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Impacts of Agricultural Research on Poverty: Findings of an Integrated Economic and Social Analysis

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ABSTRACT

The extent to which agricultural research has reduced poverty has become an increasing concern of policymakers, donors, and researchers. Until recently, poverty reduction was a secondary goal of agricultural research. The primary focus was on increasing food supplies and reducing food prices, a strategy that was successful in increasing the yields of important food staples. When increased productivity is combined with increased agricultural employment, lower food prices, and increased off-farm employment, agricultural research can be credited with significant reductions in rural poverty. However, these benefits do not necessarily materialize, and thus it is essential to understand how agricultural technologies influence and are influenced by the diverse livelihood strategies, vulnerability context, relations of gender and power, and other conditions of the poor.

This paper reports findings of a CGIAR research project including seven case studies of different types of agricultural research: aggregate investments in agricultural research in China and India; rice, vegetable, and fishpond technologies in Bangladesh; soil fertility replenishment in Kenya; hybrid maize in Zimbabwe, and creolized maize in Mexico. The case studies found adoption was influenced by the technologies' likelihood to increase or decrease vulnerability, whether the poor have the assets needed to adopt, the nature of disseminating institutions, and cultural factors such as gender roles and taste preferences. Dissemination processes have become increasingly diversified and have a significant impact on who is reached with the technology and how well they are able to take advantage of it. A wide variety of direct impacts on adopting households were identified, including those related to increased production, income, knowledge, changes in power relationships (favoring men or women; richer or poorer farmers), and increased or decreased vulnerability. Poor people often benefit from these technologies, especially if these technologies are designed to build on assets that they have, though the studies also showed that impacts on the poor were sometimes limited by asset requirements for adoption or dissemination practices. Indirect effects were also important. Poor people were helped by declining food prices, though benefits to poor farmers were dampened by falling output prices. Increased stability and even marginal improvements in agricultural production were valued by poor households for providing food security and a launching pad into other activities. Increased agricultural employment was also a major benefit, improving incomes and stability of employment.

This paper identifies lessons that for future impact assessments. These included the identification of factors that should be understand at an early stage, such as the priority poor people put on managing risk; the types of social differentia-tion (gender; class; ethnicity, etc.) that will affect the uptake and impacts of technologies; the variety of traits that farmers value; and the role of agriculture in livelihood strategies. With regard to methodology, the case studies underscore the need to consider direct and indirect impacts and to avoid restricting analysis to only impacts that can be easily quantified. Mixing disciplines and research methods are essential to conducting impact assessments. Finally, the study concludes that for impact assessment to make a difference, researchers must conduct research and impact assessment in a way that facilitates institutional learning and change.

Keywords: poverty, agricultural research, sustainable livelihoods, vulnerability, agricultural extension, Bangladesh, China, India, Mexico, Kenya, Zimbabwe,

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1. INTRODUCTION

The extent to which agricultural research has reduced poverty has become an increasing concern of policymakers, donors, and researchers. Until recently, poverty reduction was a secondary goal of agricultural research. The primary focus was on increasing food supplies and reducing food prices, a strategy that was successful in substantially increasing the yields of important food staples. When increased productivity is combined with increased agricultural employment, lower food prices, and increased off-farm employment, agricultural research can be credited with significant reductions in rural poverty. This has been the case particularly in Asia and Latin America, where the vast majority of the developing world population and the world's poor live.[3] However, the paths of causality are complex and highly contingent. The benefits do not necessarily materialize for poor people, and some effects can be negative. Two major reviews of the literature conclude that whether technology benefits poor people depends not on the characteristics of

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[1] This paper synthesizes the results of seven case studies managed by IFPRI, and led by the respective CGIAR centers identified in Table 1. The full results of these case studies are reported in Bellon et al. 2003; Bourdillon et al. 2002; Fan 2002; Fan, et al. 2002a; Fan et al. 2002b; Fan and Hazell 2001; Hallman et al. 2003; Hossain et al. 2003; Place et al. 2003. The authors thank Anthony Bebbington, Jere Behrman, and Robert Chambers for their contributions as members of the study's independent advisory committee, and for their valuable comments on an earlier draft of this paper. The lead authors, Meinzen-Dick and Adato, are listed in reverse alphabetical order.

[2] Ruth Meinzen-Dick is a Senior Research Fellow,Michelle Adato, a Research Fellow and Lawrence Haddad and Peter Hazell are Division Directors at the International Food Policy Research Institute in Washington, DC.

[3] Hazell and Haddad 2001; Lipton and Longhurst 1989; Walker and Ryan 1990; Hazell and Ramasamy 1991; David and Otsuka, 1994; Kerr and Kolavalli, 1999; Pinstrup-Andersen and Hazell, 1985; Tribe, 1994; Rosegrant and Hazell, 1999.

technology per se, but also on underlying socioeconomic conditions (Kerr and Kolavalli 1999; Hazell and Haddad 2001).

Despite the contributions of agricultural research, poverty still "abounds even in countries that have national surpluses" (Hazell and Haddad 2001). For many developing countries, simply growing more food is no longer a pressing national objective. Food security—at the national level—has been achieved through some combination of production and trade. According to Pinstrup-Anderson and Javier (2001), "the challenge of agricultural research now lies in developing strategies that more explicitly address the needs of the poor."

Agricultural research has generally assumed a particular causal pathway from research to improved production to reduced poverty. The fact is, however, that there are various effects on various types of poverty that are generated by various ways of producing food. In the past, researchers focused on increasing food staples in irrigated and high potential areas where they saw productivity returns would be highest. But production increases in high potential areas do not necessarily benefit poor farmers. This is because many of the poor live in areas that lack infrastructure to take advantage of improved technologies. It is also because many of the poor—even if resident in high potential areas—lack the control of land, water, labor, credit, or other critical assets necessary to take advantage of improved technologies.

The context within which agricultural research is undertaken is changing rapidly. Under market liberalization, where markets function as intended, improvements in agricultural productivity in any one country will not generate large indirect impacts on poverty through food price reductions. In addition, in many countries, agriculture has shrunk significantly in its economic importance relative to other sectors, and both the poor and

nonpoor are diversifying their income sources so that farm income and agricultural wage earnings often account for minority shares of total household income (Tacoli 2002). Thus the direct effects of agricultural production on employment and poverty may not be as significant as they once were, though they often generate related activities such as providing inputs, processing outputs, or maintenance of capital goods.

Some types of agricultural research are becoming more privatized with the advent of biotechnology and stronger assertion of intellectual property rights over genetic resources. But research on many crops and livestock that poor people in developing countries grow and eat is not attractive to the private sector. Nor is most research on natural resource management practices to improve productivity on small farms and in less-favored regions. Finally, the social and political context of farming is changing in many countries, with increasing expectations of local people and the international community that governance be more responsive to local needs and local participation in decision-making.

Donors and developing country governments spend $8 billion per year on agricultural research in developing countries ($300 million of this is spent by the CGIAR system). The changing context means that publicly funded agricultural research must pay more attention than ever to poverty reduction. Research should assess the different impacts on poverty generated by different methods of producing a given amount of food. It should seek ways to improve agricultural productivity in areas where the largest numbers of poor people live, of products that large numbers of poor consume, and in areas where indirect price effects on poverty will be the largest. Agricultural researchers must be cognizant of how agriculture fits into livelihood and income strategies of socially differentiated groups of poor people. Finally, there must be attention to the effects of agricultural research on important dimensions of

welfare—including vulnerability, power, and access to institutions—that cannot easily be measured using standard indicators.

Paying more attention to poverty reduction means strengthening the ability to recognize and measure it. This requires combining strong evaluation designs that generate good data, integrated research methods and economic and social analysis, and sufficient capacity to undertake the assessments. Finally, there should be an interest in learning from and applying the results of such assessments elsewhere.

To respond to these needs, CGIAR's Standing Panel on Impact Assessment (SPIA) commissioned the International Food Policy Research Institute (IFPRI) to develop and coordinate a CGIAR-wide project on poverty assessment. The first phase of the research synthesized the literature on the linkages between agricultural research and poverty. This review (Kerr and Kolavalli 1999) concludes that the Green Revolution enabled vast increases in crop yields and output, but that early modern varieties had a narrow genetic base and their performance was highly dependent on irrigation, chemical fertilizers, pesticides, and herbicides. They note that more recently there has been considerable success in developing cultivars with more broad-based genetic composition whose yields are less sensitive to irrigation and other inputs.

More specifically, Kerr and Kolavalli had several central findings:

- Total cereal production has increased three-fold and agricultural employment has grown by 60 percent since 1961. However, population gains have partially offset these increases.
- Whether poor farmers benefit from these developments depends on underlying socioeconomic conditions. Enabling conditions include an equitable distribution of land and income, secure ownership and tenancy rights, efficient input and output markets that serve all farmers, research and extension systems that are geared toward small and large farms, and scale-neutral technologies.
- Agroecological conditions also affect the distribution of benefits.

- Improved varieties have raised employment, though less so recently than in the 1960s. Furthermore, changes in wages are difficult to track because of other factors that influence wages: nonagricultural-sector wages, economic policies, and increased numbers of jobseekers and migrants.

- Growth in agricultural productivity can stimulate growth in the nonfarm rural sector, which can contribute to poverty reduction. However, poverty reduction through growth takes considerable time and depends on the presence of many other conditions unrelated to agriculture.

Kerr and Kolavalli also identified several areas in which impact assessments are weak. First is in measuring the indirect effects of a technology and of numerous confounding factors. This problem is greatest with regard to measuring the distribution of income across different types of farms or between farm and labor income. This is the topic upon which much of the literature on the negative distributional consequences focuses. Other research argues that, despite greater food availability at lower prices, if increased production and lower food prices come at the cost of lower wages and income for poor farmers, this serves to keep poor people poor. Finally, it is difficult to compare studies, as they use different methods, ask different questions, and define problems differently. Kerr and Kolavalli call for a set of coordinated studies using a common methodology, both quantitative and qualitative.

To address the shortcomings identified in the existing studies, a second phase of the SPIA/IFPRI project initiated new empirical case studies of the impact of agricultural research on poverty. The five studies share a common set of questions, conceptual framework, and methods. The two principal objectives of this phase of the project were to increase the impact of agricultural research on poverty reduction and contribute to an improved understanding within CGIAR and its partners of the relationship between agricultural research and poverty reduction. Within these were three subobjectives (IFPRI 2000):

1. Refine and test best-practice methods for quantitatively assessing the impact of agricultural research on the poor.

2. Develop and test appropriate methods of social and economic analysis within a sustainable livelihoods (SL) framework. The aim is to examine the context in which new technologies are released and adopted and to better understand how agricultural research affects broader definitions of poverty and social outcomes.

3. Strengthen the capacity of CGIAR centers and national agricultural research centers (NARs) to undertake integrated economic and social poverty impact assessments and to internalize a poverty impact assessment culture for the future. This will lay the groundwork for a potential system-wide initiative on poverty impact assessment that will live beyond the life of the current project.

Section 2 of this paper describes the seven case studies undertaken to assess the impact of different agricultural technologies on poverty by several CGIAR centers in diverse regions of the world. Section 3 explains the conceptual framework used to analyze poverty impact—including issues of causality, meanings of poverty, and livelihoods. Section 4 describes the multiple research methods used in each case study. Section 5 synthesizes the empirical results of the case studies, including findings on adoption, dissemination, and poverty impacts. Section 6 summarizes key findings and draws conclusions about how to study impact and the importance of institutional learning and change (ILAC) to take advantage of the insights gained in these studies.

2. ASSESSING THE IMPACT OF AGRICULTURAL RESEARCH ON POVERTY: THE SEVEN CASE STUDIES

Seven pilot case studies were selected to develop new approaches for assessing poverty impacts at different scales and to tease out the linkages between agricultural research and poverty. There were several selection criteria. Taken together the case studies aimed to:

- provide significant representation of important types of recent CGIAR research and of geographic areas
- demonstrate the different channels through which agricultural research can affect the poor, including intrahousehold effects, on-farm production effects, labor market effects, indirect growth, and nonfarm and food price effects
- improve understanding of the conditioning economic and social factors that determine whether agricultural research benefits the poor, and provide guidelines on appropriate policies that may be needed to complement technological change to enhance favorable impacts on the poor
- use rigorous methodologies, particularly with respect to establishing causality via proper counterfactuals while controlling for important confounding factors
- utilize a range of data and methodological approaches that are sensitive to a broad perspective regarding the livelihoods of the poor

Because of time and budget constraints, priority was given to case studies for which CGIAR centers could build on ongoing or recently completed empirical work. Typically, this meant looking for strong extant datasets collected for other research purposes that could be adapted and expanded for this project. The seven case studies are found in Table 1.

Table 1--Case studies of impact of agricultural research

Country	Technology	Case study leader	Lead CGIAR center
Bangladesh	Modern rice varieties	Mahabub Hossain	International Rice Research Institute (IRRI)
Bangladesh	Polyculture fishponds Improved vegetables	Kelly Hallman	International Food Policy Research Institute (IFPRI)
Kenya	Soil fertility management	Frank Place	World Agroforestry Centre (ICRAF)
Zimbabwe	Modern maize varieties	John Hoddinott	International Food Policy Research Institute (IFPRI)
Mexico	Creolized maize varieties	Mauricio Bellon	Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT)
India	Agricultural research, productivity growth, and poverty reduction	Shenggen Fan	International Food Policy Research Institute (IFPRI)
China	Agricultural research, productivity growth, and poverty reduction	Shenggen Fan	International Food Policy Research Institute (IFPRI)

The self-selection of the case studies by the participating centers created the possibility that the most promising projects were put forward for analysis. We cannot fully control for this possibility. However, for several reasons we are fairly confident about the selection. First, none of the projects was designed with poverty reduction as an explicit goal. Second, all but one project involved some degree of completed or ongoing research that could not be easily altered to enhance their poverty reduction impact. Third, some of the studies dealt with broader research aggregates than individual technologies, making it difficult to anticipate the size and direction of the net impacts on poverty (e.g., IFPRI's India and China studies). Finally, each research team was composed of CGIAR and non-CGIAR researchers, which helped to assure independence in reporting results. As the results report both positive and negative findings, it seems likely that model projects were not necessarily put forward and that balance was achieved in the conduct and reporting of the research.

We recognize that seven case studies cannot be representative of agricultural research, nor cover even the major variations that are likely to affect the impact of agricultural research on poverty. The case studies should be seen as examples for developing impact assessment methods—methods that are increasingly being adopted by other CGIAR centers.[4] Still, the findings of these case studies do point to some important impacts and patterns, which we synthesize in this paper.

Five of the seven case studies use household- and community-level data within an integrated social and economic analysis—structured around the SL framework—while two employ econometric analysis of secondary data at district or higher levels of aggregation.

[4] For example, an ongoing study of the dissemination and impact of improved banana varieties in Uganda and Tanzania, led by the International Plant Genetic Resources Institute's (IPGRI) International Network for the Improvement of Banana and Plantain is using the livelihoods approach along with integrated quantitative and qualitative data collection (see Lusty and Smale 2003).

The former provide more detail on the mechanisms by which agricultural research affects the poor, particularly in terms of the direct effects, whereas the latter better quantify the magnitude of impacts on poverty, particularly indirect impacts. A brief description of each case follows.

MODERN RICE VARIETIES IN BANGLADESH

This study assesses the impact on poverty of the technological changes in rice cultivation made by IRRI and its national partners in Bangladesh. Rice is the most important crop in Bangladesh, being grown over almost 75 percent of the cultivated area. High population densities, small farm sizes, and frequent floods and cyclones have contributed to serious widespread poverty and vulnerability in rural Bangladesh. Modern varieties (MVs) with higher yield potential were first introduced over 20 years ago, and 47 varieties have since been released for different agroecological conditions. The varieties were developed and released following a top-down breeding process with little farmer involvement. Formal dissemination relied on government extension services, but farmer-to-farmer dissemination has played a major role in the rapid expansion of MVs over the last 15 years. MVs now cover two-thirds of the rice area.

Because of the importance of rice and the increases in both yield and the labor requirements of MVs, agricultural research has had both direct effects on adopting farmers and indirect effects on employment and prices. This case study analyzes direct on-farm benefits, indirect effects through employment and rice prices, and positive or negative impacts of mediating institutions such as the markets for land, labor, water, and credit. Nationwide panel data existed for 1987, 1990, and 1995 that were supplemented in 2000 with a resurvey and qualitative data collection on institutional change (Hossain et al. 2003).

IMPROVED VEGETABLE AND FISHPOND MANAGEMENT IN BANGLADESH

This case study assesses the poverty impact of two different technologies that were disseminated by NGOs in Bangladesh: new vegetable varieties (supported by AVRDC and BARI) and polyculture fishpond production (supported by ICLARM with Fisheries Research Institute and Mymensingh Aquaculture Extension Project). In the vegetable program, the NGO provided the technology with credit and training to groups of poor women for two years before the start of the panel study in 1996. The NGO promoting one of the fishpond programs organized groups of landless women to lease fishponds, beginning in 1993. The other fishpond program is a governmental project that began in 1988. The project focuses on those with private fishponds and hence has worked more with men from households with more assets. These differences allow for the examination of the impact of different technologies and dissemination processes on men and women from households with different bundles of assets. Gender aspects are particularly important in the highly patriarchal context of Bangladesh. The case-study supplemented a rich multiround survey dataset with further qualitative data to examine different dissemination pathways (especially through NGOs and women's groups), vulnerability to natural and other disasters, and a wide range of poverty reduction outcomes, including empowerment of women.

AGROFORESTRY-BASED SOIL FERTILITY REPLENISHMENT INTERVENTIONS IN WESTERN KENYA

This study assesses the impacts of low-cost agroforestry-based soil fertility replenishment (SRF) systems on the livelihoods of poor farmers in western Kenya. The improved fallow system involves the broadcasting of tree or shrub seed into an existing maize stand, using species that produce important amounts of nitrogen and other nutrients and reduce weeds. The biomass transfer system involves the harvesting of a common shrub

that farmers harvest from roadsides or plant on their farms, applying the leaves at planting time and later as mulch. The study collected new data to examine how SFR technology affects farmers' assets, why different groups of farmers adopt (or adopt differently), and what were the effects on a range of livelihood outcomes. The study also compared diverse technology dissemination methods being promoted by government and NGOs to evaluate their effectiveness in reaching the poor, and the effects of participation in dissemination on human and social capital formation.

HIGH-YIELDING VARIETY (HYV) MAIZE IN RESETTLEMENT AREAS OF ZIMBABWE

This case study examines patterns of diffusion and impact of two generations of HYV maize in selected resettlement areas of rural Zimbabwe. Unlike the other case studies that assess mainly public sector and CGIAR involvement in research and dissemination, this study involved a major private sector player, Seed Co, which initially worked in cooperation with the government. The first generation hybrids, released in the early 1980s, provided dramatic increases in yield and were widely adopted by smallholders. Second generation hybrids released in the 1990s were developed to resist diseases important to commercial farmers. These were not as widely adopted by smallholders. Impact is assessed in terms of selected livelihood outcomes, including incomes, vulnerability, assets, and nutrition. The study built upon a unique household survey dataset that provides detailed information for the same households in 1982–83, 1987, and annually from 1992 to 2000. This allowed an examination of the dynamics of poverty, the nature of vulnerability, and the responses to drought in terms of diversification of livelihoods and investment in various assets. A key characteristic of the study is that it was conducted on resettlement areas during a period of

political turmoil. Because all settlers were given a similar allotment of land, initial differences in assets among respondents are not as great as in other cases, though economic differentiation did occur.

CREOLIZATION OF TUXPEÑO-DERIVED MAIZE MATERIAL IN MEXICO

This study documents how farmers in lowland tropical Mexico cross maize varieties from CIMMYT with local landraces to create "creolized" varieties. This adaptive research enables farmers, particularly poor ones, to better meet their needs by combining the preferred characteristics of improved varieties and landraces. The widespread use of creolized varieties is important for assessing the impact of the improved varieties, because impact studies that only examine the direct adoption of improved varieties will underestimate their impact. This study collected new data to reveal patterns of diffusion and adaptation, assess poverty impacts, and increase understanding of how improved, creolized, and local varieties respond to the needs and livelihood strategies of different groups of farmers. The study also examined local seed distribution systems to understand how the institutional context within which technology is developed, disseminated, and demanded affects adoption. The aim of the study is to understand and narrow the gap between what farmers want and what breeders offer.

AGRICULTURAL RESEARCH, PRODUCTIVITY GROWTH, AND POVERTY REDUCTION IN INDIA AND CHINA

These two studies use subnational secondary data for recent decades to measure the impact of public investments in agricultural research and development (R&D) on agricultural productivity growth and poverty in India and China. Econometric models are estimated that track the different channels through which agricultural R&D affects rural and urban poverty.

The studies also trace the parentage of some key crop varieties to calculate in approximate terms the contribution of CGIAR's own research to productivity growth and poverty reduction. The studies mask a huge variety of individual technologies, but together they capture their direct and indirect impacts on poverty at a huge scale that includes over 2 billion people and a significant share of total agricultural output in the developing world.

3. CONCEPTUAL FRAMEWORK

Our approach to assessing the impact of agricultural technology on poverty has been driven by the following key concerns that

- causal links can be established between the technology and its impact on poverty
- poverty outcomes are assessed in a multidimensional manner to more fully capture the net impact of the technology
- there is an appreciation of the need to explore diverse causal pathways among research, food production, and poverty, the contexts within which the poverty impacts of technology are generated, the need to understand how technology fits into people's livelihoods strategies, and the tradeoffs that adoption entails

ESTABLISHING CAUSAL LINKS

One of the weaknesses identified in previous research on the impact of agricultural research lay in establishing the counterfactual: what would have happened without the research (Kerr and Kolavalli 1999). Even without formal agricultural research, the agricultural sector is not static: farmers themselves innovate and changes in other sectors can affect agricultural productivity. Care has been taken in these cases to distinguish what can be attributed to agricultural research as opposed to other factors. The China and India case studies use analysis of cross-sectional and time-series data to econometrically distinguish between the influence of agricultural research and other factors. Three of the micro-oriented

case studies use panel survey data to estimate poverty differences between adopting and nonadopting households (controlling for other factors) attributable to new technologies over time. In addition, all of the five micro-oriented case studies draw upon assessments by different types of rural people (rich, poor, men, women) of the effects the technologies have had. While the identification of causal relations is still subject to qualification, the use of statistical methodology and multiple approaches permits more confidence about the nature of causal effects than in much previous literature, in part because of the explicit exploration of the robustness of estimates to different assumptions and approaches.

SEEING POVERTY AS MULTIDIMENSIONAL

To date, the vast majority of poverty impact assessments of agricultural technology have relied on quantitative economic approaches (see Pingali 2001; Kerr and Kolavalli 1999). The advantages of quantitative measures of poverty are fully utilized in the India and China case studies, which rely on econometric methods and official time-series data on the number of poor falling below established income thresholds at the state level. These studies are able to track changes in poverty over several decades, for rural and urban people separately in different states. They are also able to attribute changes in poverty to underlying driver variables, including agricultural research. The analysis in these case studies captures a full range of direct and indirect economic pathways through which agricultural research can affect the poor and the rural poor, from agricultural productivity growth and changes in rural wages and employment, to labor markets and on-farm productivity.

There are, however, important limitations to approaches that rely solely on quantitative economic approaches. Recent work on participatory appraisal (Chambers 1994, 1997), sustainable livelihoods (Ashley and Carney 1999), and chronic poverty (Hulme 2003)

highlights the many dimensions of poverty—some of which are not amenable to the quantification or abstraction from social processes that typifies most economic analyses. People's inability to influence decisions that affect their future, vulnerability to natural disasters and economic trends, and physical safety and dignity are dimensions of poverty that are perpetuated by a lack of connections, assets, information, and time. These conditions are in turn often rooted in social processes that exclude certain types of individuals from such sources of power. Techniques from other social sciences such as sociology are useful in analyzing these aspects of poverty.

Five of the SPIA case studies take this broader view of poverty—both in terms of outcomes and the processes generating those outcomes—and combine external standards of poverty with aspects identified by informants in the studies. Poverty is viewed in these five case studies as dynamic, with an emphasis on vulnerability—the threats to livelihoods from shocks or trends that people face or fear, and with which they may be unable to cope, thus throwing them into, or deeper into, poverty. Furthermore, in addition to poverty headcount and severity (depth of poverty) measures, attention is given to social differentiation among the poor by class, ethnicity, gender, and other locally specific differences. Where panel data was used, poverty duration and dynamics (movement in and out of poverty) are also considered. Until now this broader conception of poverty has been largely absent in CGIAR's impact assessment work.

UNDERSTANDING THE LIVELIHOOD CONTEXT WITHIN WHICH AGRICULTURAL TECHNOLOGY AFFECTS POVERTY

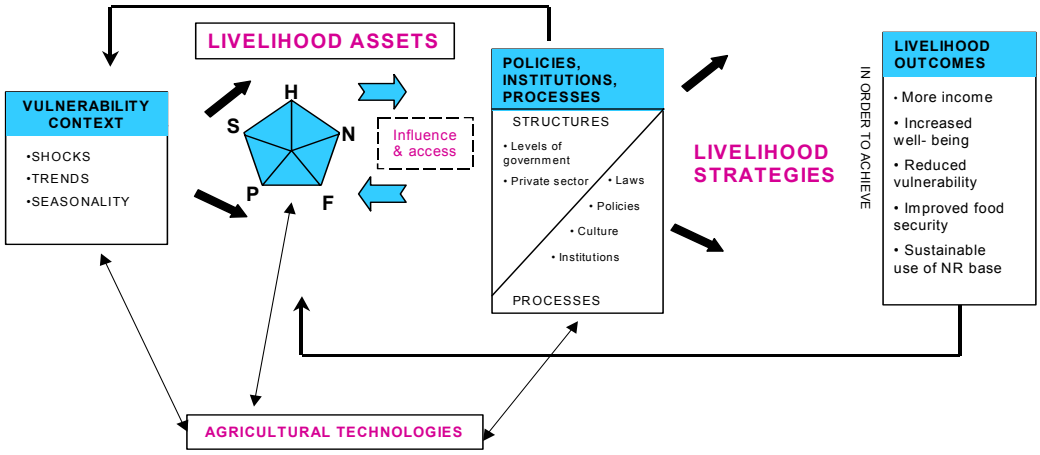
To conduct this study, a common conceptual framework pointing to cross-cutting themes was needed to obtain comparable results across the cases. The sustainable livelihoods

framework was able to take into account the multiple dimensions of poverty and the diverse causal pathways among agricultural research, dissemination, production, and poverty.[5] Livelihood approaches recognize that for poor people, survival and prosperity depend on the pursuit of diverse and multiple activities simultaneously by different family members, taking advantage of different opportunities and resources at different times. The SL framework is a tool for analyzing the causes of poverty, identifying people's access to resources and their diverse livelihood strategies, and linking relevant factors at micro, intermediate, and macro levels. For a longer discussion of the strengths and weaknesses of the SL framework in the context of this study, see Adato and Meinzen-Dick (2003).

Figure 1 shows the potential interactions between the SL framework and agricultural technologies. The starting point is the vulnerability context. This encompasses trends (e.g., natural resources and economic indicators), shocks (e.g., health and natural disasters), and seasonality (e.g., in yields, prices, and employment). Both external and internally perceived assessments of vulnerability influence people's behavior, including decisions whether to adopt new agricultural technologies. The SL framework also emphasizes the role of assets: natural capital (e.g., water, land, and forests), physical capital (e.g., roads and water reticulation); financial capital (e.g., credit, insurance, and savings), human capital (e.g., farming knowledge, education, and labor power), social capital (e.g., neighbors and local farmer organizations), and political capital (e.g., enfranchisement and relationships with local agriculture and environment authorities).

[5] The SL framework was recommended by a major donor to the study, the U.K. Department for International Development (DfID), which was promoting is framework at the time and which wanted to test the usefulness of the framework in the context of agricultural research.

Figure 1--The SL conceptual framework: Potential interactions with agricultural technologies



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Source: Adapted from DfID 2001.

The SL framework then points to formal and informal institutions that influence access to assets, livelihood strategies, and vulnerability (policies, institutions, and processes). It considers multiple levels and actors. Livelihood outcomes, which may be positive or negative, range from changes in assets and vulnerability to changes in dignity and power. The framework is dynamic, recognizing change that is due to external factors and that which is a result of people's actions.

Agricultural research and technology development can be seen within this framework in a number of ways:

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

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

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

Many conventional economic approaches to the impact of agricultural research can be "mapped" into the SL framework. The constraints to adoption literature has been particularly important in assessing whether the poor are able to benefit directly from new technologies. Many of the key factors that have been identified as potential constraints to adoption relate to vulnerability; the "asset pentagon"; or policies, institutions, and processes—main categories in the SL framework. For example, in reviewing the constraints-to-adoption literature, Knox Mcculloch et al. (1998) classify the main types of constraints in terms of environmental and price risk (related to vulnerability), infrastructure and market access (physical capital), wealth and credit (financial capital), information and labor (human capital), irrigation and property rights (natural capital), collective action (social capital), and price policy and culture (policies, institutions, and processes). Empirical case studies in this project have examined such potential constraints to adoption through quantitative and qualitative analysis. The extent to which these factors have influenced the ability of poor farmers to benefit from the technology are reported in the individual case studies and are synthesized later in this paper.

Use of the SL framework adds complexity to a study, but it implies a willingness to acknowledge that livelihoods—and the processes that make interventions effective or not—

are complex. However, for researchers in a number of disciplines, the framework will still be too simple in that it does not include a way of thinking about a number of important concepts that influence why people make certain choices or why they may or may not benefit from an intervention. One such concept is culture, including values, beliefs, tradition, language, identity, notions of status, and even preferences for taste and texture. Another is power relationships, e.g. gender, class, and ethnicity may permeate all aspects of livelihoods represented in the framework, but the framework does not provide any explicit way of understanding them. History and experience are other areas that do emerge within the framework. Aside from historical macro-political factors that might influence the relationships between technology and poverty, the micro experience of current or past generations of farmers can profoundly affect how people respond to new or repeated opportunities, and the trust or suspicion with which they view outsiders or other farmers (Adato and Meinzen-Dick 2003). The case study findings in section 5 of this paper provide examples of the significance of culture, power, and history in mediating the impact of agricultural research and dissemination approaches. Even some concepts that are taken as given by proponents of SL analysis, such as gender or other types of social differentiation, are not explicit in the framework, nor does it give one a means of analyzing these concepts. These factors must be evaluated by other means.

4. METHODS OF DATA COLLECTION

The five micro-oriented studies were designed as integrated economic and social analyses, drawing on the perspectives and methodologies of economists, sociologists, and anthropologists from CGIAR centers and universities in the United Kingdom, the Netherlands, and the case study countries. Using mixed-method research enabled the triangulation of data and increased analytical power as each data source helped with interpretation of the other. Full details of the data collection and analysis methods are available in the case study reports. In summary, however, the case studies included the following data collection methods:

- *Household and community surveys*: All case studies included household surveys, some had community survey data, and all except the Mexico study had some panel data to measure change over time. The Bangladesh, Zimbabwe, and Mexico studies collected data at the household member level, allowing for comparisons between men and women. Although some qualitative data are included, researchers mostly used econometric techniques to analyze the data.

- *Secondary data*: These provided the basis for sampling frames, a cross-check on the information from the study with other regions or nationally representative samples, and a background on the study regions.

- *Focus groups:* All five studies used focus groups, albeit to different extents and in different ways. Some used them as the primary source of qualitative data collection on the full range of research questions (the two Bangladesh cases and the dissemination study in the Kenya case), and used other qualitative methods as supplements. Other studies used focus groups to cross-check data, follow up on themes identified through the household-level case studies, or obtain additional types of data facilitated by group interactions. Many used participatory exercises such as seasonality mapping or vulnerability ranking. Separate groups were convened for men and women and, wherever possible, data were disaggregated by approximate poverty status, matching members to sample survey households (which permits knowing the sample properties for the qualitative data).

- *Household-level case studies:* The primary qualitative data collection method in the Zimbabwe, Kenya, and Mexico studies was household-level case studies. Fieldworkers lived in sample villages for three to six months, selecting approximately 10 case-study households per village, using available survey data to disaggregate households by poverty levels and other social categories of interest (e.g., female-

headed households, "older" and "younger" households) so that they could be placed in the context of the broader community (Zimbabwe and Kenya) and qualitative data to disaggregate where prior survey data was not available (Mexico). The household case studies involved repeated visits to households, conducting formal and informal interviews, observing and participating in daily activities such as farming, extension field days, and social interactions and activities.

- *Key informant interviews*: The case studies all used in-depth interviews with individuals who had specialized knowledge about some aspect of the agricultural technologies or poverty in the study areas. These included researchers from CGIAR and national centers, NGOs, community organizations, governmental project staff, extension agents, local seed distributors and shops, agricultural researchers from the private sector, community elders, chiefs, and early adopting farm households.

Wherever possible, qualitative data was linked to quantitative data. For example, the Bangladesh fish and vegetable case used the survey to select focus group members who met specific poverty categories, and then filled in other members of the focus groups with men or women from similar households. The Zimbabwe and Kenya studies used the existing survey data to inform the selection of household case studies, identifying households by adoption patterns (e.g., early, later, never) and by socioeconomic and demographic characteristics. As a result, the qualitative data are less vulnerable to the oft-raised concern regarding "representativeness."

5. THE IMPACTS OF TECHNOLOGY ON POVERTY: RESULTS OF THE CASE STUDIES

This section of the paper examines the rate, pattern, and determinants of adoption, the ways in which dissemination modes affect adoption, and the impacts of technology adoption on poverty. The impact of agricultural technology on poverty will be affected by the rate and pattern of the adoption of that technology. If an agricultural technology is not adopted, it is unlikely to have an effect. But the pattern of adoption (who adopts it, when, and for what) is

also likely to affect the distribution of benefits and costs. Therefore the case studies explicitly investigated the rate and pattern of adoption of the new technologies. Early on, it became clear from the qualitative work that the rate and pattern of adoption is affected by who is doing the dissemination and how it is implemented. The impacts of the technology are direct (for those who adopt) and indirect (for those who adopt and for some of those who do not). Some benefits and costs are quantifiable and others are not. Expected benefits and costs, in turn, affect the likelihood of adoption, thus completing the circle (though complicating the identification of causality).

THE RATE, PATTERN, AND DETERMINANTS OF TECHNOLOGY ADOPTION[6]

Farmers experience directly the effects of agricultural research when they adopt the resulting technologies. It is thus important to examine facilitating factors and barriers to adoption to see how the benefits are distributed between better-off and worse-off households, and between men and women within households. This helps identify factors that might include or exclude various groups from direct benefits. Three main factors were cited as affecting adoption: (a) whether the technologies were anticipated by potential adopters to increase or decrease farmer vulnerability, (b) whether the farmers had the requisite assets to make technology adoption worthwhile, and (c) the nature of mediating institutions, including the extent to which they represented the interests of poor people and people's attitudes toward the institutions. Permeating all three areas are relationships of gender, class, and power that can help explain how people are positioned with respect to vulnerability, assets, and institutions, and whether they benefit from the technologies.

[6] The term *technologies* describes the output of agricultural research, but broadly defined to include not only physical technologies, but also germplasm and management practices.

Vulnerability: One of the most striking characteristics of poor people's lives is not just their low income, but also their vulnerability[7] to many hazards, including loss of income, health, and even basic safety (Quisumbing and Hoddinott 2003a; 2003b; Skoufias 2003). Several case studies found that concerns about vulnerability—and whether agricultural research will increase or decrease it—were significant determinants of adoption. In assessing constraints and outcomes, the case studies examined both self-subjective and external, 'objective' assessments of vulnerability as potential factors affecting adoption. Subjective assessments of risk affect directly behavior and adoption decisions because they incorporate what potential adopters understand about what outsiders might consider more objective assessments.

Some of the new technologies in the case studies increased vulnerability in some respect. This was particularly true of polyculture fishponds in Bangladesh, in which owners reported losing their season's investment due to many different factors, including diseases of the fish and even poisoning of the pond by others. In Mexico, new maize varieties are a source of uncertainty in terms of how they will perform under the farmer's particular conditions. Many farmers do not adopt until they have seen a variety growing on fields nearby. In both Mexico and Zimbabwe, dependence on the market to get improved seed each year is another source of vulnerability for people who may not always have the cash necessary to buy seed or cannot count on traders having good quality seed. This favors open-pollinated varieties (OPVs), which can be replanted without a significant reduction in yield, over hybrids that must be purchased every season. Poor seed quality from the distributing NGO was also a constraint to vegetable production in Bangladesh. Zimbabwean farmers' perceptions of their vulnerability to witchcraft—or their fear of being accused of using

[7] Defined as an inability or high cost of managing the negative consequences of exposure to hazards.

witchcraft as a result of showing too much interest in their neighbors' field practices—provided a constraint diffusion of new technology through farmers learning from their neighbors. The institutional arrangements of group fishponds in Bangladesh introduced another source of vulnerability: production became susceptible to intragroup conflict. Worry about increased vulnerability in the context of diseases that reduce the labor available for farm activities was also cited as a factor restricting the adoption of labor-intensive technologies, especially in areas with high prevalence of HIV/AIDS.

Other technologies reduced vulnerability. Creolized maize varieties were seen as more resistant to local stresses. Agroforestry alternatives to chemical fertilizer reduced cash input requirements and farmers' concerns about "spoiling the soil." Modern rice varieties changed the seasonal pattern of rice production in Bangladesh, thereby reducing the length of the "hungry season" before the first major harvest of the year. Women in Bangladesh valued the vegetable program because it increased productive employment around the homestead, thereby reducing their vulnerability to harassment from going outside the homestead for employment.

The implication of this finding is that agricultural research must look beyond increasing average productivity if the goal is for the poor to adopt and benefit from the technologies. For example, stable yields may be more important than higher but more volatile yields. Agricultural research now pays considerable attention to adaptation of technology to biophysical sources of vulnerability (e.g., drought and pest resistance, rice varieties for deep water conditions in Bangladesh), but the institutional and social factors that increase vulnerability are not always considered. Dealing with these issues might require

technologies that reduce dependence on purchased inputs and are provided by strengthened supporting institutions, e.g., those that facilitate access to effective crop insurance.

Assets: Poor people generally have fewer assets than the nonpoor. This means that agricultural technologies that require a high level of assets to adopt are more likely to exclude the poor from direct benefits. All agricultural production requires some combination of assets, but those technologies that build upon the assets that the poor are likely to have are more likely to be adopted by the poor than those that require large "lumpy" investments.

Rice in Bangladesh presents a classic case of a technology that does not require large amounts of assets to adopt. Although land is needed to grow rice, MVs could be adopted on any size holding. However, MVs require more labor than traditional varieties (TVs). As a result, smaller farmers had a higher adoption rate than larger farmers, since they were likely to have relatively more access to more motivated (i.e., family) labor. Because MVs did not require long-term investment, even tenants could adopt. However, water control is usually required. This favored those at higher elevations, provided they had irrigation pumps (physical capital). Here the government's policy to liberalize imports of small pumps reduced the lumpiness of irrigation investments, and the expansion of water markets increased smallholder access to water control, enabling them to adopt MVs.

Comparing the outcomes of the vegetable and fishpond experiences in Bangladesh shows how the asset threshold requirements of a technology affect whether it is adopted primarily by the rich or by the poor. Improved vegetables were disseminated to poor women, who could grow them on their homestead land. Since even households with no agricultural land have some homestead land, very poor families could participate. In contrast, one of the fishpond programs focused on those with private fishponds, who tended to be nonpoor.

Moreover, homestead land is more under women's control. Farmland (including fishponds) is more likely to be under men's control. Hence the vegetable program reached women, whereas control of output of the private fishpond program went mostly to men. Given the gendered nature of poverty in Bangladesh, these differences in control over assets and technology are important.

The agroforestry program in Kenya and the group fishpond program in Bangladesh provided alternatives to large private land holdings for technology adoption. In Kenya, small farms might not have enough land to devote to trees for soil fertility replenishment, but biomass transfer allowed even those with little land to cut leaves from shrubs growing alongside roads and other public land to use on their fields. This, however, required considerable labor, which the poor did not always have. Group fishponds substitute social capital (a proxy for which is the strength and functioning of group membership) for ownership of natural capital (land), thereby allowing landless women to adopt the technology, provided the groups could be sustained. However, difficulties with the technology itself or the organizations disseminating the technology could cause groups to fall apart.

While natural capital assets like land and water are the most obvious factors affecting the decision to adopt technologies, other assets also play a major role. Financial capital is needed for any purchased inputs, which favors those with savings, credit, or remittances. Physical capital includes not only pumpsets, but also access to roads and other infrastructure, which affects access to markets and even to information. Social capital may also play a role, as in the group fishponds (e.g., the propensity for collective action), or groups for collective nurseries and technology dissemination in the Kenyan agroforestry case (e.g., the transfer of

information), or social networks for seed exchange (e.g., to reduce transaction costs and increase trust) in Mexico. Again, differences in control over assets within the household may make a difference. In Zimbabwe, men were more likely to adopt hybrids because they had more access to cash and markets, whereas women's social networks gave them an advantage in obtaining seed for OPVs.

Human capital includes both labor and knowledge. The poor are often assumed to be "labor surplus," but the case studies indicate that this is not always true. Lack of able-bodied adults was often cited as a reason that households were poor. Furthermore, poor households are often involved in multiple livelihood activities, thereby reducing their labor availability for intensive farming operations. While this may exclude extremely poor households from adopting new technologies, the quantitative analyses of the five micro case studies did not find labor scarcity to be a major reason for the poor not to adopt technologies.

Quantitative analyses often use schooling attainment as a proxy for the knowledge dimension of human capital. By combining this with qualitative analysis, the micro-oriented case studies showed where the level of formal schooling was an inadequate measure of the knowledge needed to adopt and how formal education might indeed play a role. In Kenya, schooling attainment did not have a significant effect because disseminating institutions made efforts to explain the technology in the simplest possible terms. The Zimbabwe study revealed generational differences in the way youth and their parents obtained information about new technologies: the older generation relied on direct observation and practical experience, while the youth relied on advertisements, contact with extension agents, and more "theoretical" learning.

Attention to the assets needed to adopt particular technologies can help agricultural research provide direct benefits to the poor. Even within the household, considerable differences in control over assets, between men and women, and younger and older generations, can affect who adopts and benefits from the technologies. The micro-oriented case studies indicate that aspects of the technology itself or the accompanying policies and institutions that lower the amount of land, education, or cash required to adopt the technology, or allow substitution of one asset for another (e.g., collective action or labor for land), can help the poor to adopt the technologies.

Mediating institutions: The SL framework highlights the role that policies, institutions, and processes play in shaping how people gain access to various assets and use them to create livelihood strategies. The relevant institutions here involve a combination of governmental policies, governmental and nongovernmental systems for agricultural extension, cultural norms, power relations, gender roles, land tenure, markets for inputs and outputs, and labor relations. Although this synthesis cannot capture the diversity of effects discussed in the individual case studies, we highlight some key factors.

It is not only agricultural policies that influence the adoption and impact of agricultural research. In Bangladesh, liberalization of imports led to increased availability of small pumpsets, which was key to widespread adoption of MVs. A range of political processes in Zimbabwe has mediated the impacts of agricultural technology in several ways, and in turn technology was politicized. Postindependence resettlement projects provided people with land that, together with technology packages, facilitated adoption. However, the eventual decline in governmental investment in agriculture, first in maize breeding and then in Agritex extension, and the increasing role of the private sector, directed the priorities for

agricultural research and extension toward the needs of larger-scale, nonpoor producers. A shift in Agritex priorities toward cash-croppers, and the volatile political climate of recent years has lead to a mistrustful atmosphere, where some farmers in one of the study areas viewed the phasing out of the older, 'more reliable' varieties and replacing them with the newer varieties as a conspiracy between Agritex and the private sector to discredit the government.

Power relations relevant to adoption play out between farmers and outsiders, within communities, and even within households. Traders who supply seed, private sector breeders, and government or other extension agents can have considerable power over smallholders, pushing the adoption of, or restricting access to, particular technologies (e.g., Seed Co withdrawing favored hybrid varieties in Zimbabwe so that farmers felt forced to adopt new varieties). Intracommunity power relations in Kenyan villages were reproduced among farmer groups organized for agroforestry promotion. In both the Zimbabwean maize and Bangladesh fish/vegetable cases, men were dominant in the households, but women could strengthen their standing if they had control over some aspects of production via NGO efforts.

Culture also mediates people's experience of agriculture to make new technologies more attractive or constrain people's ability to take advantage of them. Staple foods are often laden with cultural meaning and values (e.g., maize in Mexico and rice in Bangladesh). Notions of an ideal "good farmer" in Kenya reflect and drive people's aspirations and perceptions of what they should strive for, even if myriad constraints confound their achievements. The belief in witchcraft in Zimbabwe, and more specifically the fear of being accused of witchcraft, affected sharing of information on maize performance among farmers.

Restrictions on women's mobility in Bangladesh affect their ability to move freely outside of the home, where most technology use and dissemination takes place. In Mexico, participation in religious festivals is important for social status and drives poor farmers to harvest their maize early and sell the grain before the price reaches its maximum. This would imply advantages to more diversity in terms of maize varieties that can be harvested at different times.

While specific cultural norms are not generalizable from one context to another, the importance of considering how agricultural research and technologies interact with culture at different levels to affect adoption or outcomes certainly is. Cultures change over time, often even in response to technical changes and the uptake of technologies. Who adopts the new technologies (whether women or men, elites or lower classes) is also affected by culture.

TECHNOLOGY DISSEMINATION PATHWAYS

Dissemination pathways—how people learn about or obtain a technology—play a fundamental role in affecting who learns about new technologies and who adopts. The different case studies examined very different dissemination methods. Methods have diversified away from sole reliance on extension that uses government agents to visit individual farmers. Though these methods still exist (and were still popular with farmers in Kenya), dissemination now involves mass media (e.g., radio in Zimbabwe) and a wide array of methods in which farmers are trained collectively, and where farmers train each other. In Zimbabwe and Kenya these include farmer field days, demonstration units, seminars, meetings, chief's "barazas," and training for youth in schools. Because of the emphasis of the government, NGOs and ICRAF in western Kenya on innovation in dissemination methods,

they include farmer exchanges, and the formation or use of farmers', women's, and church organizations for dissemination. In Bangladesh, dissemination of fishponds and vegetables mainly occurred through training and credit offered by government and NGOs. "Model farmers" and/or "adaptive research farmers" (often better-off farmers) who serve as examples to others and adapt new technologies to local conditions, were important in Bangladesh rice, Zimbabwe, and Kenya. In Mexico dissemination was mainly limited to governmental distribution of seed and provision of advice, with some participation of the private sector. In all five cases, informal methods of exchange and learning among farmers played a large role in dissemination (with the exception of one region of Zimbabwe).

Collectively, the findings reinforce the notion that there is no one best method for dissemination. Rather, a diversity of methods is preferred by farmers, and indeed is needed to reach different types of farmers. This points to the importance of conducting sufficient research ex ante on potential dissemination options—and on the local culture and power relations they are embedded in—before determining the most appropriate means of dissemination.

In addition the findings: (a) highlight the importance of trust in facilitating or hindering effective dissemination, (b) illustrate the extensive use of formal local organizations—NGOs, user groups, and community based-organizations in general in sharing and screening information, (c) demonstrate the widespread use of informal social networks for sharing of experiences, and (d) confirm the potential of farmer participation in the technology development process as a way of enhancing dissemination.

Trust: In both Bangladesh cases and in Mexico, the case studies found a low level of confidence in public agencies and public officials in general, including those responsible for

dissemination of agricultural technologies. In the two Bangladesh case studies, governmental extension agents are seen as uninterested and not reaching the poor, especially poor women: "the government officers are just there for their own interests. They sit in their offices but they don't come to us" (Hallman et al. 2003).

In Zimbabwe, trust in the government was high during dissemination of the first generation of maize in the early 1980s, because the government was dedicated to providing an enabling environment for small-scale commercial production and devoted resources accordingly. However, in the later period, a number of factors combined to lower farmers' assessments of the government. First, government is seen to have narrowed its concerns to better-off farmers. Second, in one region Agritex officers are seen to have only impractical "book" knowledge of maize cultivation (though younger farmers tended to trust the knowledge of these officers more than did older farmers, who trusted their own experience more). Third, political instability more recently has created more distrust in general. When women were not given resettlement land in their own right they have always been excluded from Zimbabwean government dissemination channels, with men operating in the public sphere, attending dissemination activities, and otherwise taking responsibility for commercial maize production. Women expressed preference for OPVs, where they obtain seed and sell maize through their informal networks, and which do not require obtaining loans for fertilizer, since women do not have access to these credit markets. Government did not provide extension for OPVs, and in fact it was unlawful to plant these for many years.[8]

[8] The particularly volatile political climate of recent years has undoubtedly further complicated relationships between the government and farmers, but determining the relation between these developments and improved maize was beyond the scope of this study. It also would have been difficult for fieldworkers to explore this issue directly. Even without this line of questioning, they were forced to leave the field a month early because of rumors related to their political objectives that threatened their safety.

In Mexico governmental extension services are widely criticized for arriving late or not at all. “There is no faith in the government now, because they don’t come through with what they promise, because sometimes…they come to promise us and the support comes so late that nothing can be done” (Bellon et al. 2003). In addition, government seed is seen to be of bad quality and not worth paying for, and the distribution of seed and agricultural support has been politicized, i.e., a reward for political support. These findings underscore the point that history is an important factor to examine in understanding adoption and impact. People are influenced by what came before—e.g., in Mexico bad experience with government seeds, and in Zimbabwe, loan defaults where the purchase of fertilizer was followed by drought.

Even where new technologies or systems have resolved earlier problems, people are often not willing to take another chance. Because history and experience are not readily brought out through the SL framework, it is important to use the framework in conjunction with other modes of analysis, or introduce additional useful concepts as needed (Adato and Meinzen-Dick 2003). If government remains a major source of dissemination of agricultural technologies, then the generalized lack of trust in government found across the case studies is problematic. Only in Kenya was distrust of government not a significant issue, where the Ministry of Agriculture and Rural Development (MoARD)—heavily involved in the dissemination of soil fertility replenishment technologies—was rated highly by many farmers. This may be because MoARD has developed innovations in dissemination, involving networks of catchment committees. In Kenya, successful efforts were made by government (and NGOs and ICRAF) to disseminate to women. This is important because where there are intrahousehold differences in control over resources, who has access to technologies matters for individual welfare outcomes.

NGOs had a better reputation than government among farmers who had experience with them. This is mainly the case in Bangladesh, where NGOs play a large role in dissemination. Poor groups in both Bangladesh cases reported being reached by NGOs. However, in the vegetable and fishpond case some farmers said the very poor were excluded due to insufficient resources, and that lack of social connections and education discouraged the participation of very poor people in such organizations. It is clear that access to assets and power enable nonpoor farmers to join and influence organizations. Still, in both cases NGOs were not viewed entirely favorably; rather, their performance was highly variable in terms of competence, integrity and operating style. They were seen to be particularly unfair with regard to giving credit, by disbursing more easily to favored people. They were also said by some very poor women to treat people unequally: "they only give seeds and loans to people with whom they have a good relationship" (Hallman et al. 2003). In the vegetable and fishpond study, participation in NGOs was limited by having small children at home and by small household size, i.e., participating in organizations takes time. Nevertheless, the women who did participate were the major beneficiaries of these programs. Membership in NGOs was found to increase women's confidence due to the solidarity of the group, the new status and freedom of movement, and heightened political consciousness. However, when a fishpond did fail due to inadequate NGO supervision, it was felt to be very disempowering for participating women. This means that for an NGO to help the poor requires attention not only the technologies, but also to organizational issues, including the operation of the NGO itself and the farmer groups with which it works.

The other study where NGOs featured heavily was in Kenya, where groups organized by NGOs and other institutions were said to have provided new social solidarity and

confidence among some participants. The Kenya Woodfuel Agroforestry Programme, run by an NGO, got the highest review among disseminating organizations. However, NGOs in Kenya were also criticized for providing insufficient support and leaving too early. The timing of a disseminating institution's decision to exit should be carefully assessed, as this was a widespread local concern: "what limits full implementation is that [farmers] are usually left before [they are] standing on their feet" (Place et al. 2003).

The private sector is also involved in dissemination, mainly in Zimbabwe and Mexico where they are involved in maize seed distribution. In all cases where the private sector featured, they were said to be concerned with the needs of larger, commercial or "successful" farmers, and less concerned with the needs of poor farmers. In Zimbabwe, the private sector played a large role in dissemination of the second generation of maize in the 1990s, focusing on maize traits of most concern to commercial farmers rather than the preferences of poor farmers. In Mexico, the private sector does not feature strongly, except that it is seen to provide better quality seed than the government, though less affordable to the poor. The small farmers interviewed in the Mexico case study suspected the motives of the companies, and this affected whether farmers accept advice from this sector: "They tell us that the hybrids will not produce from one year to the next. But I think that this is a lie because the seed companies are making money" (Bellon et al. 2003). Banking is another private sector that is viewed unfavorably by poor farmers, requiring collateral that they do not have and blocking their access to other credit by holding farmers' farming certificates due to outstanding loans or defaults.

CGIAR centers and NARs were rarely identified by farmers as disseminators. As indicated above, farmers identify governmental extension services, NGOs, and the private

sector as the disseminating organizations with which they have experience. The one exception was in Kenya, where ICRAF is widely recognized and evaluated highly in the wide pilot dissemination area. The only criticism from farmers was for the system of adaptive research farmers. ICRAF was seen as giving too much attention to these farmers and it left one village too soon.

Finally, it is important to note that choices of varieties are often made from among what is available, whether or not the sources are trusted or the varieties desirable. In Mexico and Zimbabwe, farmers explained that they often take what they can get. According to a Zimbabwean farmer, "we adopted the new seed varieties because our trusted variety R201 is no longer available. If it comes back from wherever it is we will go back and grow it" (Bourdillon et al. 2002).

Local Organizations: One innovation in dissemination methods involves the use of local organizations or groups. These are intended to increase the efficiency of dissemination through reaching multiple farmers, building capacity through training groups to train others, and empowering farmers through engaging them in collective endeavors (particularly for women who might not otherwise have this access). The two technologies where group-based methods were widely used were the fishponds in Bangladesh and soil fertility replenishment in Kenya. In both cases, groups met some of the above objectives with respect to efficiency, capacity, and empowerment in various ways. For example, in the Bangladesh fishpond study, one NGO disseminated fish technology to households with sufficient resources to own private fishponds, while another was able to reach the poor by facilitating the formation of groups of landless or land-poor households that could collectively rent a pond.

However, working with groups also proved complicated and problematic, as local power relationships and other social dynamics tend to be reproduced in organizations. For example, in one area of Bangladesh, only one-quarter of the group members received training, other groups misappropriated funds (in part due to insufficient supervision by the NGO), others never functioned well as a unit. Other problems raised in Bangladesh were the perceptions that groups unfairly favored some people, that many people cannot join a group because groups or ponds are not available, or people are reluctant to join. Women in particular may be reluctant to join or to leave the home for group activities. On the other hand, when they did join, women explained several ways in which they felt empowered.

The Kenya dissemination methods went the furthest in terms of innovation, in the concentration of different institutions on different methods, and in the use of local organizations. For this reason, more attention is given in this section to the Kenya case as an illustration of the benefits and drawbacks of these dissemination innovations. All the villages studied in the qualitative research on dissemination in Kenya used different forms of local groups. These groups were intended not only to disseminate technology, but also to strengthen human and social capital such that farmers can sustain the dissemination process inside the village and ultimately expand it to others. In practice, Kenya groups received mixed assessments, with problems similar to those encountered in Bangladesh.

In Kenya, groups were seen as a relatively important source of information. In one case, poor women said that “committee members participated very much in organizing and mobilizing farmers” (Place et al. 2003). However, women also experienced many problems such as a low level of participation in groups, either because of self-exclusion, exclusion by group members, or the failure to conduct dissemination with other farmers as envisioned. In

general women were more positive in their evaluation of groups than were men, particularly about women's groups. Poor and nonpoor women alike said that domination by men in the mixed groups reduces women's participation and learning, suggesting the importance of having separate groups for men and women. In one village, some women's, church, and welfare groups were also agriculture groups that contributed food to funerals. This joining of group functions can support social capital and address people's priorities, especially in the context of widespread AIDS. Existing groups that incorporate dissemination tend to be more active and sustainable than new groups formed solely for this purpose.

Groups in the Kenya case had mixed impacts on social capital. Some groups said that the extension activities had brought their community closer together, e.g., "discussing and exchanging information about the various technologies," where they "now work mostly as a team" (Place et al. 2003). However, local groups also introduced or exacerbated social tensions and politics. One or more of the following issues were reported in all except one village: failure to reach farmers outside of the group, uneven distribution of resources, domination of groups by farmers of greater wealth or social status, conflicts over resources, rivalry among leadership, mismanagement of funds, the ability of some to amass wealth through the process, and domination by elites. However, poor farmers did acquire some power through the process. In one village, for example, poor men said that farmers made demands on the committee and the committee in turn made demands for extension services on the government. The lesson to be derived from these mixed experiences is that group-based methods, like other development efforts that involve community participation, may have payoffs that make them worth pursuing, but they require careful attention to achieve effective and equitable outcomes. There is a growing literature on conditions for collective

action, which can be applied to identify where group-based approaches are likely to be effective (e.g., where agriculture is important to livelihoods, group sizes are manageable, there is a history of cooperation, and social divisions are not too great).[9] Similarly, research on gender and participation highlights the importance of both formal and informal rules and incentives for ensuring women's effective participation.[10] These may be as simple as allowing both male and female household heads to be members or choosing a time and place to meet that is convenient for women; or more complex, involving increasing women's confidence to participate or running meetings in such a way that women feel free to speak out.

Informal social networks: Despite the importance of institutions of government, NGOs, the private sector, agricultural research institutes, and local organizations, the most consistently important dissemination institution across the case studies were informal social networks. In Zimbabwe and Mexico for example, farmers extensively use informal networks to get the maize seeds they preferred. Women in particular used networks to obtain OPVs that many prefer but cannot acquire officially. In Mexico and in the Bangladesh rice study, most seeds come from farmers' own harvests or exchanges with neighbors. In Mexico, farmers trust these seeds far more than those from the government, because they trust these informal relationships, and because they are able to see a new maize variety perform in the field before taking the risk of planting it. As one farmer explained:

> What happens is that sometimes the maize is unknown and you don't trust to buy it. Rather, you go with your people because you see that the crop grows well and the ears are pretty. So you ask if they have some stored and you buy a bit for planting. With the seed from the stores, there is no confidence…. You have to see it

[9] See Baland and Platteau 1996; Ostrom 1990; Place et al. 2002.
[10] See Agarwal 2001; Guijt and Shah 1998; Meinzen-Dick and Zwarteveen 2001.

> growing in the fields of your neighbors who have grown that variety. If not, you don't buy it. (Bellon et al. 2003)

As with trust in formal institutions, trust among farmers is important for informal methods of dissemination to function well. In Kenya, conversation and observation of others' fields is a key source of dissemination. However, this method cannot always be assumed to work. In one region of Zimbabwe, people deny learning by observing the fields of neighbors, because showing too much interest in your neighbors' fields can provoke accusations of witchcraft. Similar fears limit people's willingness to discuss yields and crop income with others. In this region, information from neighbors is viewed with suspicion, and information is currently disseminated in a fragmentary fashion in a climate of distrust. In this environment, informal farmer-to-farmer dissemination should not be heavily relied upon. These are important dynamics to understand prior to developing a dissemination strategy, which requires qualitative research, which in turn requires building sufficient trust to obtain information on sensitive topics such as witchcraft. This issue is not insignificant: 71 percent of the qualitative sample in this region believed that magic enhances agricultural skills. Even those who said they do not believe in magic still sometimes took measures to protect their fields from bad magic (Bourdillon et al. 2002).

Farmer participation in breeding and adaptation: Participatory processes in breeding have become popular in many CGIAR centers, although there were not many cases of this among our studies. The Bangladesh IRRI and Kenya studies reported that new technologies and management systems were being tested in farmers' fields, and that there were fora for obtaining feedback from farmers. In Kenya this occurred through ICRAF's and CARE's use of adaptive research farmers (ARFs), individuals who are selected for testing technology under local conditions (they are supposed to be selected with community participation, but

there was some question as to whether this occurred). In terms of feedback for researchers, the study found that this system is important for adapting technology to local conditions. At the same time, this system seems to have some adverse impacts on social capital. ARFs were sometimes unpopular: they were blamed for not teaching others and were said to be using their position to gain "*power and prestige*" over other farmers, and they were resented for the amount of attention they received from outsiders: ARFs "are frequently visited and make others feel left out and different from the preferred farmers " (Place et al. 2003). As in the case of local organizations, technology dissemination articulates with local social systems and can have adverse effects on social capital and on how local people respond to outside organizations in the future. This again underscores the importance of ex ante research to understand and better plan for these social dynamics.

In the villages studied in Mexico, there was no evidence of farmer participation in the formal work of plant breeders. However, the Mexico study is the best example of the farmer breeding and experimentation, in the sense that—intentionally or by accident—farmers were continuously crossing maize and developing creolized varieties with traits that they valued. As explained by one farmer:

> A year ago, I planted the one we call tablita in one plot and in another together with another variety. But if I cross it now with 526 it produces half yellowish grains and the ear is a little bit narrower. Now I planted it the same, but with only a little 526 to see if it continues the same. I planted together with 534; I'm going to see how that works out…. What happened [when 526 was crossed with tablita] was that I got some yellow ears but it became stronger. That is what we want—to cross a criollo with a variety to make it more resistant so that it doesn't rot much. (Bellon et al. 2003)

Whereas CIMMYT and the Mexican government had bred for mainly for height and yield, the CIMMYT case study of farmers' informal crossing of varieties revealed the many

other traits that farmers value due to factors including their vulnerability context, asset base, and cultural preferences. The challenge for plant breeders in Mexico is to understand these adaptation processes to better learn about what farmers want.

IMPACTS ON WELLBEING

Agricultural research can address poverty through direct effects on farm households that adopt the resulting technologies, and on the indirect effects for the wider population. Some direct impacts, such as changes in agricultural productivity and farm income, are generally easier to measure; these have been the focus of much impact research. Some direct effects such as empowerment and social capital formation are less easy to assess and are rarely evaluated. Direct effects are experiences by the adopters, but adoption may have a much broader set of indirect impacts on adopters and nonadopters. Indirect effects include lower food prices, more off-farm employment opportunities, and higher wage rates in those nonfarm activities. As households diversify away from agriculture as the mainstay of their livelihoods, these indirect effects are likely to become more important. The seven case studies provide evidence on a range of both direct and indirect impacts on poverty outcomes.

Direct impacts

Agricultural productivity and incomes: Of the five micro-oriented case studies, rice in Bangladesh shows the largest productivity impacts of agricultural research. Average yields increased 2.4 percent per year, from 1.52 t/ha in 1965 to 3.48 t/ha by 2000–01. Not all of this increase can be attributed to MVs: during this time, TVs increased their yields to 2.14 t/ha (0.9 percent per year) due to improved fertilizer and water control. However, the higher yields of MVs produced an additional 13.1 mt in 2000 compared to the output of TVs. This difference was important due to area constraints on rice cultivation in the context of rapid

population growth. Hossain et al. (2003) calculate that each year the incremental yields of MVs can feed about 59 million people, or 46 percent of the 2000 population. At the same time, the annual income gains directly from rice cultivation are not large ($237/year for the average farm size of 0.67 ha, equivalent to 21 percent of total annual household income). This is mainly due to small farm sizes and the falling real price of rice—attributable, in part, to the increases in rice production. On the other hand these same falling rice prices increase the real purchasing power of poor consumers.

The polyculture fishponds also increase fish yields to levels substantially above those realized by traditional fishpond practices and by rice cultivation (IFPRI et al. 1998). Adopting households sold three times as much fish per pond area as those using traditional practices. Cash profits for private fishponds averaged $223 per ha compared to $147 per ha for traditional fishponds.[11] The effect on household income is much more modest because of the long growing cycle (16 months) and because fishponds form a very small portion of the households' livelihood strategies, and hence of their income portfolio. Monthly income from fishponds for adopting households averaged $1.36, compared to $0.79 for nonadopting households—a difference that was dwarfed by income from rice and especially off-farm income. Indeed, monthly household income was slightly larger for nonadopters ($14.61 compared to $13.68 for adopters). For group (as opposed to private) fishponds, only five of nine operated as planned. Where they were functioning, profits averaged $156/ha, but the large group size (10–27 members) meant that each member received only $0.35 per month on average. This indicates that although the poor can sometimes substitute social capital for natural capital, the returns are not necessarily the same to both.

[11] Comparisons for fish are based on mean productivity and profitability of fishponds for matched groups of adopters and nonadopters, controlling for pond size and NGO membership (see Hallman and Lewis 2003). Figures reported in Taka/acre, converted to US$/ha at prevailing exchange rates of $1=Tk 46.5.

Yields and profits for improved vegetable varieties were *not* consistently higher than for local varieties of vegetables, but by introducing women to homestead cultivation, the programs did increase vegetable cultivation among landless and land-poor households, with cash profits averaging $72/ha/crop, or $36/ha/month ($33 profit after family labor inputs) for program households. This was higher than the profits from even HYV rice ($21/ha/crop or $5.25/ha/month) in the same location, and the vegetable growing season is only half as long as for rice (IFPRI et al. 1998). But the limited size of homestead plots mean that land-poor women cannot expand the area under vegetables, and these crops can supply only a small portion of household income.

The soil fertility replenishment techniques in the Kenyan case are associated with mean increases in maize productivity of 128 percent for improved fallows and 114 percent for biomass transfer—slightly better than the effects of fertilizer use. The average increase in maize profits from biomass transfer is $26.16/season/household, and for improved fallows $21.46 in nonpilot villages. These figures are small because of small sizes of plots on which they were applied (averaging under an acre) and are likely to underestimate total productivity increases because they do not include increased bean production on the fields. When the soil fertility techniques were applied to vegetable plots, the returns were up to 10 times as great as for maize plots.

The Zimbabwe case study focused mainly on the second generation maize varieties. First generation maize was seen as very successful, even for smallholders, and is associated with the doubling of maize production during 1979–85. The second generation hybrids, developed primarily to increase resistance to drought and diseases of concern to commercial farmers, did not provide such apparent productivity increases to smallholders. Households

that adopted the first generation did receive higher yields and incomes. Comparing adopters and nonadopters within a regression framework that controls for confounders such as higher education, skills, and other assets finds a mean income gain of $51, or approximately 10 percent of mean household incomes.

Assessing the productivity impact of creolized maize is less straightforward. On the one hand, farmers reported that the improved germplasm was associated with higher yields. Yields of creolized varieties were higher than those of landraces but lower than for improved varieties that had not been creolized. The differences between varieties were small relative to the differences in yields between good and bad years and between favorable and unfavorable locations. On the other hand, yields tell only part of the story, because much of the benefit of creolized varieties derives from their lower level of yield variability and other traits. In both regions, creolized varieties present useful combinations of traits that reduce some of the tradeoffs between landraces and improved germplasm.

In Oaxaca, most advantages were associated with landraces (resistance to ear rot, ease of shelling, making nixtamal, and pasture); however both improved and creolized varieties were superior with respect to resistance to lodging—a key vulnerability factor in the area. Creolized varieties were superior for yield by weight to both improved varieties and landraces. In Chiapas, hybrids were seen as superior on most characteristics, though creolized varieties were seen as superior in resistance to lodging in comparison to landraces, and resistance to insects in storage with respect to hybrids—two strong sources of vulnerability. These results are for men. In Chiapas women were overwhelmingly negative toward hybrids, while women in Oaxaca were more positive or neutral. The reasons for these results are not clear.

Overall, maize production was not seen as a major route out of poverty, but it did contribute to livelihood security—primarily as essential to food security in Oaxaca and providing cash income and food security in Chiapas: "We need it to live; without it we don't eat."

Across the case studies, small farm sizes were not a constraint to the adoption of the technologies, except for the case of private fishponds in one of the Bangladesh sites. However, those with more land and other assets tend to receive larger direct benefits from improved technologies because they are adopting them over larger areas.

The extent to which benefits went to women or men depended on gender roles in agriculture and efforts to target the technologies to women. Special efforts to disseminate improved vegetable and group fishpond technologies through women's groups reached landless women in Bangladesh, despite strong cultural preferences given to men and landed households. In Kenya, designing dissemination materials to be simple and understandable even by those with low literacy allowed women with very little education to adopt the technology on a par with others.

But whereas smallholders were not excluded from the technologies, neither were productivity increases from the technologies, themselves, a major route out of poverty. This is partly because only the Bangladesh rice and first generation maize in Zimbabwe were "green revolution" types of technology. These technologies generated large productivity increases for staple crops, and in a context of unmet demand the price declines were not as large as they would later become. Furthermore, small holding sizes and low returns to agriculture in general meant that the technologies themselves did not contribute greatly to household incomes. This is particularly true of more recent staple cereal crops where low

output prices have been due, in part, to productivity increases induced by agricultural research. Diversification out of agriculture is associated with larger income gains in most of the cases studied. However, income gains from agricultural technology can also facilitate diversification, as in the case of Zimbabwe where higher maize yields of better-off farmers enabled acquisition of livestock, which reduced the vulnerability of adults and children to the effects of drought. Diversification into nonagricultural activities can also reduce vulnerability to fluctuations in income due to weather and pests.

The broader livelihoods analysis indicates that yields and incomes tell only part of the story of the impacts of agricultural research on the welfare of farm households. For many, increases in the stability of production were also very important (e.g., creolized maize in Mexico). Even for households diversifying out of agriculture, the continued household production for home consumption and the generation of cash income provided needed stability and a launching pad for some members to branch out into other activities.

Other direct impacts: Some of the case studies identified other direct impacts of agricultural research that are less tangible than yield and income impacts. Adoption of knowledge-intensive practices is associated with increases in human capital skills or generalized knowledge. In Kenya, for example, increased knowledge of soil fertility replenishment practices carried over into better understanding of soil fertility on the whole farm. Those successfully adopting improved fishponds in Bangladesh reported seeing themselves as "scientists." Women cultivating improved vegetables in Bangladesh also reported empowerment in dealing with traders and their husbands, and there were statistically significant empowerment effects in terms of freedom of movement, freedom from physical violence, and political knowledge and awareness. Sharing the increases in vegetables and fish

with friends and family was also reported in Bangladesh. This may not contribute measurably to household income or even nutrition of the adopting households (compared to nonadopters), but it helps build social capital by strengthening ties among households—a vital asset, especially for the poor.

As discussed in Section 5.2, agricultural technologies can also affect social capital formation, particularly where technologies are disseminated through groups. This was the case for agroforestry approaches in Kenya and vegetable and fishpond technologies in Bangladesh. Where the technology is successful and groups function effectively, we observed increases in social capital, which can have other benefits for households and communities, such as mutual insurance. However, if things did not go well with the technology dissemination, it caused strains in the community and loss of social capital. This was particularly a problem in Bangladesh when fishpond groups broke up, or where the NGO or other organization delivering the technology had technical problems or lost the trust of the community.

Indirect impacts

Looking at the effects of new agricultural technologies only on those who adopt the technologies gives only a partial picture of their impact. There may also be substantial impacts on farm and nonfarm households through direct sharing of output (e.g., to neighbors and family members) and through labor and food market effects.

Of the micro-oriented case studies, the study of the impact of modern rice research in Bangladesh provides the clearest evidence on the indirect impacts of agricultural research. This is at least partly because yield increases were large and rice was a widely grown crop. This generated large spillover effects on other households. The higher labor intensity of modern rice varieties increased demand for agricultural labor, thereby increasing

employment of agricultural wage laborers.[12] It also contributed to an increase in leasing out of land, so that more households could become cultivators. A shift from daily wage rates to piecework contracts for laborers, and from sharecropping to fixed-rate tenancies also allowed laborers and tenants to earn more from rice (Hossain et al. 2002). Poor men and women also placed a high value on an increase in the dignity of agricultural labor contracts: they no longer had to do unpaid service for landowning households in order to be offered wage employment in harvesting and other activities. Instead, prospective employers had to call people by name and request them to come to work.

In both Bangladesh cases, there were substantial increases in nonagricultural employment. Some of this is directly attributable to the new technologies, such as increases in transporting rice or selling fish fry (small stock). Other increases are more generally attributable to rising prosperity to which increased agricultural productivity has contributed.

Another type of indirect effect is seen when farmers adapt and then diffuse technologies. The clearest example of this is in Mexico, where farmers crossed improved germplasm with their own varieties, which spread to many farmers who would not have bought "improved" varieties. Similarly in Bangladesh, a few years after the dissemination of new vegetable varieties, it was difficult to distinguish adopting from nonadopting households, because the original package had been adapted in many different ways, with seeds and the knowledge about how to use them disseminated to neighbors.

But not all indirect effects have been positive. In the Bangladesh rice case study, focus groups repeatedly identified declining soil fertility as a problem caused by the intensification of rice production. Poor men and women also expressed concern about the

[12] In 1987, farmers used 206 person days/ha for MVs, compared to 142 for traditional varieties. By 2000, that difference had shrunk to 133 and 110 person days/ha, due to mechanization in response to growing labor shortages (Hossain et al. 2003).

decline in availability of wild green leafy vegetables which had grown on common land or fallows but were squeezed out due to rice intensification, and about declining wild fish availability due to pesticide use.

At the national scale, the impacts of agricultural research on the poor were also measured for India and China over the past few decades. At this scale of analysis, qualitative measures of poverty are less useful because they cannot be meaningfully aggregated across households and communities to the national level or compared over long periods of time. For these reasons, the India and China case studies relied exclusively on econometric analysis of official income-based poverty data. Strengths of the approach include an ability to track the different channels through which agricultural R&D impacts on the poor in rural and urban areas, control for other factors that influence the outcome, analyze the sources of change over long periods of time, and compare investments in agricultural R&D to other governmental investments. Weaknesses include an inability to capture other important dimensions of poverty (e.g., empowerment) or to triangulate findings against more in-depth, micro-based evidence.

The results for both countries show that agricultural research played a key role in the dramatic decline in rural poverty during the Green Revolution era. In India, rural poverty fell from about two-thirds of the rural population in the early 1960s to about one-third by the late 1980s; in China rural poverty fell from about one-third of the rural population in 1970 to about 10 percent by 1984 (Fan et al. 1999, 2002). These reductions were all the more remarkable given continuing rural population growth. After controlling for different factors, including a wide array of public policies and investments, agricultural research investments

are shown to be one of the most important drivers of agricultural productivity growth and rural poverty reduction (Fan et al. 1999, 2002).

The importance of different contributing factors has changed over time (for example, irrigation investments are much less productive today than they were in the 1970s), but agricultural research investments continue to give high returns and favorable poverty impacts. In fact, in both countries today, additional agricultural research investments give higher productivity returns than any other public investment in rural areas, and they have very favorable poverty impacts. The size of the poverty impact of these public investments is second only to rural infrastructure and education in China, and to rural roads in India. Moreover, unlike earlier years when agricultural research investments in irrigated areas gave the best returns, the highest returns and largest poverty impacts can often be achieved today by investing in many less-developed (or less-favored) rainfed agricultural areas.

In terms of the pathways through which agricultural research affect the poor, increases in agricultural productivity proved to be the most important in both countries. This led to direct on-farm benefits, but also contributed to higher wages and greater employment in rural labor markets (farm and nonfarm) and lower food prices. The latter impact also reduces urban poverty (the urban poor spend approximately half of their income on food). In India there was some tendency for higher agricultural productivity to increase landlessness when, in the initial stages of the Green Revolution, larger farmers with better access to capital, technology, and credit bought up land, but the effect was statistically insignificant because of subsequent programs to increase smallholders' access to credit and technology.

Additional analysis was undertaken to trace some of the benefits of the CGIAR's own research for China and India (Fan et al.2003). The analysis has been completed for rice

where the parentage of rice varieties has been traced in both countries and, combined with available yield trials data and the econometric analysis reported above, has been used to calculate the share of the productivity growth and poverty impacts attributable to improved genetic material received from IRRI. The results indicate that rice improvement research has contributed tremendously to rice production in both countries. The annual benefits from total rice research (national plus IRRI) were about 20 percent of the annual value of national rice production in both countries during the 1980s and 1990s and exceeded total rice research investment in these countries by a factor of 10. IRRI's research made important contributions to these gains. Even using a conservative attribution rule (the geometric rule as used by Fan et al. 2003) for crediting plant variety ancestors, IRRI's research can be attributed with 1.7–6.8 percent of the annual rice research benefits in China over the period 1991–2000, and with 17.8–45.4 percent in India. In value terms, these benefits are sufficient to have paid the full costs of IRRI's global rice program more than 20 times during the past decade.

Rice research in India and China has helped raise large numbers of rural people out of poverty. In India, about 1.5 million poor came out of poverty each year between 1991 and 1999 as a result of rice variety research, and about one-third of that improvement was due to IRRI's research. In China the number of poor who came out of poverty as a result of rice research declined over the years, from 5 million in 1991 to 1.4 million in 1999, of which about only about 5 percent was attributable to IRRI's research. For every $1 million invested by IRRI in 1999 in its global rice research program, some 1,500 and 13,000 rural poor rose above the poverty line, respectively, in China and India alone (poverty benefits will have been generated in other countries too). Most of these benefits are the results of research

conducted prior to 1990. IRRI's rice research investment has declined since then, and so has the corresponding growth in experimental farm yields.

6. CONCLUSIONS

This concluding section:

- summarizes the conclusions of the case studies on the factors affecting the adoption of the technology, on the connections between adoption and dissemination, and on the quantitative and qualitative assessments of impact
- draws some lessons about undertaking assessments of the impact of agricultural technology on poverty and what can be learned from a methods and process perspective
- discusses implications from the case studies for the design of future agricultural research, particularly with regard to what public institutions should do differently with respect to the framing, design, implementation, and evaluation of research.

ADOPTION, DISSEMINATION, AND IMPACTS

Adoption: The decision to adopt does not easily fit into a conventional econometric model. While asset holdings are clearly important to technology adoption, other factors are crucially important, and these are more challenging to capture in a quantitative regression framework. Three main factors were cited as affecting adoption: whether the technologies were expected to increase or decrease farmer vulnerability, whether the poor have the requisite assets to make technology adoption worthwhile, and the nature of mediating institutions. The results are summarized in Table 2.

Table 2--Factors affecting technology adoption in the five micro case studies

Case studies	Adoption
Bangladesh (rice)	▪ Assets: main asset required to adopt MVs was water control. ▪ Institutions: recognizing the need to liberalize imports of small waterpumps overcame this potential asset constraint to adoption.
Bangladesh (fishponds & vegetables)	▪ Vulnerability concerns inhibited adoption: disease of fish, deliberate poisoning of pond ▪ Assets: group ponds tried to overcome lack of private ownership of natural capital as a constraint to adoption using group approach. ▪ Vegetable production reduced physical vulnerability of women as they do not have to go outside the homestead to undertake agricultural activities.
Mexico (maize)	▪ Vulnerability perceived in trying new varieties of improved maize without observing performance, and in certain traits of hybrids and landraces. ▪ Vulnerability: creolization reduced vulnerability. ▪ Institutions: low level of trust in government seed and assistance; high trust in social networks.
Zimbabwe (maize)	▪ Vulnerability perceived to increase due to reliance on market for improved seed ▪ Assets: men's access to financial assets and formal marketing institutions made them more likely than women to adopt HYVs. Women preferred OPVs, where seeds and markets are accessed through their informal networks, enabling them a degree of independence from male control. ▪ Vulnerability: concern over accusations of withcraft from observing neighbors' fields or sharing information on yields and income. ▪ Institutions: seed companies promoting the new varieties by withdrawing older ones.
Kenya (soil fertility replenishment)	▪ Vulnerability to labor shortages in the context of AIDS from adoption of labor intensive SFR. ▪ SFR reduced concerns about "spoiling the soil." ▪ Assets: biomass transfer did not require much land ownership. ▪ Assets: education not necessary for adoption-specific knowledge to be transferred. ▪ Institutions: mixed experience with groups—some empowerment and increased social cohesion, but also existing power relationships that work against the poor reproduced in context of new technology adoption function of groups.

Dissemination: It is clear that it is not entirely possible to separate adoption from the nature of the dissemination process. Dissemination processes have a significant impact on who is reached with the technology and how well they are able to take advantage of them. Dissemination methods have increasingly diversified over time. While direct visits by extension to farmers still exist, dissemination involves a wide array of methods in which

farmers are trained collectively and where farmers teach each other. There is no one best method of dissemination that applies to all regions or even all groups of farmers within one region. Each method observed was mediated by local histories and social dynamics. It is thus important to conduct sufficient research on local cultural and power relationships to understand how people interact and learn before determining the most appropriate means of dissemination.

Attitudes toward and trust in institutions is a key factor in facilitating or hindering dissemination. In almost all cases, there was a low level of confidence in public agencies and officials, including those responsible for dissemination of agricultural technologies. Moreover, governments sometimes paid insufficient attention to the role of women in agriculture and their specific extension needs. NGOs tended to have a better reputation than government among farmers who had had the most experience with them. They tend to be better at targeting the poor and women. However, their performance was highly variable in terms of competence, integrity, and operating style. In all cases where the private sector featured, they were seen as concerned with the needs of larger, commercial, or "successful" farmers, and less with the needs of poor farmers.

One innovative dissemination method involved the use of local organizations. These are intended to increase efficiency through reaching multiple farmers at once, build capacity through training groups to train others, and empower farmers through engagement with other farmers in collective endeavors. While local organizations sometimes achieve these objectives, they also tend to reproduce local power relationships and other social dynamics. They may be dominated by elites, exclude some people, require resources to join, create conflicts over resources, mismanage funds, or fail to reach farmers outside of the group.

Women's groups offer advantages to women who might not otherwise have the opportunity to engage in collective activities. However, in some contexts women may be reluctant to join groups due to time constraints or social pressures. Group-based methods, like other development efforts that involve community participation, may have payoffs that make them worth pursuing. When they work, they are extremely rewarding for participants and disseminating institutions. However, there are no shortcuts. The complications, drawbacks, time, effort, and vigilance involved with making them inclusive and effective should not be underestimated.

Despite the importance of the above formal institutions in dissemination, a consistently important dissemination institution across the case studies is the informal social network. Informal networks also give farmers the opportunity observe the performance of their neighbors' new varieties before trying them. However, there may be certain cases where cultural beliefs can restrict certain informal practices. These are important dynamics to understand prior to developing any dissemination strategy that relies heavily on farmer-to-farmer dissemination.

Use of model farmers or "adaptive research farmers" was found to be important for testing technologies and adapting them to local conditions before they are disseminated to other farmers. At the same time, this system has adverse impacts on local social relationships: the farmers are resented for the attention they receive from outsiders. This again underscores the importance of research to understand local dynamics so that these problems might be avoided by, for example, bringing more farmers into the learning process at an earlier stage. The Mexico case, while not involving farmer participation, provides an example of the value of farmer breeding and experimentation, in the sense that farmers were

continuously crossing maize and developing new varieties with traits that they valued, affected by their vulnerability context, asset base, cultural preferences, and other factors. The challenge is for breeders to learn from these adaptive processes about what farmers want.

Impacts on poverty: A wide variety of direct impacts on adopting households were clearly identified by the case studies. These include positive effects such as increased production and income, less obvious positive outcomes such as increased knowledge and empowerment of women, and negative effects such as decreased soil fertility and availability of wild vegetables (from intensive rice cultivation).

However, the micro-oriented case studies have indicated that the direct impacts of agricultural research on productivity and income for the poor were limited by a number of factors. First, constraints to adoption would of course limit their direct benefits. In particular, technologies that require high levels of assets—whether land, water, finances, or even human capital—are likely to exclude the very poor. The case studies demonstrate some examples of these constraints, such as in Mexico and Kenya where certain varieties of maize were more suited to the resource endowments of for better-off farmers. However, the case studies also indicate that the poor are not necessarily excluded, especially if the technologies or their delivery are designed to build on the assets that they do have. For example, HYV rice in Bangladesh was adopted at a higher rate by smaller farmers and tenants because it is scale neutral and labor intensive. Vegetable programs in the other Bangladesh case study helped even landless women make use of their homesteads for production. Similarly, agroforestry programs reached even illiterate women by designing training materials that they could understand.

Declining real food prices, especially for basic grains, played a larger role in limiting the direct income gains to poor producers from agricultural technologies (though many will have gained as net consumers of basic grains). Even the substantial productivity gains of HYV rice did not lead to very large income gains in Bangladesh because of the falling output prices. Other technologies, which showed lower proportionate increases in yields, had even lower impacts on incomes. Diversification of livelihood strategies out of agriculture further constrained the direct contribution of agricultural research to incomes. This was, in part, a response to declining output prices and to other opportunities.

Despite these limitations on the direct income effects of the agricultural technologies studied in the five micro-oriented case studies, the technologies were still important for poverty reduction. The increased stability and even marginal improvements in agricultural production afforded by technology (e.g., in Mexico and Bangladesh) was valued by poor households for providing food security and a launching pad into other activities. Increased agricultural employment was also a major benefit for the poor in Bangladesh, improving not only incomes and stability of employment, but also improving the labor contracts. There were also empowerment benefits of technologies successfully disseminated to poor women and some strengthening of collective action capacity. If we recognize poverty as being more than low incomes, then contributions of agricultural production to reducing vulnerability and empowering poor women and men need to be taken into consideration when evaluating technology.

The impacts are not only felt by households that adopt the technologies; indirect impacts on other households are also important. A full summary of direct and indirect impacts is provided in Table 3.

While reductions in food prices made increased production less profitable for farmers, it increased access to food for millions of poor households. This was seen in the Bangladesh rice case study and the India and China case studies. The latter two studies indicate major impacts on both rural and urban poverty in China and India via a lowering of food prices, due in large part to agricultural R&D. Technology diffusion was also very important in Bangladesh (vegetables), Mexico (creolized maize), and Kenya (soil fertility replenishment), as were empowerment effects that are likely to have ramifications beyond the farm and for nonfarm households as improvements in working conditions and the capacity to negotiate and make decisions are transmitted by various institutions.

Table 3--The indirect and direct effects of agricultural technology adoption in the seven case studies

Case studies	Direct effects	Indirect effects
India	• Large impacts on poverty—both rural and urban; higher in less favored areas.	
China	• Large impacts on poverty—both rural and urban; higher in less favored areas.	
Bangladesh (rice)	• Large productivity increases due to improved varieties. Income increases constrained by farm size and low price. • Declining soil fertility.	• Low price of rice important for net food purchasers. • Increases in employment opportunities in agriculture. • Improvement in working conditions in agriculture. • Decrease in availability of wild green leafy vegetables.
Bangladesh (fishponds & vegetables)	• Improved productivity of fishpond and vegetable production. • Small impacts on income of poor because technologies formed small part of household livelihoods and some of the private fishpond owners not poor to begin with. • Increased empowerment of women, when technology directed to them.	• Increased availability of vegetables in study sites. • Social capital strengthened by some groups disseminating the technology, but weakened when groups fell apart. • Diffusion of vegetable technologies.
Mexico (maize)	• Yields increased due to improved varieties, but perceived as more variable—hence creolization as an intermediate solution (reduced variability). • Not perceived as route out of poverty but as providing a solid base from which to diversify. • Maize is perceived as essential to being able to feed one's family, especially for the poorest farmers.	• Widespread diffusion and adaptation of improved maize via creolization led to reduction of tradeoffs between traits of improved maize and landraces; increased ability to predict performance.
Zimbabwe (maize)	• Income gain of 10 percent, less of a gain for poorer farm households. • Better-off farmers able to convert productivity-driven income gains to asset accumulation, increasing resilience to shocks.	• Built networks for information and technology demonstration for men.
Kenya (soil fertility replenishment)	• Doubling of maize productivity compared to no SFR; better results than with fertilizer and no SFR. • Spillovers in knowledge: improved understanding of soil fertility issues on whole farm. • Increased access to technology for women	• Social capital strengthened by some groups disseminating the technology, particularly women's groups; use of "adaptive research farmer" created new social tensions.

LESSONS ABOUT POVERTY IMPACT ASSESSMENT

Several lessons can be drawn from the case studies on methods.

1. **In terms of both the quantitative and qualitative methods, the case studies pay much attention to the limitations on their ability to make causal statements.** Lack of significant attention to the design features of an evaluation can severely undermine the ability of the research to draw inferences about causation. Ultimately, the ability to do so boils down to controlling for unobservable factors between groups that have adopted the technology and those that have not (another interesting comparison would be between different dissemination pathways. Also required are large enough sample sizes, given the variability in outcomes, to detect a statistically significant difference, if it exists. Finally, we must be able to control for the endogeneity of variables that may affect the outcomes of interest. Ideally, from an evaluation perspective one would want to randomly allocate technology to a control and treatment group, prevent diffusion of technology between groups and have sufficient sample size to detect a difference in key indicators. This is rarely if ever seen in practice in evaluating agricultural research, and it could lead to ethical questions about diffusing a useful technology to some and purposely withholding it from others. However, such research can be conducted where diffusion, for logistical or financial reasons, has to be done in phases.[13]

   If this cannot be attained, attention must be given to constructing a control or comparison group that is matched as closely on observable and unobservable characteristics, pre-technology adoption. This is fairly straightforward to do on

[13] See Skoufias and McClafferty 2002 for this approach in the context of a social program.

observable characteristics, and the Bangladesh fishpond and vegetable work did this most thoroughly by the use of a village census with questions like "Would you adopt if this technology were available?" The other four micro case studies in Mexico, Zimbabwe, Bangladesh, and Kenya had to explicitly model the decision to adopt and then incorporate the results in the equations used to assess the impact on poverty. This was most convincing when panel data were available such as in the Zimbabwe and both Bangladesh cases studies, as this allows controlling for household and community unobserved effects that remain relatively fixed over time.

On the qualitative side, attention was given to capturing social differentiation by conducting focus groups with men and women and with different income groups, and tapping into their assessments of impacts. Nevertheless, there are also tradeoffs involved, as such controls often involve higher costs. Researchers need to optimize the cost effectiveness (in the broad sense) of the studies.

2. **The case studies brought out the need to consider direct and indirect impacts and to avoid restricting analysis to only those impacts that can be easily quantified.** The completion of a portfolio of impacts should always be undertaken, as illustrated in Table 5. If we had focused on direct impacts only we would have missed the food price impacts and the wage rate and employment effects that were observed for rice in Bangladesh, and in the India and China case studies more generally, and effects on community-wide social capital, both positive and negative. If we had focused solely on quantitative measures we would have been puzzled as to why vegetable and fishpond adoption in Bangladesh was not more widespread (concern about vulnerability) and we would have caught the wage changes but missed

the improvement in quality of employment in the Bangladesh rice case study. We would have also missed the empowerment effects of vegetable growing for women in Bangladesh and the farmers' feelings of "being scientists." In addition, we would have missed the spillover from the greater attention paid by Kenyan farmers to soil fertility on non-SFR crops. The Mexico study in particular discovered that:

> …there is a need to go beyond a simplistic concept of yield as the yardstick of impact and look at the set of traits that farmers value, how those traits are being supplied by the germplasm available, and the tradeoffs they entail. Even yield is a more complex concept than ton/ha…. Farmers have different concepts of yield which are not necessarily correlated, e.g., yield by weight, yield by volume, yield of dough to make tortillas. (Bellon et al. 2003)

Table 5--A matrix of impacts for agricultural technology

Impacts	Quantifiable	Qualitative
Direct	e.g., productivity, reduced tradeoffs among traits	e.g., vulnerability
Indirect	e.g., price changes, wage rate changes, employment changes	e.g., community-wide changes in women's empowerment

3. **The SL framework provided a useful method for thinking about the multiple and interactive influences on livelihoods and a means of communicating across disciplines.** The SL framework draws on many concepts from other frameworks, paradigms, and disciplines with which the interdisciplinary teams of researchers were familiar to varying extents. (Indeed, some researchers felt that the same issues could have been covered without this framework.) Nevertheless, it assured that all research teams considered a wide range of issues related to vulnerability, assets, and institutions that are normally excluded in conventional impact assessments, and provided a useful "checklist" of issues to be considered, helping ensure that important explanatory factors were not overlooked, even in a broadly conceived study. The SL

approach implies a willingness to acknowledge that livelihoods—and the processes that make interventions effective or not—are complex. Nevertheless, the framework still does not include some important concepts that explain people's behavior and position in relation to technology (e.g., culture, power and experience), and could not accommodate the nuances of some particular situations. Other concepts from sociology, anthropology, and economics were thus integrated as needed.

4. **The case studies confirmed that mixing disciplines from the social sciences—economics, sociology, and anthropology—and using mixed methods from within these disciplines—panel surveys, qualitative interviews, focus groups, and ethnographic methods—are essential to conducting impact assessments.** Economics methods provided the basis for measurement of adoption and many types of impacts, while sociology and anthropology contributed to an explanation of these findings, including understanding of how social relationships of gender, class and power, and culture and other noneconomic aspects of people's lives help to explain vulnerability, assets, and people's relationship to institutions. They also contribute to an understanding of dissemination processes and how they influence adoption. Rigor is not simply a matter of establishing proper counterfactuals and controls. The integration and triangulation of research methods provides a different type of rigor that is needed for a study of how technologies interact with livelihoods and affect poverty.

Finally, we found that donors can be a positive force for institutional change, if they are committed to such innovation. The SPIA poverty impact assessment studies were originally conceived as economic studies, measuring poverty in terms of income, expenditure, and nutrition. One of the study donors, DfID, recognized the need for a

multidisciplinary, mixed-method approach for assessing poverty impact, and supported the total redesign of the study with substantial additional funding for social analysis and early-stage technical support for the integration. It also made this redesign a condition of funding. While conditionality is often resisted in research, it can be a shock that is sometimes required to provoke a change in institutional culture.

LESSONS FOR THE DESIGN OF FUTURE AGRICULTURAL RESEARCH

What are the implications of the study findings for the relevant parts of the CGIAR or other technology development and dissemination institutions? What should scientists, policymakers, and disseminators learn, take away, and change as a result of the insights and findings from this research?

1. **The studies identified types of priorities of poor people, and of impacts of research, that need to be known in advance or at least in the very early stages of the evolution of research.**

   Some illustrations follow:

- *The priority the poor themselves place on managing risk, and their weak capacity to do so.* Anything that increases their exposure to risk—or their perceptions of exposure to risk—assuming debt to purchase inputs, depending on government or NGOs that are perceived as undependable—in the absence of insurance or recourse mechanisms will seem less attractive, even if it is productivity-enhancing.
- *The types of social differentiation that will affect the uptake and impacts of different technologies.* Technologies with low input requirements and especially low cash inputs are likely to be especially attractive to the poor. Women and men may be

differently affected, so paying particular attention to cultural norms with regard to women and the assets available to them—and building upon those assets (e.g., homestead production)—can be especially beneficial for poverty reduction.

- *The variety of traits that farmers value beyond yield* include factors such as stability in yield, taste and texture, and resistance to weather, pests, and disease. Different varieties involve tradeoffs, and new varieties can reduce these tradeoffs, but local priorities must be understood. Learning about these priorities can be key to producing impacts.
- *The assumption that developing country farmers, especially poor farmers, have a relative surplus of labor available,* is not always valid. Our studies found that many poor agricultural producers face severe time constraints, particularly in environments where HIV/AIDS has killed or disabled much of the working-age population and increased the demands on time for caring for the afflicted. Although labor-saving technologies may reduce employment opportunities in some contexts, they may also allow households to diversify into other income earning activities or devote more time to childcare or caring for ill family members.
- *The importance and role of agriculture in livelihood strategies,* so that technology can be tailored to fit those strategies, and be aimed where agriculture still plays a significant role in the lives of poor farmers.
- *The value of homestead production for women* in contexts of curtailed spatial mobility. This production close to home is more tractable given other production activities, e.g., childcare, but also reduces women's vulnerability to harassment.

- Such insights are to varying degrees context-specific. The payoffs from them can be high indeed. The financial and human-resource costs of the present studies are not trivial, but in our experience neither are they prohibitive, being in the order of $200,000 per case study. While this is a small fraction of the investment that goes into the development of the technology itself, the challenge now is to evolve and adopt cost- and time-effective approaches and methods to enable scientists and other decisionmakers to learn about and appreciate poor people's conditions and priorities, anticipate impacts, and tailor their research accordingly.

2. **Dissemination matters for adoption and for generation of direct and indirect impacts.**

   More thought needs to be given to the dissemination strategies at an early stage in the research design. In this way, technology is more likely to be adopted, and unintended effects can be diminished. For example, different social environments will be more or less amenable to individual, group-based, or informal dissemination activities. While farmers' groups can be an effective means of diffusion, they often reproduce power relationships, and it is important to try to understand these power dynamics before forming groups. Similarly, adaptive research farmers are important for testing technologies, but it is important to understand the social dynamics unleashed through this system, and take more time for facilitating community participation in the selection process and ongoing contacts. Social barriers to inclusion can be taken into consideration and sometimes circumvented. For example, women's groups could disseminate vegetable technology, and SFR groups could include poorer farmers.

3. The formation of new partnerships is essential if agricultural research organizations, including CGIAR, are to be informed by and have an impact on livelihoods of poor people.

While CGIAR cannot tailor technologies for the enormous range of context-specific livelihood strategies found throughout the poor regions of the world, it must facilitate such a tailoring. It can only do so by creating meaningful partnerships with a range of institutions that better understand local livelihood strategies. These partnerships will help CGIAR develop research processes that lead to generic technologies that have the potential for strengthening livelihood strategies and reducing vulnerability (a scaling up of local knowledge from both men and women). The partnerships will also increase the realization of that potential by helping poor people tailor the technology so that it empowers them both within and outside the agricultural realm.

Forming these partnerships will not be easy. National governments remain essential partners, but where they maintain traditional top-down, male-dominated approaches they will not be helpful. Capacity building can help in this regard. Government departments and NARs that have moved to more farmer-centered, gender-sensitive, and participatory approaches (such as in western Kenya) should be sought as partners. National NGOs are an important resource for dissemination, because they are often closer to the ground and have different perspectives on local environments than governmental agents. But like government their performance is also variable and their approaches and performance should be evaluated closely. The strategic choice of partner is a crucial decision in targeting agricultural technology to

the poor. Other decisions, such as which areas to work in or which crops to target will be important, but the choice of partners for the dissemination and development of the technology can be even more important. Engaging the right partners should be considered an integral part of the research process.

INSTITUTIONAL LEARNING AND CHANGE

Finally—and perhaps most important to increasing the impact of this work—we have to be willing to conduct research and impact assessment within the context of an institutional learning and change (ILAC) perspective. According to Watts et al. (forthcoming), ILAC "can be fostered by a spirit of critical self-awareness among professionals and an open culture of reflective learning within organizations. In such an environment, errors and dead ends are recognized as opportunities for both individual and institutional learning that can lead to improved performance." Research is structured to involve multiple stakeholders in a process that is more participatory, iterative, interactive, reflective, and adaptive than conventional "pipeline" research. This is consistent with the changing CGIAR mandate to be increasingly poverty-focused. As Robert Chambers noted at an IFPRI workshop on ILAC in 2003, "as the development community strives to address new and more intense demands, its players are challenged to accept and internalize changes in their concepts, methods, mindsets, values, behaviors and relationships" (see Horton and McKay 2003).

As part of impact assessment, ILAC means research organizations should ask how technology development and dissemination could have been done differently given what we now know about its impact, and what aspects of the institution constrain a different approach. Then organizations should act upon that information. In addition to studying the factors underlying success, this requires a willingness for research managers to be self-critical,

recognize changing clientele and their needs, acknowledge mistakes and failures, and benefit from them by seeking lessons. It also involves a critical examination of institutional rules and norms that may or may not facilitate organizational learning.

One of the lessons gained from the studies presented here was that if research scientists and managers had been involved early on and through all stages of these impact assessments, and if reflection and adaptation processes were better incorporated, these studies would have been positioned to make more of an impact on the institutional practices of the respective centers. The overall poverty impact project coordinated by IFPRI met its objectives related to developing, testing, and refining methods for integrated economic and social analysis, and to better understanding how agricultural research affects livelihoods and poverty. However (in the spirit of acknowledging weaknesses and learning from them that is a part of ILAC), the project only partially met its third objective of "strengthen[ing] the capacity of CG centers and NARS to undertake integrated economic and social poverty impact assessments and to internalize a poverty impact assessment culture for the future" (IFPRI 2000). Appreciation of and capacity for such analysis was built within the centers that led the studies,[14] and some other centers expressed interest in applying a similar approach. But reaching centers outside of the study and influencing cultural change within them was beyond what this project could achieve. Outreach activities are just beginning, and encouraging institutional change is an objective of the outreach, but ILAC is a more involved set of processes that will require far greater attention. With this in mind, new poverty impact assessment studies are being designed in an ILAC framework, drawing on the methods,

[14] However, one point made by Adato and Meinzen-Dick (2002) is that long-term capacity would have been strengthened far more if sociologists and anthropologists were brought on staff in the centers, rather than relying on external collaborators, or 'outsourcing' the social analysis.

findings, and lessons from these studies, and a new initiative on ILAC has been launched within the CGIAR.[15]

[15] This initiative was sparked by the IFPRI poverty impact study, which held a workshop on ILAC in February 2003 designed to integrate ILAC into the new case studies, and to develop ideas for a center-wide ILAC initiative. See Horton and McKay (2003) and Watts *et al.* (forthcoming) for a detailed discussion of ILAC and what it means in the context of the CGIAR, and more information about the new ILAC initiative.

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