework that can incorporate linkages with the non-farm rural economy, the impact of trends and shocks on different assets that make up the livelihood (e.g. HIV/AIDS in Africa) and so on. Similarly, it can be expected to be useful in identifying transaction costs that may in practice limit viability of technology for the poor (risk aversion, asymmetric information, differing terms of trade, costs associated with access to markets, etc.). In addition, by explicitly recognizing 'macro-micro linkages' (i.e. policies, institutions and processes and how they impinge on livelihoods), the approach offers some scope for internalizing institutional factors in research planning processes.

Inevitably there are drawbacks – the very complexity that is the strength of SL approaches is also its weakness. Much needs to be done in order to develop appropriate tools that can effectively draw upon the array of information which SL approaches can generate. There is also a need to find the means to integrate SL-type analyses routinely into the decision-

making, prioritization and implementation processes. Nevertheless, SL approaches offer the prospect of countering the narrow, reductionist approach to research identification and design that has characterized much NR research in the past.

GREATER RECOGNITION OF PROCESS

Although largely overlooked in the literature as a 'causal' factor, process is important to donors. In practice, donor-supported NR research, whether primarily by developed or developing country bodies, must go through local organizations in order to achieve impact. This implies the need for organizational appraisal and, most likely, consideration of capacity-building needs. Stronger linkages with development projects offer one route but an alternative approach might be for donors to adopt a broader definition of research to include capacity-building elements.

The importance of organizations to the delivery of successful innovations suggests that impact assessments should include these in any study. Criteria for assessing the institutional impact of NR research, however, still requires work in order to be meaningful in the context of development objectives. One option is to devote more effort to the *ex ante* identification of uptake pathways which in turn may provide a framework in which the performance of organizations can be assessed.

THE OBJECTIVES OF IMPACT ASSESSMENT STUDIES THEMSELVES

There appears to be a need for more learning-orientated impact assessment initiatives. Ultimately, success in institutionalizing an evaluation culture is only likely where the process is recognized as valuable. There will remain a need for advocacy type studies (donors and local research organizations will still be subject to political pressures) but more generally the focus should be on institutionalizing assessment practices that are less reliant on external experts and instead foster capacity locally. It is this local capacity that must continue the NR research effort once a donor-funded project has been completed.

In the light of capacity and needs, a more 'market-oriented' approach to assessment may be appropriate, with a focus on adoption, rather than

impact *per se*. Assessment of end-user 'satisfaction' and the reasons behind responses can contribute significantly to the development of research products, although such measures fall short of the rigour normally associated with impact studies. However, in so far as assessment criteria are designed with the intended audience in mind, there is a circularity in the argument if donors signal that more informal measures are acceptable, then they will be used.

BIBLIOGRAPHY

ALAUDDIN, M. and TISDELL, C. (1991) *The Green Revolution and Economic Development: The Process and Its Impact in Bangladesh*. New York: St. Martin's Press.

ALSTON, J., MARRA, M., PARDEY, P. and WYATT, T. (1998) Research returns redux: a meta-analysis of the returns to agricultural R&D. *EPTD Discussion Paper*, No. 38. Washington DC: International Food Policy Research Institute (IFPRI).

ALSTON, J., NORTON, G.W. and PARDEY, P. (1995) *Science Under Scarcity. Principles and Practice for Agricultural Research Evaluation and Priority Setting. Food Systems and Agrarian Change Series*. Ithaca: Cornell University Press.

ALSTON, J. and PARDEY, P. (2000) Reassessing research returns: attribution and related problems. Invited paper presented at the *Conference of the International Association of Agricultural Economists, Berlin, August 2000*.

ASIAN DEVELOPMENT BANK (1999) *The Bank's Poverty Reduction Strategy*. On-line policy statement: www.adb.org/work/policies/Poverty_Reduction/poverty1999.asp

BERDEGUÉ, J., ESCOBAR, G. and CARNEY, D. (1999) Agricultural research institutions and rural poverty alleviation. Paper prepared for the *International Centre for Tropical Agriculture (CIAT) International Workshop: Assessing the Impact of Agricultural Research on Poverty Alleviation, Costa Rica, 14–16 September 1999*.

BIGMAN, D. and LOEVINSOHN, M. (1999) Targeting agricultural R&D for poverty reduction: general principles and an illustration for sub-Saharan Africa. Paper prepared for the *International Centre for Tropical Agriculture (CIAT) International Workshop: Assessing the Impact of Agricultural Research on Poverty Alleviation, Costa Rica, 14–16 September 1999*.

BYERLEE, D. (2000) Targeting poverty alleviation in research priority setting: concepts and practice for national research organizations. Washington DC: World Bank, Rural Development Department. (Draft Paper).

CARNEY, D. (ed.) (1998) Sustainable rural livelihoods: what contribution can we make? Papers presented at the *Department for International Development's Natural Resources Advisers' Conference, July 1998*.

COLLINSON, M. and TOLLENS, E. (1994) The impact of the international agricultural research centres: measurement, quantification and interpretation. *Issues in Agriculture*, No. 6. Washington DC: Consultative Group on International Agricultural Research (CGIAR).

COLMAN, D. and YOUNG, T. (1989) Principles of agricultural economics: markets and prices in less developed countries. *Wye Studies in Agricultural and Rural Development*. Cambridge: Cambridge University Press.

COX, A., FARRINGTON, J. and GILLING, J. (1998) *Reaching the Poor? Developing a Poverty Screen for Agricultural Research Proposals. Working Paper*, No. 112. London: Overseas Development Institute (ODI).

DAVIS, J.S., ORAM, P.A. and RYAN, J.G. (1987) *Assessment of Agricultural Research Priorities: An International Perspective. ACIAR Monograph*, No. 4. Canberra: Australian Centre for International Agricultural Research (ACIAR)/International Food Policy Research Institute (IFPRI).

DFID (1999) *Economic Well-being. International Development Target Strategy Paper*. Consultation document. London: Department for International Development.

DIRVEN, M. (1999) Rural poverties and innovation in agriculture. Paper prepared for the *International Centre for Tropical Agriculture (CIAT) International Workshop: Assessing the Impact of Agricultural Research on Poverty Alleviation, Costa Rica, 14–16 September 1999*.

ELLIS, F. (1988) Peasant economics: farm household and agrarian development. *Wye Studies in Agricultural and Rural Development*. Cambridge: Cambridge University Press.

FAN, S., HAZELL, P. and THORAT, S. (1999) Linkages between government spending, growth and poverty in rural India. *Research Report*, No. 110. Washington DC: International Food Policy Research Institute (IFPRI).

FREEBAIRN, D. (1995) Did the green revolution concentrate incomes? A quantitative study of research reports. *World Development*, **23**(2): 265–279.

GRILICHES, Z. (1958) Research costs and social returns: hybrid corn and related innovations. *Journal of Political Economy*, **66**(5): 419–431.

HAZELL, P. (1999) The impact of agricultural research on the poor: a review of the state of knowledge. Draft paper prepared for the *International Centre for Tropical Agriculture (CIAT) International Workshop: Assessing the Impact of Agricultural Research on Poverty Alleviation, Costa Rica, 14–16 September 1999*.

HENDERSON, J.S. (2000) Evaluating the impact of forestry research for development. *International Forestry Review*, **2**(3): 191–199.

KERR, J. and KOLAVALLI, S. (1999) Impact of agricultural research on poverty alleviation: conceptual framework with illustrations from the literature. *EPTD Discussion Paper*, No. 56. Washington DC: International Food Policy Research Institute (IFPRI).

LIPTON, M. and LONGHURST, R. (1989) *New Seeds and Poor People*. Baltimore: Johns Hopkins University Press.

LÓPEZ-PEREIRA, M. and MORRIS, M. (1994) *Impacts of International Maize Breeding Research in the Developing World, 1966–1990*. Mexico

City: International Center for the Improvement of Maize and Wheat (CIMMYT).

MENZ, K., LUBULWA, G. and LAL, P. (1999) Poverty alleviation through agricultural research: the ACIAR experience. Paper prepared for the *International Centre for Tropical Agriculture (CIAT) International Workshop: Assessing the Impact of Agricultural Research on Poverty Alleviation, Costa Rica, 14–16 September 1999*.

MAXWELL, S. (1999) The meaning and measurement of poverty. *Poverty Briefing*, No. 3. London: Overseas Development Institute (ODI).

PARILLA, L. (1995) Farm households and the farm resource base. In: *A Profile of Upland Farming Systems on Sloping Land in the Philippines. Working Paper*, No 46. Menz, K., O'Brien, G. and Parilla, L. Canberra: Australian Centre for International Agricultural Research (ACIAR).

PATTANAYAK, S. and MERCER, D.E. (1996) *Valuing Soil Conservation Benefits of Agroforestry Practices. FPEI Working Paper*, No. 59. Research Triangle Park, North Carolina: South-eastern Centre for Forest Economics Research.

RAVALLION, M. and LOKSHIN, M. (1999) *Subjective Economic Welfare. Working Paper*, No. 2106. Washington DC: World Bank, Development Research Group.

SCHERR, S. and HAUG, R. (1999) Sharpening the focus on poverty in public international agricultural research for development. Draft paper prepared for the *International Centre for Tropical Agriculture (CIAT) International Workshop: Assessing the Impact of Agricultural Research on Poverty Alleviation, Costa Rica, 14–16 September 1999*.

SHIVA, V. (1991) *The Violence of the Green Revolution*. London: Zed Books.

UNDP (1999) *Human Development Report*. New York: United Nations Development Programme.

UNDP (1998) *Sustainable Livelihoods Concept Paper*. New York: United Nations Development Programme.

VAN DE WALLE, D. (1995) *Public Spending and the Poor: What We Know, What We Need to Know. Policy Research Working Paper*, No. 1476. Washington DC: World Bank.

VON BRAUN, J., HOPKINS, R., PUETZ, D. and PANDYA-LORCH, R. (1993) Aid to agriculture: reversing the decline. *Food Policy Statement*, No. 17. Washington DC: International Food Policy Research Institute (IFPRI).

WOLFENSOHN, J. (2000) Rethinking development – challenges and opportunities. Speech at the *Tenth Ministerial Meeting of UNCTAD, Bangkok, Thailand, 16 February*. Washington DC: World Bank.

ABBREVIATIONS

ASARECA	Association for Strengthening Agricultural Research in East and Central Africa
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	International Center for the Improvement of Maize and Wheat
DAC	Development Assistance Committee
DFID	Department for International Development
ECA	Eastern and Central Africa
NR	natural resources
OECD	Organization for Economic Co-operation and Development
PRONATTA	Competitive Fund of Colombia's National Technology Transfer Program
SL	sustainable livelihoods
UNDP	United Nations Development Programme

OTHER TITLES IN THIS SERIES

- 1 Rural Finance
- 2 Institutional Development and Poverty Reduction
- 3 Agricultural Sector Investment Programmes – Experience in Africa
- 4 Non-farm Rural Livelihoods
- 5 International Trade in Agricultural Commodities – Liberalization and its Implications for Development and Poverty Reduction in the ACP States
- 6 HIV/AIDS and Rural Livelihoods in Sub-Saharan Africa
- 7 Improving Smallholder Access to Purchased Inputs in Sub-Saharan Africa
- 8 Performance and Impact Assessment: Emerging Systems Among Development Agencies
- 9 The Role of Natural Resources in the Livelihoods of the Urban Poor
- 11 Pastoralism and Sustainable Livelihoods: An Emerging Agenda
- 12 Ethical Consumers and Ethical Trade: A Review of Current Literature
- 13 Agricultural Marketing in Developing Countries: The Role of NGOs and CBOs

