Designing Investments in Agricultural Research for Enhanced Poverty Impacts

Derek Byerlee
Gary Alex
Designing Investments in Agricultural Research for Enhanced Poverty Impacts

Derek Byerlee and Gary Alex

Sustainable Agricultural Systems, Knowledge and Institutions (SASKI)

Sustainable Agricultural Systems, Knowledge and Institutions (SASKI) is a thematic group that promotes sustainable agricultural production, processing and marketing systems through gender-responsive knowledge institutions with the Agriculture and Rural Development Family of the World Bank. Agriculture is defined to include crops, livestock, and aquaculture.
Contents

Foreword iv

Executive Summary v

1. How Does Research Link to Poverty Reduction 1

2. Key Issues for Research and Poverty Reduction 4
   - Broad-based Growth Strategies Have Sharply Reduced Poverty 4
   - Future Strategies Require Poverty Targets 5
   - Overcoming Institutional Weaknesses in Research Systems 6
   - Addressing Diversity Within the Sector 7

3. Good Practice for Enhancing Poverty Reduction Impacts of Investments in Research Systems 10
   - Analyzing the Structure and Nature of Poverty 10
   - Selecting a Broad Strategy 11
   - Setting Specific Priorities for Investments 12
   - Strengthening the Institutional Base 15
   - Promoting Inclusive Participation 17
   - Linking to Innovation Uptake Pathways 18
   - Putting in Place an M&E System 19

References 21
Agricultural growth in developing countries is critical to the Bank’s efforts to reduce poverty. Agricultural growth in turn requires investment in agricultural research, which has traditionally provided high returns on the investment. Future investments in agricultural research, however, require a more explicit linkage of the investment with poverty reduction strategies. This SASKI Good Practice Note discusses various strategies that aim at broad-based productivity growth, as well as ways of carefully targeting investments to enhance poverty impacts. Enhancing pro-poor impacts of investments in agricultural research will require: defining the nature and causes of poverty, establishing appropriate strategies, setting priorities, strengthening institutions, involving poor farmers at all stages, promoting uptake of new technologies, and follow-up monitoring and evaluation. These investments must also address long standing institutional weaknesses in research systems, such as inadequate funding, low salaries for scientists, and poor links with user groups.

This series of SASKI Good Practice Notes aims to disseminate innovative ideas, experience, and recommendations that may assist World Bank staff, leaders in borrower countries, and Bank partners to prepare and implement lending programs. The SASKI Thematic Team welcomes feedback and contributions to the series.

This note benefited from inputs and comments by Julio Berdegué, German Escobar, Matthew McMahon, and James Ryan. Participants at a 2002 SASKI seminar, where the paper was discussed, also contributed many helpful comments and suggestions.

Marie-Hélène Collion
Chair, SASKI Thematic Group
Executive Summary

Considerable empirical evidence indicates that agricultural growth is a priority for reducing poverty in developing countries. Investment in agricultural research is a major source of agricultural growth, and can provide powerful direct and indirect impacts on rural and urban poverty. The World Bank's Rural Strategy identifies agricultural science and technology as a high priority for future support, but this support must be more focused on the Bank's overarching objective of poverty reduction.

Several decades of experience provide evidence that a broad-based approach to promoting agricultural growth can have substantial impacts on poverty reduction where: (a) agriculture is important to the incomes of rural poor; (b) the agro-ecological base allows significant potential for productivity growth; (c) land distribution is relatively equitable; and (d) the poor consume nontradable food staples. Without these preconditions for win-win productivity growth and poverty reduction, agricultural research may still have strong poverty reduction impacts, but must be carefully targeted on poor producers and consumers.

Diversity in farm types and farming systems shapes the potential impact of agricultural research programs on poverty reduction. Agricultural innovation by commercial farmers in favorable environments can lead to poverty reduction if it generates employment (for example, labor for production of high value commodities) and/or provides cheaper food. Development of small-scale, market-oriented family farms offers the greatest potential for poverty reduction, if improved technologies are widely adopted. For very poor farm households in unfavorable production environments, agricultural innovation can usually lead to sustainable progress in poverty reduction only as part of a broad-based effort to diversify livelihood strategies of those households.

Strong agricultural research systems are therefore crucial in addressing agricultural growth and poverty issues. In many countries, however, these institutions have serious weaknesses, such as poor incentives to attract quality scientists, lack of operating budgets, and ineffective links with clients. A first priority must be to address these overall institutional weaknesses and improve efficiency and effectiveness of national agricultural research systems. Improvements in research system performance regardless of type of user will likely provide large benefits to the poor as well. The poverty reduction impacts of investments in agricultural research can be enhanced through the following steps:

Analyzing the nature and causes of poverty: The starting point in developing options and priorities for enhancing the poverty-reduction effects of research investments is the review of poverty assessment surveys and poverty reduction strategic papers (PRSPs) to identify types of poverty (rural and urban), their determinants, and the contexts in which they occur (geographical, farming systems, and livelihood strategies).

Establishing a broad strategy for research investments: Based on poverty analyses, research strategies might differ between and within countries depending on: (a) the income level of the country; (b) market and trade
designing investments in agricultural research for enhanced poverty impacts

policies; (c) agroclimatic potential; (d) rural infrastructure, service provision, and market access; and (e) the labor situation. In general, where most of the poor are in rural areas and agriculture is a significant share of their livelihoods (for example, much of Africa and South Asia), broad-based approaches to stimulate agricultural productivity will be the preferred strategy, with judicious targeting as appropriate. In other situations, more focused pro-poor approaches might be needed, based on priority setting for research resource allocation and institutional innovation appropriate to the poor.

Setting specific priorities for investments: Within these broad strategies, resources can be allocated to specific priorities important to poor producers and consumers. Priorities might be set by geographical region (provided there is demonstrated agricultural potential), by commodities produced and consumed by the poor (especially staple foods and nutrient-enhanced foods), by type of technology (for example, low-external input systems or natural resources conservation), or type of research (for example, basic research on crop or livestock traits of importance to the poor).

Strengthening the institutional base for research: Investment strategies must promote development of research institutions that more effectively address client needs. Building sustainable capacity will generally involve participatory approaches that empower the poor and rely on:

- **Private sector research** to free up and re-focus **public resources for pro-poor programs** by reducing policy and regulatory barriers to private investment.
- **Contractual and competitive mechanisms** to improve efficiency, enhance institutional pluralism in carrying out research, and promote pro-poor effectiveness.
- **Financial sustainability** through reforms that build political support for research especially from poorer groups, and provide cofinancing of research on commercial crop and livestock commodities.
- **Decentralized** research, especially adaptive research, to put scientists closer to users and enhance user participation in setting the research agenda.
- **Building capacity of producer organizations** to integrate user groups into research.

Promote inclusive participation by the poor: Participatory research is important to assess relevance of technologies, identify client needs, build capacity of individuals and local institutions, and encourage demand for services. Inclusion of women is particularly important because they play a major role in agricultural production. Participation by minorities, such as tribal and caste groups, is also important to overcome past bias and ensure equity for these groups. Involvement can occur at various levels, including governance, program planning, priority setting, research execution, and evaluation.

Promote uptake of research findings by the poor: Research programs need to pro-actively plan for promoting uptake of innovations, forming strategic alliances with private firms, NGOs, producer groups, and others to make findings available to the poor.

Implement monitoring and evaluation systems to measure impacts: Monitoring program impacts, outcomes, and outputs relevant to poverty reduction requires quantitative and qualitative indicators for research investments. Beneficiary assessments and participatory evaluations are important in obtaining input from the poor on program assessments.
How Does Research Link to Poverty Reduction?

The World Bank is the largest international financier of agricultural research in developing countries, with a portfolio of loans totaling about US$1 billion. It is also the largest donor to the Consultative Group on International Agricultural Research (CGIAR). The recently revamped Rural Strategy for the Bank, Reaching the Rural Poor, identifies agricultural science and technology as a priority for future support to rural and urban poverty. The Strategy also emphasizes that all lending operations must be more focused on the Bank's overarching objective of poverty reduction.

In this note, the linkages between agricultural research and poverty reduction are summarized. Strategies and program design options that can increase the effectiveness of the World Bank's lending program on poverty reduction are also identified.

Poverty is concentrated in rural areas and over one-half of the world's extreme poor work in agriculture (IFAD 2001). Empirical evidence indicates that agricultural growth is a priority for reducing poverty in many situations (Box 1). Investment in agricultural research is one of the major sources of agricultural growth, and hundreds of studies in developing countries have shown these investments to generate high payoffs, with returns averaging over 40 percent (Table 1).

Investment in agricultural research can also provide powerful direct and indirect impacts on rural and urban poverty. Agricultural research may directly benefit poor farmers who adopt improved technologies by increasing their incomes and/or reducing production and marketing risks (for example, by breeding for pest resistance). It may also improve management of natural resources on which the poor depend for many of their livelihood strategies.

Indirect effects may be even larger. Productivity growth through research results in reduced food prices—a benefit especially important to the poor in both rural and urban areas as they typically spend a high proportion of their income on food. Research can also increase the nutritional status of foods important to the poor. Employment, migration, and wage effects of
increased production and value-added processing are important to the poor, who often depend on agricultural wage labor. Agricultural growth also provides important multipliers to overall economic growth through demand for production inputs and increased purchasing power of producers. Finally, the development of human and social capital through demand-driven agricultural research systems is important to empowering the poor to improve their access not only to technology, but also to assets and markets.

For these reasons, poverty impacts of agricultural research investment are often high compared to other public investments. This is shown by recent IFPRI studies in India and China comparing the reduction in the number of poor people per unit of investment for different types of public investments (Box 2). In these studies, investment in agricultural research, infrastructure, and education provided the highest poverty reduction effects. Translated into US dollars, the cost of removing one person from poverty is about $180 in India and about $380 in China. These figures are quite comparable to an international study that estimated a cost of $179 per person removed from poverty for Asia (Thirtle, Lin and Piesse 2002). Since the rate of

Table 1: Estimated Rates of Return to Investment in Agricultural Research

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of estimates</th>
<th>Median rate of return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>188</td>
<td>34</td>
</tr>
<tr>
<td>Asia</td>
<td>222</td>
<td>50</td>
</tr>
<tr>
<td>Latin America</td>
<td>262</td>
<td>43</td>
</tr>
<tr>
<td>Middle East/North Africa</td>
<td>11</td>
<td>36</td>
</tr>
<tr>
<td>All developing countries</td>
<td>683</td>
<td>43</td>
</tr>
<tr>
<td>All developed countries</td>
<td>990</td>
<td>46</td>
</tr>
<tr>
<td>All</td>
<td>1,772</td>
<td>44</td>
</tr>
</tbody>
</table>

Source: Alston and others (2000).
Box 2: Impact of Past Agricultural Research on Poverty Reduction

Substantial evidence indicates that the poverty reduction impact of agricultural research investment is high compared to other public investments. In India agricultural research had the highest productivity impacts and the second highest poverty reduction effect after rural roads. One million Rupees spent on agricultural research reduces the number of poor by 90 persons. Likewise in China the impact of Yuan 100,000 on poverty reduction is higher than for all other investment except education (Fan, Zhang, and Zhang 2000; Fan, Hazell and Thorat, 1999).

The strength of the link between agricultural growth and poverty is, however, conditioned by agro-ecological conditions, level of technology use, access to assets, infrastructure, markets and institutions, and other factors. Therefore, for any specific situation, an analysis of the potential for research to contribute to poverty reduction must start with a review and assessment of the broader sectoral context for investment.
Key Issues for Research and Poverty Reduction

The potential for research investments to reduce poverty depends on many factors, including the structure of farm types and markets, the strategy adopted for public financing of agricultural research, and the strength and effectiveness of research institutions, especially their ability to reach the poor. In all cases, investment in research is only one instrument for poverty reduction, and must always be designed as part of a wider national strategy for poverty reduction.

**Broad-based growth strategies have sharply reduced poverty**

A key issue in financing research investments for poverty reduction is whether to invest for broad-based productivity growth that provides both direct and indirect benefits to the poor (for both producers and consumers) or to focus “pro-poor” investments directly on the livelihoods of the poor. Several decades of experience provide three major conclusions that justify broad-based research investments for poverty reduction in many circumstances:

- Except where farm size is strongly bimodal, small-scale farmers have usually adopted improved technologies with a short lag time relative to larger farmers
- Increasing agricultural productivity through yield-enhancing technology has enhanced rural employment and wages with direct benefits to the poorest households
- Indirect benefits of technical change for poor consumers (both rural and urban) have often been larger than the direct effects on producers, especially where rapid technical change lowers prices of food staples that constitute a large portion of the expenditures of poor households.1

---

1 Globally increased cereal yields—mainly due to technological innovation—contributed to a decline in real prices for cereals of 28-30 percent between 1982 and 1997 (Rosegrant and others 2001).
The broad-based approach can be the major strategy for research investments where: agriculture is important to the incomes of rural poor; the agro-ecological base allows significant potential for productivity growth; land distribution is relatively equitable; the poor consume non-tradeable food staples; and reasonably well-functioning markets exist for agricultural inputs and outputs. In such situations, productivity growth in the dominant small-scale farming sector will likely have large poverty reduction effects. In these situations, efforts to shift research resources from general productivity growth to other social objectives have often resulted in unacceptable productivity trade-offs, ultimately threatening interests of the poor.

Nonetheless, the preconditions for win-win productivity growth and poverty reduction (for example, unimodal agriculture, and reasonably well-functioning input and output markets) are often not present. Estimated elasticities of poverty reduction with respect to agricultural productivity increases in different regions are shown in Table 2. These are relatively high in Africa and Asia, where large numbers of poor people depend on agriculture. For example, an increase in yields of 1 percent in Africa reduces the number of poor people by 0.72 percent. Based on the estimated effect of research investments on yields, an investment of $179 in agricultural research would remove one person from poverty. The low elasticity for Latin America reflects both the low share of GNP from agriculture, as well as the bimodal agrarian structure in which commercial farms have received most of the gains in agricultural productivity. In Latin America, agricultural research may still have strong poverty reduction impacts, but must be carefully targeted on poor producers and consumers.

**Future strategies require poverty targets**

Recent developments suggest increased opportunities for focusing on pro-poor investments, even in areas that have previously benefited from broad-based approaches.

- Rural incomes are becoming more diversified, with a declining share of income from agriculture, especially from food staples
- Increasing private investment in research for more commercial agriculture should free public resources to focus on poorer farmers and marginal areas
- Liberalization of trade has integrated markets, reducing effects of productivity growth on domestic food prices and opening new opportunities for high-value crops in specific locations

<table>
<thead>
<tr>
<th>Region</th>
<th>Percent in poverty</th>
<th>Number in poverty (millions)</th>
<th>Elasticity of number of poor to yield changes</th>
<th>Research cost per person removed from poverty</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Asia</td>
<td>15</td>
<td>278</td>
<td>0.48</td>
<td>$179</td>
</tr>
<tr>
<td>South Asia</td>
<td>40</td>
<td>522</td>
<td>0.48</td>
<td>$179</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>46</td>
<td>291</td>
<td>0.72</td>
<td>$144</td>
</tr>
<tr>
<td>Latin America</td>
<td>16</td>
<td>78</td>
<td>0.10</td>
<td>$11,397</td>
</tr>
</tbody>
</table>

*Source: Thirtle, Lin and Piesse (2002).*
• Food producers are subject to competitive pressures that can squeeze many farmers—especially poor farmers—out of markets or further marginalize them, unless they develop new knowledge and skills.

• There is growing pressure to focus on less-favored regions and environments that have been bypassed by past research investments.

• Livelihood shocks, due to natural disasters, conflict and market risks, are becoming more common and increasing the vulnerability of the poor.

Analysis of the potential for research investments to contribute to poverty reduction must recognize this complexity and the possible tradeoffs between targeting general productivity growth versus direct poverty reduction. Specific strategies will depend largely on poverty diagnosis relating to livelihood strategies of the poor, their resource constraints, and market environments for agricultural products, but some targeting of pro-poor investment will likely be appropriate in most situations.

**Overcoming Institutional Weaknesses in Research Systems**

Although past investment in agricultural research has had important impacts on poverty, many research systems are constrained by institutional weaknesses that limit their efficiency, effectiveness, and sustainability. These problems are multiplied by growing funding constraints. Although most products of agricultural research continue to be public goods, public funding for agricultural research averages only 0.6 percent of agricultural GDP for developing countries, compared to 2.6 percent for industrial countries (Pardey and Beintema 2001).

Public research organizations in many countries have serious institutional weaknesses related to their incentives to attract quality scientists, lack of operating budgets, and lack of effective links with clients. The underlying problem in all of these constraints is inadequate national commitment to agricultural research and to addressing fiscal and governance problems of public research institutions. At the same time, the private sector has little incentive to fill the gap in research funding, especially in developing technologies for poor farmers. A first priority must be to address these institutional weaknesses to enhance the overall efficiency and effectiveness of research programs. Institutional innovations to improve research system performance regardless of type of user will likely provide large benefits to the poor as well (Byerlee 2000).

The development of a national constituency for research is critical to building effective and sustainable research programs. Providing a voice to the poor in the operation of those programs is also important to enhance responsiveness to issues of importance to them. Enhancing client influence over, and support for, public sector research underlies many current reforms (decentralization, participatory planning and implementation, user co-financing, better monitoring and evaluation, and client responsiveness). These reforms promote development of the “demand-side” of the market for research services and influence political processes at the national level that determine the level of financing for research and who gets the services financed. Investments must build a strong constituency for public sector research and a constituency that ensures that this public research addresses public goods issues and the needs of the poor.

Past research programs were often not designed with adequate understanding of the needs and constraints of users, and of the poor in particular and, even as research institutions become more user oriented and demand-driven, they may not necessarily address the needs of the poor. Priorities tend to be set by wealthier farmers who are more politically powerful, more accessible geographically, socially and linguistically, and more literate and cognizant of research potential. A positive development in recent years has been the growth in number of private, quasi-private, not-for-profit, and
community-based organizations that are stepping in to fill gaps in public sector provision of agricultural research services. Many of the new organizations are primarily or exclusively dedicated to working with poor rural communities that often had little voice under old institutional structures.

Key issues to consider when assessing opportunities for improving agricultural research systems include:

- Is sufficient attention given to a pluralistic mix of public, private and NGO organizations in funding and delivery of research services? Which types of farms are typically served by which institutions?
- Is the service cost-effective in terms of cost per beneficiary and impact? Are programs financially sustainable and able to retain high quality human resources? Will cost-recovery mechanisms to increase sustainability bias services against the poor?
- Are the poor able to participate and are they involved in meaningful ways in program governance and evaluation? How can human and social capital development be maximized to empower the poor in setting the research agenda?

**ADDRESSING DIVERSITY WITHIN THE SECTOR**

Diversity in farm types and farming systems shapes the potential impact of agricultural research programs on poverty reduction. Farms vary substantially in resources available and the production and marketing environments in which the farm operate (Figure 1) (Berdegué and Escobar 2001).²

Figure 1: Conceptual Delineation of Three Farming Worlds – Commercial (A), Small-Scale Market-Oriented (B), and Subsistence-Oriented (C)

² To be complete, this figure should include rural landless households that depend on agriculture for wage labor and employment. Often the poorest groups, they benefit directly from employment resulting from increases in farm productivity, as well as from lower food prices.
Agricultural innovation by commercial farmers (A) in favorable environments can lead to poverty reduction if it generates employment (for example, labor for production of high value commodities) and/or provides cheaper food, both of which have positive poverty alleviation effects. However, much of the research for this sector should be provided by the private sector.

Development of small-scale but market-oriented family farms (B) in areas with reasonable or good agricultural potential offers the greatest opportunity for direct poverty reduction through agricultural innovation. Agricultural research policies must seek to increase productivity broadly within this group and/or help these farmers diversify into production systems in which they have a competitive advantage.

For very poor farm households in unfavorable production environments (C), agricultural innovation can usually lead to sustainable progress in poverty reduction only as part of a broad-based effort to diversify livelihood strategies of those households. In some extremely harsh environments, there is little potential to improve agricultural productivity and investment in social and economic infrastructure to increase options, because off-farm employment and out-migration will usually provide higher payoffs than investment in research.

The direct and indirect poverty reduction impacts and strategies for each farm type are summarized in Table 3. The focus of agricultural research programs must depend on a diagnosis of the relative importance and dynamics of the

Table 3: Strategies for Enhancing Poverty Reduction Impacts of Agricultural Research by Farm Type

<table>
<thead>
<tr>
<th>Sector</th>
<th>Direct impacts</th>
<th>Indirect impacts</th>
<th>Major institutional actors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial farmers</td>
<td>Increase micronutrient content of food to provide nutritional benefits.</td>
<td>Promote labor-intensive, high-value industries (for example, cut flowers and horticulture). Increase productivity to reduce food prices for nontradable food staples.</td>
<td>Private agribusiness Public regulatory framework Producer and trade organizations</td>
</tr>
<tr>
<td>Small, market-oriented farmers</td>
<td>Diversify production to increase value-addition and high value crop/livestock production. Develop technologies to reduce production risks. Strengthen producer organizations to improve demand for research and build human and social capital.</td>
<td>Increase agricultural productivity to stimulate overall economic growth. Develop labor-intensive production systems to generate employment. Increase productivity to reduce food prices for nontradable food staples.</td>
<td>Public research Public-private partnerships Producer organizations NGOs</td>
</tr>
<tr>
<td>Subsistence-oriented farmers</td>
<td>Increase productivity and reduce production risks for food for home consumption. Encourage market access for higher value crops/livestock. Improve natural resource management and develop environmental services markets.</td>
<td>Build human and social capital necessary to address a range of livelihood opportunities.</td>
<td>Public research Producer and community organizations NGOs</td>
</tr>
</tbody>
</table>
effects on each of these farm groups. In situations where small-scale family farms in moderate to high potential areas dominate the sector, these should be the focus of research programs. However, there are situations where the poor are concentrated in unfavorable production environments and—to the extent that these areas have potential to raise productivity—they must be the focus of research. In any event, the institutional actors with comparative advantage for implementing the needed research will vary in each case. The public sector usually has the mandate to conduct research relevant to the needs of the poor, and NGOs and community organizations can be important for the poorest groups (C).

A further issue, especially important to poor farm households, is that of risk and vulnerability. For these households, research efforts should seek to minimize risk and develop more diversified livelihood strategies.
3

Good Practice for Enhancing Poverty Reduction Impacts of Investments in Research Systems

Good practice in developing research programs for enhanced poverty reduction requires attention to strategy development, priority setting, institutional development, uptake of findings, and monitoring and evaluation.

Analyzing the structure and nature of poverty

The starting point in developing a strategy for enhancing the poverty reduction effects of agricultural research investment is the analysis of the different types of poverty (rural and urban), their determinants, the contexts in which they occur, and the livelihood response strategies adopted by the poor. Poverty assessment surveys and poverty reduction strategy programs (PRSPs) are good starting points for this analysis. The analyst should look for patterns of geographical concentration of poverty, areas where agriculture is especially important for the poor, and major causes of risk and vulnerability (for example, droughts, markets, disease epidemics). More information on poverty analyses and PRSPs is available on the World Bank PovertyNet website <http://www.worldbank.org/poverty/strategies/index.htm>.

Within agriculture, an analysis of commodities important to poor producers and consumers will guide priority setting. The analysis must focus on whether increased agricultural productivity is likely to contribute to poverty reduction and what innovations are
likely to be the most effective. Finally, a diagnosis of the institutional strengths and weaknesses of research systems should assess how effectively different institutions respond to demands of the poor (see Box 3 for a summary of some of the key issues for an assessment).

**Selecting a Broad Strategy**

The wide variation in country situations requires adapting research strategies to the country or local situation. Table 4 taken from Hazell and Haddad (2001) shows how quite different priorities and strategies emerge between and within countries depending on: (i) the income level of the country, (ii) market and trade policies, (iii) agro-climatic potential, (iv) rural infrastructure, service provision and market access, and (v) the labor situation. Although it is common wisdom that research for the poor must focus on marginal areas, this analysis shows that at least for low-income countries, research in high potential areas will often provide higher payoffs (Box 4).

Examples of common strategies include:

- Where small-scale farming dominates and rural poverty is pervasive, broad-based productivity investment strategies may maximize poverty reduction both directly through increased incomes of farmers and indirectly through food prices, employment generation, and wider growth linkages.
- Where most of the poor are net consumers of agricultural products, investment in agricultural research might be justified irrespective of the participation of the poor in production.
- Where the poor are concentrated in certain geographical regions or production systems, focused investment on particular commodities, regions, and technology traits and on empowering rural communities might be appropriate (see next section).
- Where the poor lack access to sufficient land and other assets, or the agricultural potential of those assets is very low, investments in agricultural research may have little direct effect on poverty reduction.

To tailor national research strategies to meet needs of the various farm types, while respond-

**Box 3: Assessing Agricultural Conditions and Research Systems**

Key points to consider:

- Location, type of poverty and of poor households—net food purchasers/sellers, labor users/sellers
- Role of agriculture in the livelihoods of the poor, and their main crop and livestock activities
- Farm types based on size and production systems, disaggregated by region, ethnicity, and gender
- Income by farm type and livelihood strategy and their variability.
- Status and trend in condition of natural resource base (water resources, pasture, land)
- Market and infrastructure base—transport costs and degree of integration with markets
- Research providers and types of producers served
- Linkages (effectiveness and efficiency) to research delivery systems and input markets.

Information sources:

- Household surveys, especially poverty assessments
- Rapid rural appraisals
- Participatory assessments of production systems and service delivery
- National statistics and research and extension reports
Table 4: Strategies for Agricultural Research to Reduce National Poverty

<table>
<thead>
<tr>
<th>Good infrastructure</th>
<th>Poor infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surplus labor</strong></td>
<td><strong>Scarce labor</strong></td>
</tr>
<tr>
<td>Low potential</td>
<td>High potential</td>
</tr>
<tr>
<td>Mid-income country</td>
<td></td>
</tr>
<tr>
<td>Markets liberalized</td>
<td></td>
</tr>
<tr>
<td>1,2,3,5</td>
<td>1,4,6</td>
</tr>
<tr>
<td>1,3,5,8</td>
<td>1,4,6,7</td>
</tr>
<tr>
<td>Markets not</td>
<td></td>
</tr>
<tr>
<td>liberalized</td>
<td></td>
</tr>
<tr>
<td>1,2,3,5</td>
<td>1,4,6</td>
</tr>
<tr>
<td>1,2,3,5,8</td>
<td>1,4,6,7,9</td>
</tr>
<tr>
<td>Low-income country</td>
<td></td>
</tr>
<tr>
<td>Markets liberalized</td>
<td></td>
</tr>
<tr>
<td>3,5</td>
<td>1,2,3,5,8</td>
</tr>
<tr>
<td>1,2,4,5,6,8</td>
<td>1,3,5,7,9</td>
</tr>
<tr>
<td>Markets not</td>
<td></td>
</tr>
<tr>
<td>liberalized</td>
<td></td>
</tr>
<tr>
<td>1,3,5,8,9</td>
<td>1,4,5,7,9</td>
</tr>
<tr>
<td>1,4,5,8,9</td>
<td>1,4,5,7,9</td>
</tr>
</tbody>
</table>

Priorities for agricultural research:
1 — Staple food production; 2 — High-value crops, trees and livestock; 3 — Employment intensive growth; 4 — Increased labor productivity; 5 — Smallholder farms; 6 — Medium and large farms; 7 — Low external-input farming; 8 — High external-input farming; 9 — Nutritional content of food staples.

Shaded areas are the high priority regions within the country group.


...ing to pressures of different political interest groups and attempting to meet the needs of poor producers and consumers is a major challenge. National strategies will have to be pragmatic, recognizing key issues but planning for investments within the constraints of available resources and information.

**SETTING SPECIFIC PRIORITIES FOR INVESTMENTS**

Pro-poor research investment faces difficulties in that benefits of research activities cannot directly target individual households or income levels, since research typically generates many spillovers and indirect effects (anticipated and unanticipated). However, resources can be allocated to specific priorities—by commodity, crop trait, and ecological zone—that are important to poor households (both producers and consumers). When based on good diagnostic work, pro-poor priority setting may improve allocation of public funds in many situations, by targeting research investments by (Byerlee 2000):

- **Geographic regions** with high rates of poverty, especially less-favored production areas (for example hills, rainfed areas, arid...
Box 4: Research Strategies: Marginal versus Favorable Areas

Many policymakers and donors call for more research on marginal areas as a way of reducing poverty and arresting resource degradation. This may be appropriate, but the situation is usually much more complex. While the poorest of the poor are often located in marginal areas, the number of people living in poverty is often higher in more favored areas (Kelly and Parthasarathy Rao 1995). In some of the most difficult areas, the rate of gain from improved technology may be very slow. Providing infrastructure, education and non-farm opportunities may bring earlier, greater, and more sustainable benefit (to both poverty reduction and conservation of natural resources) than is possible with agricultural intensification. This is especially true for areas with very high production risks and/or a fragile resource base. In addition, there are often substantial spillover benefits from productivity gains in favored areas through the operation of labor markets (that is, migration from marginal areas) and food markets (that is, lowered cost of food) (Renkow 2000; Otsuka and David 1993).

Nonetheless, there is some evidence from India suggesting that because of declining marginal returns for investments in irrigated areas—investments in technology for medium potential rainfed areas might now generate greater impacts on growth and poverty (Fan, Zhang and Zhang 2000). In fact, research resources in India have shifted sharply toward rainfed and more fragile environments over the past decade (Pal and Byerlee 2002). In other countries, there is a strong trend toward diversification of research demands due to increasing exploitation and trade in niche markets for produce from marginal areas, and emerging environmental concerns.

regions) provided there is demonstrated potential to achieve productivity gains. A high proportion of the poor in Vietnam, for example, live in upland and mountainous areas, and research investment focused on these areas offers opportunities for enhanced poverty impacts (there are currently almost no research institutes located in these areas or focused on their problems).

- **Commodities produced or consumed by the poor**, especially staple foods and nutrient-enhanced foods high in micronutrients. In Nigeria, for example, cassava with a higher yield and enhanced disease resistance was widely adopted, resulting in a substantial fall in real prices to consumers. Since cassava is the staple food of the poor in Nigeria, poor consumers captured a large share of the benefits (Box 5). Similarly, enhancing the nutritional value of products consumed by the poor can produce major benefits (Box 6).

- **Low external input production systems**, suited to farm households unable or unwilling to purchase production inputs. Poor farmers in upland areas of Mexico and Central America for example, have extensively adopted *Mucuna*, a leguminous cover crop that reduces their need to purchase nitrogenous fertilizer.

- **Diversification into high-value, labor-intensive crops and livestock** or upgrading of traditional niche products. Developing options for postharvest handling and processing can reduce postharvest losses and quality loss and can offer producers opportunities for value-added processing. Small farmers in Mexico, for example, successfully export organic coffee with the help of local and international NGOs.

- **Environmental and natural resource conservation** important to the poor (forests, pastures, fisheries). Beekeeping, for example, is often an important niche activity
Box 5: Distribution of Benefits of Cassava Research in Nigeria

Cassava is the most important food staple in Nigeria. The Nigerian Roots and Tubers Research Institute, in collaboration with IITA introduced improved cassava varieties in the 1980s that resulted in yield increases of about 30 percent on 50 percent of the cassava area. Afolami and Falusi (1999) estimated that consumers captured 72% of the benefits of this research through lower prices and that poorer consumers captured a disproportionate share of these benefits. And since poor farmers consume most of their produce, they gained relative to larger farmers.

![Percentage increase in household income graph]

<table>
<thead>
<tr>
<th>Income level ('000 Naira)</th>
<th>0</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-4</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-6</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-8</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>&gt; 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Box 6: Eradicating Childhood Blindness in Africa

Agricultural research is helping address the problem of vitamin A deficiency that threatens hundreds of thousands of African children with childhood blindness and contributes to infant mortality. Researchers have identified orange-fleshed sweet potato varieties that provide a year-round source of vitamin A, produce excellent harvests with little inputs, and are acceptable to consumers. This is particularly important in southern and eastern Africa where vitamin A-related diseases are widespread, and the traditionally grown sweet potatoes are white-fleshed varieties with little or no beta-carotene (a precursor of vitamin A). Participatory methods with largely female and poor farmers, who are the main producers and consumers of sweet potatoes, have shown that the orange-fleshed varieties are also acceptable to consumers. The new varieties have now been extensively adopted. Research has shown that even small amounts of the new sweet potato varieties in the diet can eliminate vitamin A deficiencies.


- Investments in more basic sciences, such as biotechnology, can also be pro-poor, especially if it reduces vulnerability to pests and climatic risks, substitutes for external inputs, and adds product traits (such as enhanced micronutrient content in foods important to the poor) (see Table 5 for examples).

Priority setting and the design of technologies relevant to poor farmers requires greatly increased capacity in the social sciences in all
Table 5: Crop Biotechnologies to Meet Needs of Poor Farmers and Consumers

<table>
<thead>
<tr>
<th>Technique</th>
<th>Biotechnological solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tissue culture—plant micro-propagation to produce healthy plants</td>
<td>This relatively low-cost technology has been adopted by poor farmers for bananas in China, taro in Samoa, multipurpose trees in Kenya, potato in Vietnam, and cassava in Colombia.</td>
</tr>
<tr>
<td>Anther culture (a subcategory of tissue culture) to reduce time needed for interspecific crosses</td>
<td>Crosses between Asian and African rice varieties resulted in new African rice varieties with higher yields and pest, weed, disease and climatic tolerance relative to traditional varieties. Poor farmers in upland rice areas of West Africa are now rapidly adopting these varieties.</td>
</tr>
<tr>
<td>Molecular markers to identify more precisely genes for specific characteristics, and thus speed conventional breeding</td>
<td>Molecular markers are being employed in many breeding programs, including breeding for sweet potato viruses (important to poor producers) and for quality protein maize (important to poor consumers).</td>
</tr>
<tr>
<td>Genetic engineering to insert genetic material into crop and livestock species</td>
<td>Some genetically modified products are being commercialized and widely adopted (Bt cotton for insect resistance in South Africa, Mexico, and China); others are under field testing (i.e., virus-resistant sweet potatoes and potatoes, Bt maize for insect resistance, and rice with late blight resistance). Many others under development offer traits of special significance to the poor (potatoes with higher protein, enhanced vitamin A rice, and rice with salinity tolerance).</td>
</tr>
</tbody>
</table>

research systems. Investment programs need to provide support for building such capacity both within research organizations and by contracting-in needed skills from universities.

STRENGTHENING THE INSTITUTIONAL BASE

In recognizing that the potential for targeting is highly case specific and not easily generalized, investment strategies must promote the development of research institutions that address the needs of the poor in a sustainable way. These often require participatory approaches that empower the poor at the local level to demand services. Specific institutional reforms might include (Table 6):

- Developing an institutionally pluralistic system that decentralizes or privatizes services, and strengthens client orientation and accountability. Universities, NGOs and producer organizations can often play a special role in meeting the demands of the poor for research services. In Nepal, for example, a local NGO along with farmers has undertaken an extensive participatory varietal testing program that resulted in a sharp increase in adoption of new varieties that were developed but not yet released by the public research system.
  - Promoting private sector research and freeing up and refocusing public resources for pro-poor programs, by reducing policy and regulatory barriers to private investment. For example, privatization of hybrid maize research should free resources for the public sector to produce open-pollinated varieties for poorer farmers and regions.
  - Emphasizing institutional reforms that employ contractual and competitive
### Table 6: Summary of Pro-Poor Institutional Approaches

<table>
<thead>
<tr>
<th>Investment principle</th>
<th>Objective</th>
<th>Pro-poor implementation</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus public programs on public goods</td>
<td>To ensure that government programs benefit the general public and do not crowd out private funding of research.</td>
<td>Give priority to poverty reduction and food security. Phase out public sector investment in private goods.</td>
<td>Privatization of research on appropriable technologies (for example, hybrid maize). Farmer controlled levies on commercial crops and reduced public funding.</td>
</tr>
<tr>
<td>Institutional pluralism</td>
<td>To encourage development of a range of public and private institutions with unique comparative advantages in provision of research.</td>
<td>Involve NGOs and producer organizations that tend to have a pro-poor orientation.</td>
<td>Competitive funding through producer associations (Colombia, Guinea).</td>
</tr>
<tr>
<td>Use of participatory approaches</td>
<td>To empower local communities, tap local knowledge and resources, and provide services that suit local conditions.</td>
<td>Mobilize the poor and develop their initiative and problem-solving ability. Work through, and strengthen, producer organizations and NGOs.</td>
<td>Local Agricultural Research Committees (CIALs) (Latin America).</td>
</tr>
<tr>
<td>Build culture, incentives and methodologies for pro-poor responsiveness and collaboration among agencies</td>
<td>To enhance responsiveness and effectiveness in dealing with pro-poor programs under conditions of increasing livelihood vulnerability.</td>
<td>Improve institutional arrangements for collaboration among research and extension actors and their clients within pro-poor programs.</td>
<td>National and regional innovation councils and regional technology fora.</td>
</tr>
<tr>
<td>Decentralization of operational authority and responsibilities</td>
<td>To increase user influence over programs by devolving responsibilities to the regional level.</td>
<td>Encourage regional governance mechanisms with stakeholder voice representing the poor.</td>
<td>Regional fora with strong participation of minority groups and women (Peru and Colombia).</td>
</tr>
<tr>
<td>Building human and social capital</td>
<td>To promote emergence of a new generation of institutions representing the rural poor.</td>
<td>Finance capacity development of producer organizations. Strengthen agricultural education and training programs.</td>
<td>Investment in capacity building of producer organizations and private service providers.</td>
</tr>
<tr>
<td>Cost sharing by major stakeholders</td>
<td>To enhance financial sustainability of research programs by sharing the burden of funding among central and local governments, the private commercial sector and farmers.</td>
<td>Recognize trade-offs between financial sustainability and participation of the poor. Use graduated payment schemes to require larger farmers to pay a greater percentage of program costs than poor farmers.</td>
<td>Decentralized research funds (Peru and Mexico).</td>
</tr>
</tbody>
</table>
mechanisms to improve efficiency, and promote pro-poor effectiveness. Many of these mechanisms can be directed toward poverty enhancement. For example, a competitive grants program in Colombia has awarded research and extension grants giving high weight to their likely benefits to poor farmers and landless laborers.

- **Promoting financial sustainability** through reforms that improve confidence in public institutions, and building political support for research especially from poorer groups. Cost recovery and cost sharing are important to financial sustainability, and even quite poor farmers have shown willingness to cofinance services that meet their demands (for example, cofinancing of research services by small-scale farmers in Peru). The tradeoff, however, between sustainable cofinancing and participation of the poor must be recognized, and the level of cofinancing needs to be adjusted to ability to pay.

- **Decentralizing research programs** to put scientists closer to users and enhance user participation in setting the research agenda. This is especially relevant for adaptive and location-specific research activities, as demonstrated by programs in Peru and Colombia that have established regional fora with strong representation of the poor. This brings all technology users and suppliers within a region together to agree on priorities for small-scale farmers. Decentralization may also build political support for research, as shown by the rallying of small farmers in Colombia to protest threatened closure of a research and extension project.

- **Promoting international strategic alliances and regional research collaboration**, because links to the outside world are important for all systems to access new knowledge, and enhance system efficiency through collaboration. Such linkages are especially important for the many small countries where domestic "market size" is insufficient to justify comprehensive research programs.

- **Building capacity of producer organizations** to integrate user groups into research and extension systems, to strengthen technical and managerial capacities, and to encourage inclusion of women and the poor. Farmers in Burkina Faso and Guinea, for example, have received support to organize and contract adaptive research according to their needs.

While all of these approaches may be relevant, depending on the specific situation, the general consensus from experiences in World Bank lending is that institutional reforms require long-term commitments over many years. They must also give greater attention to strengthening the demand for research through decentralization and building capacity of producer organizations and user groups, complemented by opportunities to express demands through competitive approaches to funding. Use of adjustable program lending, combined with decentralized capacity building, is showing promising results in terms of reducing poverty in a number of countries.

**Promoting inclusive participation**

Participatory research approaches are important tools to assess the relevance of technologies, to identify client needs, and to develop coordinated responses to those needs. They also help to build capacity of individuals and local institutions, and to encourage demand for services where there has been little in the past (Box 7).

Typically women play a major role in agricultural production, but have much less influence on technological innovation than do men. Poverty rates are significantly higher for women-headed households. Because of past neglect of women's needs, gender analysis is an
Box 7: Farmer-Run Research: Experience with the CIALs

Turning responsibility for on-farm testing over to farmers is an attractive alternative that has been extensively tested by Centro Internacional de Agrícola Tropical (CIAT) in several NARSs of Latin America. Under the CIAL program (CIAL-Spanish acronym for “Local Committee for Adaptive Research), begun in 1990, an institution with interest in technology dissemination (usually a state agency, NGO, or cooperative) facilitates a meeting in which a community analyzes potential needs for local technology testing. If the community is interested in undertaking local research, it selects a four-member Committee (the CIAL) from the community to coordinate the research work. Outside technical staff from the organizing institution assist in planning and analysis of research trials and a paraprofessional (a CIAL-experienced farmer) monitors and advises on the research. Technical staff visit 2-3 times per season after the first 2-3 seasons.

CIALs operate with a small CIAL Fund (US$500 per community) to cover the risks of crop failure or to subsidize the costs of trials. These CIAL funds have been consolidated into a corporation at the national level, but each CIAL manages its own fund. The funds, like the whole program, are “owned” by the community, and managed by the Committee.

Source: Ashby and others, 2000.

essential base for planning pro-poor research investments (Fong and Bhushan 1996).

Minorities such as tribal groups, religious minorities, caste groups and other disadvantaged groups, are also disproportionately represented among the poor and extreme poor. Frequently, they reside in the least favorable production environments in remote mountainous or arid regions. They often have limited resources and restricted social and economic contact with the wider society. For these reasons and because of language barriers, intentional neglect or discrimination, and distrust or outsiders, they are often difficult to reach with agricultural services.

Agricultural research programs can improve their relevance to these groups through the following types of initiatives:

- Allocating resources for work on crops, products, and production systems most relevant to these groups, and
- Promoting and working through traditional and other organizations of these groups.

LINKING TO INNOVATION UPTAKE PATHWAYS

Even where technologies are appropriate, poor farmers are often disadvantaged because they lack access to the findings from research programs. Larger, wealthier farmers have more channels for accessing information and inputs to increase productivity. Even the public extension services charged with serving small farmers are more likely to serve larger farmers as active clients. Public research programs must therefore develop pro-active strategies to make the results of research available to the poor by developing partnerships and alliances with a variety of intermediaries that can work with small farmers. Public extension services remain important, but private companies, NGOs, farmer organizations, and the media are equally
important in facilitating uptake of new technologies. The International Rice Research Institute (IRRI), for example, and the Bangladesh Rice Research Institute are collaborating with NGOs, extension agencies, seed companies, and farmer groups to test mechanisms for speeding the uptake of rice technologies. Experiences of the various partners are shared in an “Uptake Forum.” Private companies (some with large research budgets), the agro-food industry, and environmental groups are other potential partners for promoting pro-poor development and for financing research efforts.

**PUTTING IN PLACE AN M&E SYSTEM**

Good monitoring and evaluation (M&E) systems for research programs are needed to track implementation in terms of pro-poor orientation. Potential indicators for impact, outcome, and output relevant to research investments are given in Table 7 (Alex and Byerlee 2000), but more work is needed to develop quantitative and qualitative indicators to improve M&E of research impacts on poverty reduction. Evaluating investments solely on the basis of economic returns can bias investment decisions.

<table>
<thead>
<tr>
<th>Table 7: Examples of Indicators for Poverty Reduction in Agricultural Research Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Impact-Level Indicator:</td>
</tr>
<tr>
<td>• Distribution of economic benefits of research by income level of producers and consumers (using economic surplus methods)</td>
</tr>
<tr>
<td>• Sustainable and active community groups / civil society or farmer organizations</td>
</tr>
<tr>
<td>Measurement</td>
</tr>
<tr>
<td>Number</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcome Indicators:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Adoption rates for new practices or technologies, by sex and farm size</td>
</tr>
<tr>
<td>• Farmer attitudes toward research</td>
</tr>
<tr>
<td>• Change in productivity (cost/unit) as a result of new technology or practices, by sex and farm size</td>
</tr>
<tr>
<td>• Change in yield variability due to new technologies</td>
</tr>
<tr>
<td>• Share of funds managed and co-financed by producer organizations/community groups</td>
</tr>
<tr>
<td>• Extent of on-farm participatory research</td>
</tr>
<tr>
<td>Measurement</td>
</tr>
<tr>
<td>Percent positive responses</td>
</tr>
<tr>
<td>Percent change from base</td>
</tr>
<tr>
<td>Percent change from base</td>
</tr>
<tr>
<td>Percent of scientist time and research budget</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Output Indicators:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Change in research resource allocation to poor regions and commodities of importance to the poor</td>
</tr>
<tr>
<td>• Changes in orientation of research (i.e., to multidisciplinary, multi-institutional)</td>
</tr>
<tr>
<td>• New technologies released with specific applicability to poor regions or farmers</td>
</tr>
<tr>
<td>• Number of projects executed by producer organizations or NGOs with a pro-poor orientation</td>
</tr>
<tr>
<td>• Number of projects executed that have an orientation toward women and minority groups</td>
</tr>
<tr>
<td>Measurement</td>
</tr>
<tr>
<td>Percent of total cost</td>
</tr>
<tr>
<td>Number</td>
</tr>
<tr>
<td>Number</td>
</tr>
</tbody>
</table>
toward commercial crops and high potential areas. Evaluations on the basis of cost per beneficiary or cost per household removed from poverty are more appropriate to assessing poverty reduction investments, but are more difficult to estimate.

Many research benefits to the poor are difficult to quantify in economic terms (greater food self-sufficiency, environmental sustainability, risk reduction, greater social capital). Even economic impacts are difficult to measure because of the variability between small farms and the range of livelihood strategies small farm households pursue. For these reasons, beneficiary assessments and participatory evaluations by the poor are valuable tools for assessing research impacts on poverty (See Box 8).

**Box 8: Beneficiary Assessment**

Beneficiary assessment is used to gather information on users’ views of programs and services. Beneficiary assessment is primarily a management tool to assist managers in improving quality and relevance of services. Conversational interviews and group discussions elicit information from services, users, providers, and stakeholders to identify program strengths and weaknesses. Beneficiary assessments have most commonly been used for extension programs, where they have been useful in understanding weaknesses and strengths of the programs and have led to important changes in policy for service delivery. EMBRAPA, the national research organization in Brazil, conducts an annual survey to provide feedback from users.

*Source: Salmen (2000)*
References


Fan, S., L. Zhang, and X. Zhang. 2000. Growth and Poverty in Rural China: The Role of Public Invest-
Designing Investments in Agricultural Research for Enhanced Poverty Impacts


Titles in the Agriculture & Rural Development Working Paper Series

Number 1—Investing in Science for Agriculture & Rural Development in the 21st Century
Number 2—No-till Farming for Sustainable Rural Development
Number 3—A Road Map from Conventional to No-till Farming
Number 4—Europe & Central Asia—Food and Agriculture in the Slovak Republic: The Challenges of EU Accession
Number 5—Integrated Pest Management in Development: Review of Trends and Implementation Strategies

\[\textsuperscript{\textcopyright}\] The first three titles were not numbered at the time of printing, but they do represent the first products in this series.