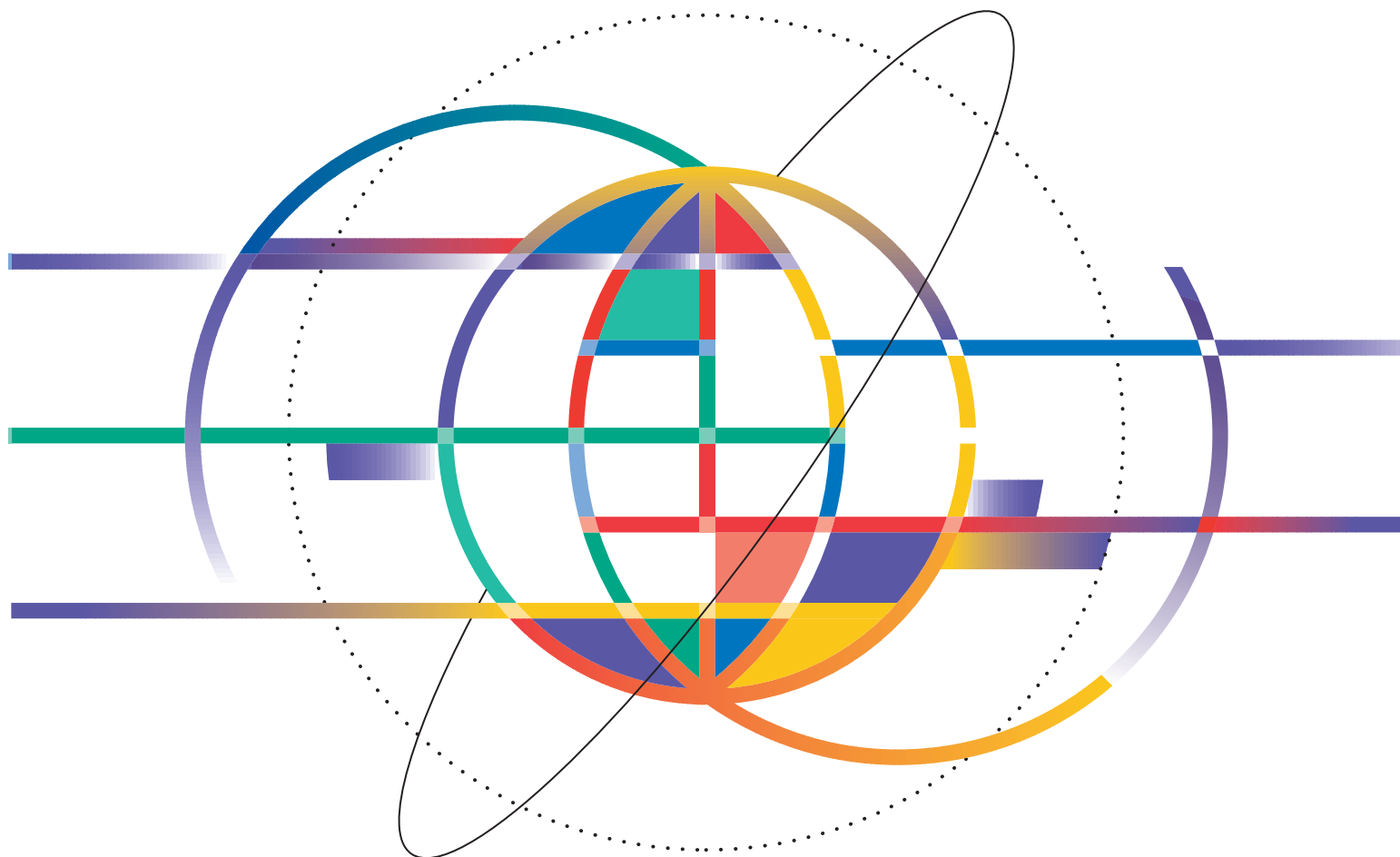


World
Development
Report

Knowledge for Development



SUMMARY

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Overview

KNOWLEDGE IS LIKE LIGHT. Weightless and intangible, it can easily travel the world, enlightening the lives of people everywhere. Yet billions of people still live in the darkness of poverty—unnecessarily. Knowledge about how to treat such a simple ailment as diarrhea has existed for centuries—but millions of children continue to die from it because their parents do not know how to save them.

Poor countries—and poor people—differ from rich ones not only because they have less capital but because they have less knowledge. Knowledge is often costly to create, and that is why much of it is created in industrial countries. But developing countries can acquire knowledge overseas as well as create their own at home. Forty years ago, Ghana and the Republic of Korea had virtually the same income per capita. By the early 1990s Korea's income per capita was six times higher than Ghana's. Some reckon that half of the difference is due to Korea's greater success in acquiring and using knowledge.

Knowledge also illuminates every economic transaction, revealing preferences, giving clarity to exchanges, informing markets. And it is lack of knowledge that causes markets to collapse, or never to come into being. When some producers began diluting milk in India, consumers could not determine its quality before buying it. Without that knowledge, the overall quality of milk fell. Producers who did not dilute their milk were put at a disadvantage, and consumers suffered.

Poor countries differ from rich in having fewer institutions to certify quality, enforce standards and performance, and gather and disseminate information needed for business transactions. Often this hurts the poor. For

example, village moneylenders often charge interest rates as high as 80 percent, because of the difficulty in assessing the creditworthiness of poor borrowers.

This *World Development Report* proposes that we look at the problems of development in a new way—from the perspective of knowledge. There are many types of knowledge. In this Report we focus on two sorts of knowledge and two types of problems that are critical for developing countries:

- *Knowledge about technology*, which we also call technical knowledge or simply know-how. Examples are nutrition, birth control, software engineering, and accountancy. Typically, developing countries have less of this know-how than industrial countries, and the poor have less than the nonpoor. We call these unequal distributions across and within countries *knowledge gaps*.
- *Knowledge about attributes*, such as the quality of a product, the diligence of a worker, or the creditworthiness of a firm—all crucial to effective markets. We call the difficulties posed by incomplete knowledge of attributes *information problems*. Mechanisms to alleviate information problems, such as product standards, training certificates, and credit reports, are fewer and weaker in developing countries. Information problems and the resulting market failures especially hurt the poor.

The relationship between knowledge gaps and information problems, their impact on development, and the ways that international institutions and developing-country governments can better address them are the central themes of this Report.

As we shall see, considering development from a knowledge perspective reinforces some well-known lessons, such as the value of an open trade regime and of universal basic education. It also focuses our attention on needs that have sometimes been overlooked: scientific and technical training, local research and development, and the critical importance of institutions to facilitate the flow of information essential for effective markets.

Approaching development from a knowledge perspective—that is, adopting policies to increase both types of knowledge, know-how and knowledge about attributes—can improve people's lives in myriad ways besides higher incomes. Better knowledge about nutrition can mean better health, even for those with little to spend on food. Knowledge about how to prevent the transmission of AIDS can save millions from debilitating illness and premature death. Public disclosure of information about industrial pollution can lead to a cleaner and more healthful environment. And microcredit programs can make it possible for poor people to invest in a better future for themselves and their children. In short, knowledge gives people greater control over their destinies.

The twin issues of knowledge gaps and information problems cannot be untangled in real life: to unleash the power of knowledge, governments must recognize and respond to both types of problems, often simultaneously. For the sake of clarity, however, we analyze these issues separately, beginning with knowledge gaps.

Narrowing knowledge gaps

Closing knowledge gaps will not be easy. Developing countries are pursuing a moving target, as the high-income industrial countries constantly push the knowledge frontier outward. Indeed, even greater than the knowledge gap is the gap in the capacity to create knowledge. Differences in some important measures of knowledge creation are far greater between rich and poor countries than the difference in income (Figure 1).

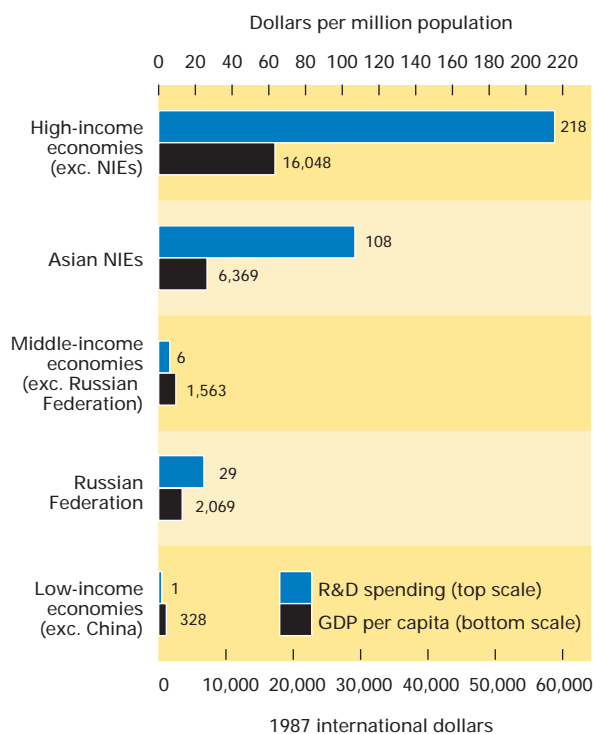
But developing countries need not reinvent the wheel—or the computer, or the treatment for malaria. Rather than re-create existing knowledge, poorer countries have the option of acquiring and adapting much knowledge already available in the richer countries. With communications costs plummeting, transferring knowledge is cheaper than ever (Figure 2). Given these advances, the stage appears to be set for a rapid narrowing of knowledge gaps and a surge in economic growth and human well-being. Why, then, isn't this transfer occurring as fast as we might expect? What conditions are necessary for developing countries to make fuller use of the global stock of knowledge?

Part One of the Report starts with a discussion of the importance of knowledge for development and of the

Figure 1

R&D spending and GDP per capita

Inequalities in the capacity to create knowledge exceed even those in income.



Note: Data are for 1991. Source: European Commission 1994.

risks and opportunities that the information revolution poses for developing countries (Chapter 1). It then examines three critical steps that developing countries must take to narrow knowledge gaps:

- *Acquiring knowledge* involves tapping and adapting knowledge available elsewhere in the world—for example, through an open trading regime, foreign investment, and licensing agreements—as well as creating knowledge locally through research and development, and building on indigenous knowledge (Chapter 2).
- *Absorbing knowledge* involves, for example, ensuring universal basic education, with special emphasis on extending education to girls and other traditionally disadvantaged groups; creating opportunities for lifelong learning; and supporting tertiary education, especially in science and engineering (Chapter 3).
- *Communicating knowledge* involves taking advantage of new information and communications technology—

through increased competition, private sector provision, and appropriate regulation—and ensuring that the poor have access (Chapter 4).

Just as knowledge gaps exist between developing and industrial countries, so too are there large gaps within countries. Strategies for closing these gaps often include the same elements, and applying them effectively will go a long way toward reducing inequality and eliminating poverty.

But even if knowledge gaps could be closed entirely, with everyone in developing countries enjoying access to the same know-how as well-educated people in the industrial countries, developing countries would still be at a disadvantage in another respect: knowledge about attributes. Because knowledge about attributes is required for every transaction, it must be generated on the spot and constantly refreshed. This requires a variety of market and nonmarket mechanisms to collect and disseminate information, many of which are weak or lacking in developing countries.

Addressing information problems

Without knowledge about attributes, markets cannot function properly. When the government steps in and addresses the problem, for example by establishing standards and certification (as it did for milk quality in India), the market functions better and everybody benefits.

Institutions, broadly defined to include governments, private organizations, laws, and social norms, contribute to establishing recognized standards and enforcing contracts, thus making possible transactions that would otherwise not occur. Rich countries have more-diverse and more-effective institutions to address information problems than do poor countries. These institutions make it possible for people to engage in economic transactions that improve their lives—from buying milk, to finding a job, to getting an education, to obtaining a loan. Information problems are often at the core of the difficulties that poor people in developing countries encounter in their daily struggle to survive and to improve their lives.

Part Two of the Report begins by discussing the nature and extent of these problems, noting that they are a major impediment to development—and especially severe for the poor (Chapter 5). The unequal distribution of information can never be entirely eliminated, but it can be ameliorated, in part through institutional innovations designed specifically for developing-country settings and the special problems confronting poor people. The rest of Part Two considers some specific problems involving information. It also describes some promising solutions in three areas where these problems are most severe, and where addressing them can make a major contribution to achieving sustainable growth that benefits the poor:

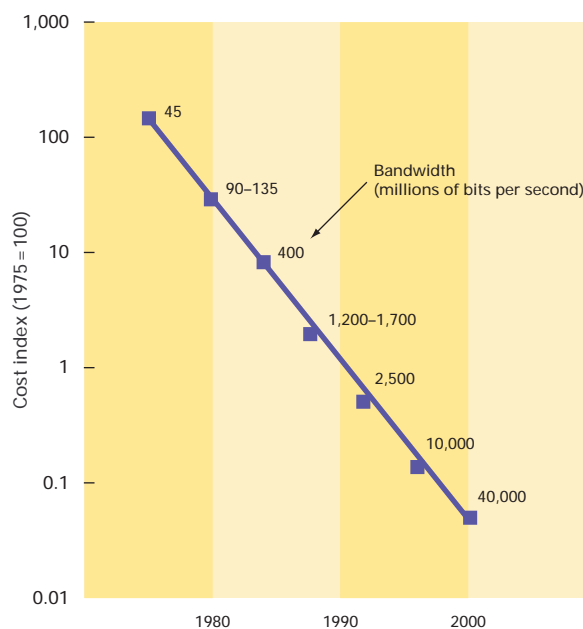
- *Processing the economy's financial information*, particularly by ensuring transparency through effective accounting and disclosure, and by designing regulatory approaches that work in information-scarce settings (Chapter 6)
- *Increasing our knowledge of the environment*, by conducting research to provide the underpinnings for effective environmental policies, and by disseminating information to create incentives for pollution reduction and responsible stewardship (Chapter 7)
- *Addressing information problems that hurt the poor*, and taking the time to learn about their needs and concerns, so that society can then offer them useful information and assist them in devising ways to reduce their isolation from markets and to improve their access to formal institutions (Chapter 8).

Most of the difficulties that developing countries face involve both knowledge gaps and information problems. To be effective, the solutions must address both issues—sometimes sequentially, often simultaneously. Because the

Figure 2

Cost trends in optical fiber transmission

The cost of sending information continues to plummet.



Note: The data underlying the index are in dollars per million bits transmitted 1 kilometer. The trendline is calculated logarithmically. Source: Bond 1997a.

possibilities for improving human well-being are so immense, we return to these twin themes throughout the Report, beginning with the story of the green revolution, which shows dramatically how knowledge gaps and information problems—and their solutions—play out in the real world.

The green revolution: A paradigm of knowledge for development

Few stories better illustrate the potential of knowledge for development—or the obstacles to diffusing that knowledge—than that of the green revolution, the decades-long, worldwide movement dedicated to the creation and dissemination of new agricultural knowledge. This quest, breeding new seeds for enhanced agricultural productivity, was undertaken in the early postwar years by a vast array of agents—nonprofit organizations, governments, multilateral institutions, private firms, banks, village moneylenders, land-rich farmers, and landless laborers—all working, deliberately or not, to improve the daily bread (or rice, or maize) of people everywhere. The English economist Thomas Malthus had predicted in the 18th century that the population of any country would eventually outstrip its food supply. What the green revolution showed

instead was that Malthus had underestimated how quickly knowledge—in agriculture, in transportation, in mechanization—would transform food production. By the second half of the 20th century, world food supply was more than keeping up with population growth.

Since the early 1950s, Asia and South America have more than doubled yields of staple crops (Figure 3; Africa, which also lags in other measures of development and knowledge, has seen only modest yield increases). Global gains in output per hectare have been dramatic, particularly for wheat, maize, and rice (Figure 4). And although the impact of the green revolution on the poor was initially a matter of controversy, time has made it clear that poor people have benefited significantly, through higher incomes, cheaper food, and increased demand for their labor.

The early steps in the green revolution mostly involved narrowing knowledge gaps. The first step was to narrow the gap between what scientists already knew about plant genetics and the widespread ignorance on this score in developing countries, reflected in the unavailability there of new crop strains based on this knowledge. This gap was narrowed largely through the research and development efforts of governments and nonprofit organizations. But why was their action necessary? Why didn't private, for-profit firms make a greater effort to address food security? Why didn't they, for example, try to commercialize existing scientific knowledge about genetics by developing more productive plant varieties themselves?

The answer is that the knowledge embodied in the seed of a new plant variety is not easily appropriated by any breeder, seed company, farmer, or even country. The varieties most suitable for transfer to developing countries, once transferred, could be easily reproduced. Farmers had only to collect the seeds from the plants grown from the original seeds and replant them. That meant no repeat business for seed developers, and not enough profit to make their effort worthwhile.

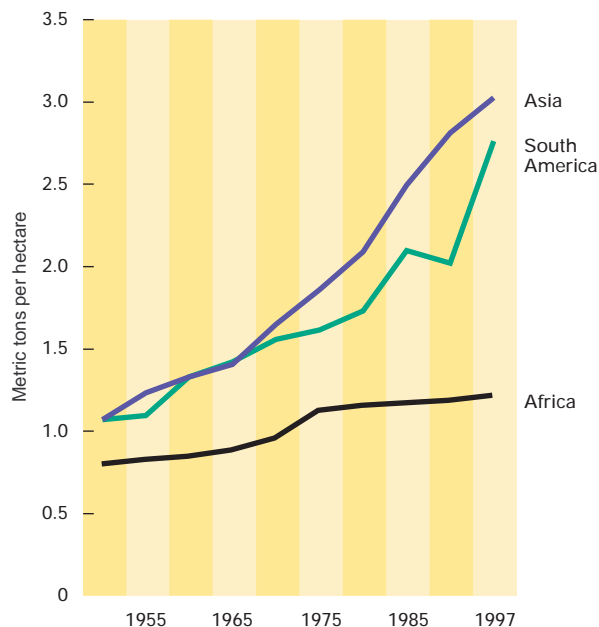
Put another way, improved seeds, like many other research outputs, have many of the characteristics of a public good. A public good is one whose full benefits in the form of profits cannot be captured by its creator but instead leak out to society at large, without the creator receiving compensation. Because private entrepreneurs have diminished incentives to provide such goods, the tradition of entrusting public entities with providing them is long. (A good example is the agricultural research the U.S. government funded in the 19th century.) Indeed, it is widely recognized in many fields that, without some collective action, there will be far too little research into developing new knowledge.

After the first modern seed varieties proved successful in the early 1960s, many developing countries established national agriculture research organizations, as some had already done, mainly with public funding, to develop

Figure 3

Cereal yields by developing region

Yields have more than doubled in much of the developing world.



Source: FAO, various years.

second-generation varieties better suited to local conditions. As a result, the number of new varieties of rice and maize released by national research organizations doubled between 1966 and 1985.

To disseminate this knowledge, developing-country governments established agricultural extension services. At first the main job of the extension agents was to inform farmers about the new seeds and techniques. But the best extension agents—and the most effective extension services—quickly learned that listening was also an important part of the job. By listening to farmers and learning from them, extension agents not only gained a better understanding of the farmers' needs and concerns. They also sometimes stumbled upon seed varieties and cultivation techniques that the researchers had missed. This two-way flow of information furthered the local adoption and adaptation of green revolution technology.

At this point in the story, the focus shifts to information problems. The driving force in the early stages of the green revolution had been the creation, dissemination, and adaptation of agricultural know-how. But the potential of these innovations could not be unleashed until millions of small farmers planted the new seeds. For this to happen, a variety of information problems had to be addressed. In particular, what assurance did farmers have that the seeds would work? Why should a farmer risk his livelihood on the say-so of an extension agent? This uncertainty, coupled with the inability of the poor to obtain credit—another classic market failure closely related to information problems—had significant implications for the rate of adoption of the new seeds.

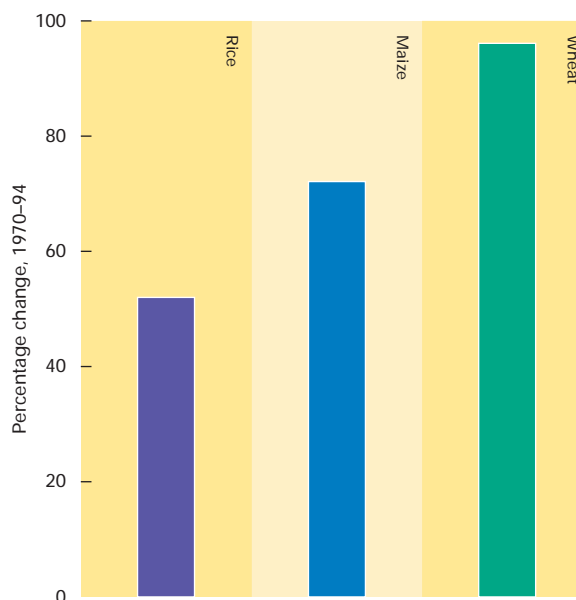
Large landholders and farmers with more education were among the first to try the new seeds, for a variety of reasons. Farmers with extensive landholdings could limit their risk by trying new seeds in test sowings on only a part of their land. They could also more quickly recover the fixed cost of their early adoption by applying what they learned across their larger farms. Educated farmers were better equipped to find out about the new varieties in the first place, and to learn the changes in cultivation practices needed to make the most of them. Perhaps most important, however, more-prosperous farmers had ready access to credit and the ability to absorb risk. Poor farmers, unable to borrow and lacking insurance or the savings to fall back on in the event of failure, could only watch and wait until their wealthier neighbors proved the value of the new seeds.

Why didn't banks or village moneylenders lend small farmers the money to buy the new seeds and fertilizer? Many poor people would repay small loans at reasonable interest, if such loans were available. But the costs of identifying the good credit risks among the poor are high relative to the size of the loans they would take out. Unsure which prospective borrowers will repay, lenders charge high interest and require collateral, which the poor often

Figure 4

Growth in yields for principal cereals

Productivity gains in some staple crops have been dramatic.



Source: CGIAR 1994–95.

lack. Even when the poor have assets (small landholdings) that could be pledged as collateral, weak legal infrastructure, including lack of land title and ineffective courts, means that enforcement of collateral pledges may be weak. Without enforcement, incentives to repay are limited, and this weakens incentives to lend. The result is that the poor often cannot borrow.

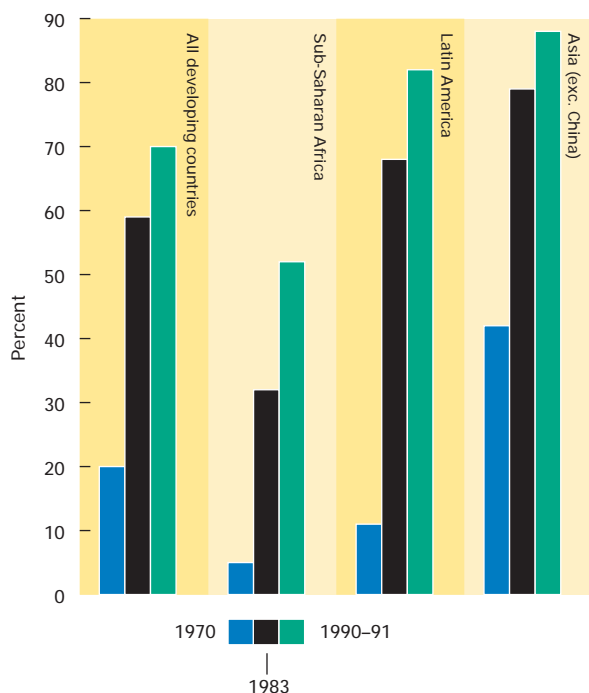
In recent years microcredit schemes have arisen to address these problems. But at the time of the green revolution, poor farmers' lack of credit, combined with their scant education (also partly attributable to lack of credit) and other factors, meant that they were often the last to adopt the new crop strains. The resulting lag between the introduction of new seeds and their widespread use can be seen in the slow expansion of areas sown with new varieties (Figure 5).

The costs of these delays were significant. If all the information problems could have been addressed—that is, if farmers could have been immediately persuaded of the potential of the new seeds, and if mechanisms had existed to provide credit to poor farmers—the productivity gains from the green revolution would have been even greater. One study found that, for a farm family with 3.7 hectares, the average loss of potential income over five years from

Figure 5

Cropland planted with new wheat varieties

New plant varieties took time to be adopted.



Source: Byerlee and Moya 1993.

slow adoption and inefficient use of high-yielding varieties was nearly *four times* its annual farm income before the introduction of the new seeds.

Eventually the green revolution did boost the incomes of poor farmers and the landless. A survey in southern India concluded that, between 1973 and 1994, the average real income of small farmers increased by 90 percent, and that of the landless—among the poorest in the farm community—by 125 percent. The poor benefited greatly from increased demand for their labor, because the high-yielding varieties demanded labor-intensive cultivating techniques. Calorie intakes for small farmers and the landless rose 58 to 81 percent, and protein intakes rose 103 to 115 percent.

What knowledge gaps and information problems mean for development

The story of the green revolution shows how creating, disseminating, and using knowledge can narrow knowledge gaps. It also shows that know-how is only one part of what determines society's well-being. Information problems lead to market failures and impede efficiency and growth.

Development thus entails the need for an institutional transformation that improves information and creates incentives for effort, innovation, saving, and investment and enables progressively complex exchanges that span increased distances and time.

The relationship between knowledge gaps and information problems is clear from the history of the green revolution, because with time it became obvious that improved varieties of plants were necessary but not sufficient to improve the lives of the rural poor. The twin challenges of knowledge for development—knowledge gaps and information problems—are also illustrated in many other examples in this Report. How they will be manifested in the next green revolution, perhaps involving gene splicing and cloning, we can only guess. We can be sure, however, that whether or not new technologies are used in ways that help the poor will depend on how well society addresses knowledge gaps and information problems.

Part Three of the Report considers the policy options for responding to these challenges from two perspectives:

- *What can international institutions do?* Chapter 9 discusses how—by creating new knowledge, transferring and adapting knowledge to the needs of developing countries, and managing knowledge so that it is kept accessible and constantly refreshed—international institutions can help developing countries bridge knowledge gaps and resolve information problems.
- *What should governments do?* Drawing on the first two parts of the Report, Chapter 10 describes how the governments of developing countries can narrow knowledge gaps, address information problems, and design policies that take into account the reality that information and markets are always imperfect.

The rest of this Overview sketches the main conclusions from these two chapters.

What can international institutions do?

Development institutions have three roles in reducing knowledge gaps: to provide international public goods, to act as intermediaries in the transfer of knowledge, and to manage the rapidly growing body of knowledge about development.

Just as there are national public goods, so there are international ones, and many types of knowledge fall into this category. No single country will invest enough in the creation of such goods, because the benefits would accrue to all countries without the creating country receiving full compensation. But international institutions, acting on behalf of everyone, can fill this gap.

One of the best-known examples, the Consultative Group for International Agricultural Research, funded the

green revolution through its worldwide sponsorship of agricultural research. It illustrates the standard response of public funding for research when there are large social returns (which exceed the private returns). Another response is to provide financial incentives for private researchers to focus on the needs of developing countries, such as the need for an affordable vaccine for AIDS.

Perhaps even more important is the role of development institutions as intermediaries. International research may produce knowledge useful for development, but the most important knowledge for development comes from developing countries themselves. Each change in policy in one country produces knowledge that may help another. Every project, successful or not, yields information about what works and what does not. Amassing this knowledge, assessing it, and making it available to others is a task beyond the capacity (and self-interest) of any single country. So the task falls to international institutions.

How well these institutions perform depends on their ability to manage vast amounts of information. For example, every World Bank staffer who works in a developing country accumulates knowledge about a particular sector or region or activity. Often this knowledge is used for the specific task requiring it, then shelved. Think how much more valuable it would be if that knowledge were made available to every other staff member working on similar issues and projects. Then add the much greater benefit to be had from sharing that knowledge with the rest of the world.

The information revolution is making it easier to manage this wealth of knowledge. By 2000, the World Bank intends that relevant parts of its knowledge base will be made available to clients, partners, and stakeholders around the world. The objective is to develop a dynamic knowledge management system capable of distilling knowledge and making it available for further adaptation and use in new settings. To do that effectively, however, also requires building the capability in developing countries to assess and adapt relevant policy and technical knowledge to local situations, and when necessary to create new knowledge, which in turn may be relevant for other countries.

International institutions can thus make important contributions. But it is what developing countries do themselves that will determine how effectively they make use of knowledge and deal with information failures. Different countries start from different positions and face different problems. But some generalizations can be made, and some are offered in the following sections.

What should governments do?

When development is considered from the perspective of knowledge, three key insights emerge:

- Because the market for knowledge often fails, there is a strong rationale for public action. The state is in a unique position to narrow knowledge gaps—for example, by adopting an open trade regime, supporting lifelong learning, or establishing a sound regulatory environment for a competitive telecommunications industry.
- Information is the lifeblood of markets, yet markets on their own do not always provide enough of it, because those who generate information cannot always appropriate the returns. Public action is thus required to provide information to verify quality, monitor performance, and regulate transactions to provide the foundation for successful market-based development.
- No matter how successful a government may be in this endeavor, knowledge gaps and information failures will remain. Every policy reform and every development program or project will be implemented in an environment that suffers from these problems to varying degrees. Even actions that on the surface have little to do with knowledge gaps or information failures are almost certain to be affected by them.

How should developing-country governments proceed, given the magnitude of knowledge gaps and the universality of information failures? Chapter 10 draws some policy conclusions from the discussions in the rest of the Report.

National strategies to narrow knowledge gaps

The Report considers a number of steps that governments can take to facilitate the acquisition, absorption, and communication of knowledge. Although it is useful for expository purposes to discuss each of them separately, in the real world they are intertwined. Policies adopted in one area have important repercussions on—and possible synergies with—each of the others. The acquisition of knowledge, whether imported from abroad or created at home, requires the absorption of knowledge, abetted by universal basic education and opportunities for lifelong learning. The exploding capacity and plummeting costs of communications technology greatly expand the potential for both the acquisition and the absorption of knowledge, creating new opportunities for two-way information flows. Government strategies to narrow knowledge gaps are most effective when they make the most of these synergies. But they also need to address information failures in their design and implementation.

Policies for acquiring knowledge

For developing countries, acquiring knowledge involves two complementary steps: obtaining knowledge by opening up to knowledge from abroad, and creating knowledge not readily available elsewhere. Three key means of facilitating the acquisition of knowledge from abroad are

an open trading regime, foreign investment, and technology licensing.

Improving the policy and business environments to create conditions favorable to trade, especially exports, is one of the most important ways for countries to obtain knowledge from abroad. To compete in the global marketplace, exporting firms must meet international benchmarks for efficiency and design. As a result, exporters tend to invest more in knowledge than firms that do not export.

Openness to foreign direct investment goes hand in hand with an open trading regime, and it provides benefits for the acquisition of knowledge in its own right. Because multinational investors are global leaders in innovation, their activities in developing countries can be important in transmitting knowledge. Valuable knowledge spillovers can occur through their training of local staff and through contacts with domestic suppliers and subcontractors. Both are evident in Malaysia, where the local plant of the U.S. firm Intel Corporation now subcontracts a growing part of its production to new firms set up by former Intel engineers. Such spillovers are not limited to manufacturing; they also occur in relatively low-technology service industries, such as food services and hotels.

Technology licensing plays a growing role in developing countries' efforts to acquire knowledge. International licensing and royalties payments worldwide increased from \$7 billion in 1976 to more than \$60 billion in 1995. Technology licensing is an effective way to get access to some of the new proprietary technologies. Domestic firms can also use licensing to leverage technological development by negotiating access to the underlying design principles of the licensed technologies, as many Korean firms have done.

As the world moves toward a knowledge-based economy, there has been a trend toward stronger protection of intellectual property rights. This trend is reflected in the recently completed agreements in the World Trade Organization on the trade-related aspects of intellectual property rights. Intellectual property rights try to balance the incentives for the generation of new knowledge with those for its dissemination. That balance is difficult to achieve. The balance is also evolving, as new technologies bring new issues for negotiation, such as the protection of biotechnology, biodiversity, and computer and information technologies.

Developing countries should participate actively in continuing international negotiations on these issues, to express their concerns that tighter intellectual property rights shift bargaining power toward the producers of knowledge and increase the knowledge gap by slowing the rate of adaptation. These concerns about intellectual property rights have to be balanced against their advantages: they stimulate the creation of new knowledge in the

world, including in developing countries. Many developing countries have found that by establishing and enforcing intellectual property rights standards that comply with international practice, they gain access to foreign markets and to foreign technology through direct investment and technology transfer.

Developing countries can take advantage of the large global stock of knowledge only if they develop the technological competence to search for appropriate technologies and to select, absorb, and adapt imported technology. The green revolution showed how new seed strains had to be further developed to suit local conditions. Even in manufacturing, knowledge produced in other countries often has to be adapted to local conditions, such as weather, consumer tastes, and the availability of complementary inputs. Similarly, progress in education, health care, and agricultural extension all require local knowledge that cannot be obtained from abroad.

In fostering the domestic creation of knowledge, governments have a special role in supporting potentially productive research, while establishing the necessary conditions for the private sector, in response to market forces, to apply the new knowledge created. Many developing countries are reforming their public research and development to make it more responsive to the market. Brazil, China, India, Korea, and Mexico have launched vast programs to help focus public laboratories on the needs of the productive sector. Their measures include corporatizing research institutes, improving the pay and recognition of researchers, and offering firms incentives to contract directly with the public labs.

Policies for absorbing knowledge

The explosion of new knowledge, accelerating technological progress, and ever-increasing competition make lifelong learning more important than ever. To narrow knowledge gaps, societies must ensure basic education for all and provide opportunities for people to continue to learn throughout their lives. Basic education is the foundation of a healthy, skilled, and agile labor force. Lifelong education beyond the basics enables countries to continually assess, adapt, and apply new knowledge.

In the past 30 years, developing countries have made enormous strides in expanding enrollments at all levels, particularly in primary school. These achievements have been invaluable and should be maintained and expanded. We have seen, for example, the importance of basic education in furthering the adoption of improved agricultural techniques. A growing economy, even a low-income one, needs people with up-to-date technical skills to participate in the global economy. Countries should consider supporting expanded adult education and training. In many cases the most cost-effective way of doing so is to support

the private sector's activities in this area, for instance by establishing standards and accreditation procedures, and in some cases by providing subsidies, especially for the poor.

Improving the education of girls is particularly important in countries with large knowledge gaps. The benefits of female education, today widely recognized, include better child nutrition and health and reduced fertility. The recent success of a program in Bangladesh demonstrates that well-planned government actions can have far-reaching impacts, even in societies where girls' education has long been neglected. Nationwide, only about 20 percent of Bangladeshi women were literate in 1990, and only a third of students in secondary schools were girls. Since then a program to provide stipends and tuition grants to girls enrolled in secondary school has rapidly increased female enrollments. By 1996, half a million girls were receiving stipends, and as many girls as boys were enrolled in participating schools.

But to sustain economic growth and to compete in the global economy, countries must go beyond basic education, as Korea has done. By 1960 Korea had achieved universal primary education—the basis for a well-educated labor force—which fueled the economy's needs as it industrialized. Incentives were also put in place for extensive private investment in tertiary education, so that by 1995 more than half of college-age adults were enrolled in a college or university. Of these, more than 80 percent were enrolled in private institutions, and private spending on tertiary education exceeded public spending.

Tapping the private sector is one way to stretch limited government resources; a complementary measure is to improve the quality of public education. To do this, and to address some of the information failures afflicting education, many countries are experimenting with new approaches to providing it. These changes take several forms: decentralizing administration, increasing school autonomy, switching to demand-side financing, increasing information about individual educational institutions, and fostering competition among private, nongovernmental, and public providers. In El Salvador, after its civil war, the government improved and expanded the community-managed schools that had sprung up when the public system broke down. Even the poorest communities set up and managed such schools, actually improving quality. One reason is that parents monitor the teachers vigorously. As a result, students lose only about half as many days to teacher absenteeism as in conventional schools.

Policies for communicating knowledge in the information age

Advances in communications have transformed society before: movable type, photography and telegraphy, the telephone, television, and the fax machine all pushed out-

ward the limits of our ability to store and transmit knowledge. Now the convergence of computing and telecommunications appears ready to shatter those limits, making it possible to send vast amounts of information anywhere in the world in seconds—at an ever-decreasing cost. This new technology greatly facilitates the acquisition and absorption of knowledge, offering developing countries unprecedented opportunities to enhance educational systems, improve policy formation and execution, and widen the range of opportunities for business and the poor. One of the great hardships endured by the poor, and by many others who live in the poorest countries, is their sense of isolation. The new communications technologies promise to reduce that sense of isolation, and to open access to knowledge in ways unimaginable not long ago.

A growing number of developing countries are taking advantage of these opportunities to leapfrog to the new technologies, largely skipping such intermediate stages as copper wires and analog telephones. Already Djibouti, Maldives, Mauritius, and Qatar all have fully digitized telephone networks. In this they have stolen a march on some industrial countries where half or more of the telephone network continues to rely on older technology, more expensive and lower in quality.

Throughout much of the developing world, however, access to even basic communications technology is available only to the fortunate few. South Asia and Sub-Saharan Africa have only about 1.5 telephone lines for every 100 people, compared with 64 lines per 100 in the United States. Lower incomes account for part of the difference, but many people in developing countries who are ready and willing to pay for a telephone are unable to obtain one. Standing in their way are inefficient state monopolies and regulatory regimes that unintentionally restrict supply. Worldwide, an estimated 28 million people, nearly all of them in developing countries, are on waiting lists for telephone installation. Given the long and uncertain delay, many others who want a telephone and could afford one simply have not bothered to apply.

Fortunately, countries can eliminate these bottlenecks—and lower the costs of telecommunications so that many more people benefit. This can be done by adopting a regulatory system that promotes and ensures competition, to prevent firms with monopoly power in some areas of service provision from using it to gain a stranglehold over others. In most cases, expanded competition should come before privatization, to avoid turning a state monopoly into a private one.

Developing countries are discovering that private involvement can rapidly extend telecommunications services, even when incomes are low. Before its reform, Ghana's telecommunications system was dominated by a money-losing state monopoly, only one in 400 people had a tele-

phone, and there was a 10-year wait. The government sold 30 percent of the state firm to a consortium of domestic and Malaysian investors, approved a competing national franchise that also included foreign investors, licensed five new cellular providers, and approved several Internet service providers, one of which now has an aggressive program to provide rural access through collaboration with the post office. In 1997, the first year after the reforms, the number of fixed lines increased by 30 percent, to 120,000, and the pace of installation is expected to accelerate.

One problem that often remains with privatization is that some isolated rural communities are not served, because they have too few people stretched out across too much territory to attract private service providers. The problem for government is knowing how much subsidy is needed to encourage private service to these communities. Chile has had encouraging success with subsidy auctions, a market-like innovation that induces firms to reveal information about their costs, to the benefit of the poor. The government awarded subsidies on a competitive basis to firms providing telephone service to small and remote locales: firms bid against each other for the right to service these areas. Unexpectedly, for half the locales and nearly 60 percent of the target population, firms proved willing to provide pay phones at no subsidy at all. With additional rounds of bidding going forward, it is expected that 98 percent of Chileans will have access to pay phones by 2000.

Expanding telecommunications holds the promise to improve every developing country's capacity to absorb knowledge, for example by providing opportunities for high-quality, low-cost adult learning. The Virtual University of the Monterrey Institute of Technology in Mexico is a consortium of collaborating universities, including 13 outside the country. It enrolls 9,000 degree and 35,000 nondegree students each year in Mexico and other Latin American countries. It delivers courses through printed texts and live and prerecorded television broadcasts, with communication between students and faculty aided by computers and the Internet.

The African Virtual University, headquartered in Nairobi, seeks to increase university enrollments and improve the quality and relevance of instruction in business, science, and engineering throughout Africa. In each participating country, a local institution is competitively selected to oversee operations. This institution provides hardware and software for interactive courses, registers students, supervises study programs, offers a structured study environment, and awards local course credit. The university has installed 27 satellite receiver terminals throughout Africa and developed a digital library, to compensate for the dearth of scientific journals in African universities. Although it is too early to assess results, such initiatives are

reason to hope that new technology can make a big contribution to narrowing knowledge gaps.

Policies for addressing information failures

Part Two of the Report describes how markets thrive—or wither—depending on the flow of information, and how information failures are especially pervasive in developing countries. Although information failures can never be eliminated, recognizing and addressing them are crucial to effective markets and therefore fundamental to rapid, equitable, and sustainable growth. As the green revolution showed, information failures in the market for knowledge itself or in related markets (such as for credit) can limit the returns to acquiring knowledge. Put another way, countries can increase the return to acquiring and using knowledge by ensuring that markets function as well as possible.

Whatever actions governments undertake, significant information imperfections and the corresponding market failures will remain, and this fact has important implications for policy design. Because these imperfections are greater in developing countries, and the institutions for addressing them often more limited, market failure will also be more prevalent. Policies need to account for this. For instance, rural extension schemes should recognize that farmers may face credit rationing, may be able to borrow only at extremely high interest rates, and may have only limited ability to absorb risk. This will limit their ability to take advantage of new assistance, for example in the form of improved seeds.

A comprehensive strategy for the effective use of knowledge requires that governments seek ways to improve information flows. But governments suffer from information limits of their own, and an appreciation of these limits should inform decisions about the scope and nature of public action. It is not just the size of the market failure that matters—it is also the government's capacity to deal with it. But as the discussion below makes clear, developing-country governments have helped to improve markets in many ways by addressing information failures.

Part Two develops in detail the types of information problems that plague developing economies. It then explores the steps that governments can take to deal with those problems in three areas where information failures are especially severe: financial markets, the environment, and measures for the poor. Here we look at three approaches to information problems that cut across all these areas: providing information to help verify quality, monitoring and enforcing performance, and ensuring two-way information flows. We highlight throughout how governments are experimenting with innovative mechanisms to reduce the costs of collecting, analyzing, and applying information. By addressing information failures up front,

governments are discovering new solutions to seemingly intractable problems, especially those that afflict the poor.

Providing information to help verify quality

Governments can smooth the workings of markets by requiring the disclosure of information that reduces the costs of market transactions, especially information about the quality of the good, service, or institution involved. In India in the 1950s, when rising production costs led producers to dilute milk, buyers were unable to determine the quality of milk sold in the market. Dairy producers who did not dilute their milk could no longer compete, leaving the market to low-quality producers. Milk quality was restored when the government took steps to ensure quality by establishing reputable brand names and distributing an inexpensive, handheld device for measuring butterfat. The results were not only more and better milk but also healthier children and higher incomes for dairy farmers.

In education and labor markets, accreditation and skills certification inform employers about the education and skills of prospective workers. Given the increased importance of lifelong learning and the increasing variety of settings in which education is provided, certification will become increasingly important, and governments should help set and validate the standards used.

In the financial sector, which is particularly prone to information problems, accounting and auditing standards make it possible for investors to compare information across firms. Standardization of balance sheets, income statements, cash flow statements, and the notes to these statements allows companies to report on their situation and activities in a consistent way, so that investors can make better-informed judgments about where to put their money. Developing-country governments can hasten the spread of good accounting standards by imposing accounting and disclosure requirements on publicly traded firms.

Similarly, common and rigorous standards make it possible to assess the health of banks, by enabling outsiders to assess the adequacy of loan-loss provisions, for example, and by ensuring that collateral is valued realistically. Improving such standards is important for an efficient financial system and for economic growth. Confidence in financial institutions enables them to attract more capital and avoid the dangers that arise from undercapitalized banks.

Improvements in accounting standards are important for the efficiency of the financial system—and for growth. Studies show that countries with sound accounting systems have more-developed financial intermediaries and faster growth. One study estimated that if Argentina had raised its accounting standards in the early 1990s to

the average then prevailing in a group of high-income economies, its annual GDP growth would have increased by 0.6 percentage point.

Governments can also promote specialized private institutions to verify the quality of goods and services. For example, the ISO 9000 quality certification procedures are private standards to which firms voluntarily adhere as a means of guaranteeing the quality of their processes and products. Such certification is especially valuable to developing-country exporters eager to establish a reputation for quality among skeptical buyers. In this case, governments need do little more than publicize the availability of the certification process.

This example shows that direct public action to set standards is not always necessary. Instead, governments can establish an institutional and legal environment, including trademark protection for brand names, that fosters private standards setting. Producers of goods whose quality is not fully apparent at the time of purchase—whether cola drinks, cars, or computer games—can use brand names to establish a reputation for quality. This enables producers to charge a premium for quality, which makes it worthwhile to market high-quality goods, which in turn benefits consumers. Of course, brand names can address information problems only if the government establishes and enforces legal standards to prevent brand piracy.

Generation of information by agents other than the government also shows promise in addressing complex environmental issues. The International Forestry Resources and Institutions Research Program in the United States brings together a network of collaborating research centers throughout the world. The centers agree on a common research method. They support the collection of primary data on forest conditions, management, and uses. And they interpret and analyze information gathered in the field. In this bottom-up approach, a university-based project serves as a clearinghouse for locally provided information with global implications.

Governments are also experimenting with self-revelation mechanisms to achieve disclosure of information at lower cost. The Chilean auction scheme already mentioned elicited information about the level of subsidy required without the government having to investigate the cost structure of each firm. A similar approach has been applied to social safety nets, ensuring that the benefits accrue to the poor while minimizing leakage to the non-poor. Means-testing, the approach commonly used in industrial countries, is expensive and often unworkable in developing countries, because the household incomes of poor people cannot be reliably determined. An alternative that reveals the needed information at close to zero cost is self-targeting, whereby benefits—be they wages or food

for work—are designed so that they are attractive only to the truly needy.

Monitoring and enforcing performance

Besides the means to verify the quality of the goods or services they buy or sell, participants in markets need a legal system to enforce contracts. Typically the problem in developing countries is not the absence of laws. Instead, it is the lack of credible enforcement: courts may be slow, and they are often corrupt, making judicial reform a necessary part of economic reform. Many countries would benefit from special courts to deal with various specialized legal issues, such as the enforcement of commercial contracts and the treatment of bankruptcy. In these countries, enforcement and, more broadly, laws that require disclosure are meaningful only if there are penalties against dishonesty and fraud.

But even when the legal system works, it is costly to use. So, in both industrial and developing countries, economic arrangements seek to be self-enforcing, to provide the right incentives on their own, with the legal system as the backdrop. Thus, credit markets are enhanced by a legal system that allows individuals to post collateral and other security for loans and allows creditors a reliable means of collecting debts when debtors fail to repay. Bankruptcy laws are therefore another essential part of a well-functioning legal system for modern private sector activity. Other government functions, such as land titling, also enhance the use of collateral. Similarly, land reform can ensure that more poor farmers have collateral, enhancing their access to credit.

The provisions of commercial law that determine the damages that may be collected if a party breaches a contract can provide important incentives to fulfill commitments. Again, achieving the right balance is crucial. If damages are too difficult to collect, there will be too few incentives to fulfill contracts; if too easy, and injured parties are overcompensated, parties may claim breach of contract under false pretenses. Criminal prosecution of fraud, undertaken when a party deliberately or repeatedly engages in promises that it does not intend to fulfill, can be an important supplement to civil action.

The government must also monitor and enforce performance, especially in finance and banking, where failure to comply with standards may not be readily apparent. Good accounting procedures are of little use if firms traded on the stock exchange are permitted to hide bad news or conceal profits. Monitoring and enforcement are also crucial in banking, given the risks of contagion (systemic risks from which the whole economy suffers) and the cost to taxpayers of banking failures. Government action in these areas can have repercussions for the entire economy. After suffering a costly banking crisis in the 1980s, Argentina adopted strict liquidity and capital requirements, which

have since helped maintain banking stability. In Thailand, relaxed limits on real estate lending led to a boom—and then a bust, which contributed to the Asian financial crisis of the late 1990s. Retaining ceilings on real estate lending might have helped avoid the problem.

In banking and finance, as in other areas, the appropriate approach to monitoring and enforcement depends both on the circumstances of the country, such as banks' capacities for risk management and the nature of the risks facing the country, and on the capabilities of the regulatory authorities. Simple rules such as ceilings on real estate lending, restrictions on the rate at which that lending may increase (speed limits), and limits on exposure to foreign exchange risk are often appropriate responses in countries that have limited regulatory capacity and face a volatile external environment. These countries may also favor stricter capital reserve requirements to provide incentives for prudent lending. Incentives for good behavior are important, because even the most effective monitoring and enforcement remain imperfect.

Countries with more sophisticated financial markets may find that the scope for evading certain regulations has increased with the arrival of new financial instruments, such as derivatives. They will have to adjust their regulations accordingly. In some cases they will have to abandon certain outmoded regulations, and in others increase disclosure requirements. Many industrial countries are shifting to regulation based on oversight of financial institutions' risk management systems. Although this can be an important complement to transaction-based regulation, they are not likely to be a perfect substitute, especially in developing countries. The dramatic failures of some financial institutions in the industrial world, large losses in others, and the questionable lending patterns of some banks—including their lending to risky countries around the world—cast doubt on the adequacy of these systems. The International Monetary Fund and the Bank for International Settlements are looking into new ways of ensuring the stability of these systems.

Just as government need not set standards directly, so it need not undertake all necessary monitoring and enforcement. Part of the success of Argentina's reforms comes from having "multiple eyes." By increasing the number of market players—such as subordinated debt holders, who have their own incentives to keep an eye on the banks—regulators have increased the chance that any failure to comply with the new standards will be detected and exposed.

One of the most promising innovations in third-party enforcement is the group lending exemplified by Bangladesh's Grameen Bank and Bolivia's Banco Solidario. In Grameen Bank's model, would-be borrowers first form small groups. Although the loans go to individuals, all members of a group understand that if any member de-

faults, none will receive subsequent loans. This gives them an incentive to monitor each other's performance, increasing the probability of repayment. Since the groups form voluntarily, borrowers can use their knowledge of their neighbors to exclude the riskiest, thus mitigating another common problem for lenders. Group lending also gives borrowers, many of whom have limited exposure to formal institutions of any type, an opportunity to learn in the company of neighbors about how credit works, and to keep abreast of each other's ideas and progress. Governments can promote group lending by incorporating the idea in public credit programs, by subsidizing the startup costs of nongovernment programs, and by providing general information about the approach.

Another innovative example of third-party monitoring is community enforcement of environmental standards. Environmental officials in Indonesia, frustrated with weak legal enforcement of water pollution standards, hit upon the idea of collecting information on compliance and disclosing it to the public. The resulting program, called PROPER, collected firm-level data on pollutants and compiled those data into a single index. A color-coding system assigned black to the worst establishments and green to the best (none of the firms earned gold, reserved for exemplary performance). Even before the information was made public, firms hurried to improve their ratings. After publication, citizens' groups used the ratings to pressure underperforming factories to clean up. Regulators, meanwhile, could focus their limited enforcement resources on the worst offenders. In the first 15 months of the program, roughly a third of the unsatisfactory performers came into compliance with the regulations.

Ensuring two-way information flows

Much of the discussion so far has focused on ways to facilitate the flow of knowledge from those who have much of it to those who have less: from industrial countries to developing, from governments to citizens, from teachers to students. But effective communication must be a two-way street. Sharing knowledge with the poor requires an understanding of their needs and concerns—and earning their trust. Only then can they be offered knowledge in a form that they can use and will accept. Almost always, listening to the poor is the first step in doing this well. And through listening, public action can benefit from knowledge that the poor themselves have to offer.

Building trust should be a priority for any program seeking to provide knowledge to the poor. Access to knowledge is of little benefit if people do not trust the source. Health workers can suggest good contraception techniques, but poor women might not use them because they suspect that the workers do not understand their life circumstances. Similar concerns lead many poor people to avoid schools and unfamiliar jobs.

Trust was essential in a health program in the state of Ceará, Brazil, where a third of the people live in extreme poverty. Starting in the 1980s, the government hired 7,300 workers (mostly women) as community health agents at minimum wage, with 235 nurses to supervise them. Recruiting people who already cared about health, the program gave them varied tasks and responsibility for results. It also launched a media campaign to raise awareness of the agents' efforts and the new health services. Mothers who previously had hidden their children from government health workers gradually began to see the agents as friends. As a result, vaccination rates for measles and polio rose from 25 percent to 90 percent, and infant mortality dropped from 102 per 1,000 live births to 65 per 1,000.

Because poor people know their own needs and circumstances, taking time to listen to them can greatly improve outcomes. In Rwanda in 1987, high charcoal prices created demand for more fuel-efficient stoves. A stove patterned on a Kenyan model proved unpopular in early trials; tests in 500 households led to changes in size, color, door design, and portability. Government assistance, managed by a team of women, involved publicity campaigns, market surveys, training programs for stovemakers, and limited initial assistance for modernizing stovemaking equipment. Private entrepreneurs then took over production and sales, without subsidies. Three years later, one in four urban households was using the redesigned stove, achieving fuel savings of 35 percent.

Scientists at the Institut des Sciences Agronomiques in Rwanda and at the Centro Internacional de Agricultura Tropical in Colombia collaborated with local women farmers to breed improved bean varieties, after they realized that listening to the women farmers in selecting crop varieties could greatly improve outcomes. The two or three varieties that the scientists first selected led to only modest increases in yields. The women were then invited to examine more than 20 bean varieties at the research stations and to take home and grow the two or three they thought most promising. They planted the selected varieties using their own methods for experimenting. Thanks largely to their better knowledge of the terrain and their personal interest in achieving higher yields with the breeds they had selected, their selections outperformed those of the scientists by 60 to 90 percent.

Beneficiary participation in the design and implementation of projects is another way of learning from the poor. The World Bank uses beneficiary assessments in its social fund projects, in which communities receive funding for projects they themselves have selected. In Zambia, for example, the views of the poor were incorporated through open consultations in public village meetings. Beneficiary participation has been shown to have a powerful impact on project outcomes. A study of 121 rural water supply projects in 49 countries found that 7 out of

every 10 projects succeeded when the intended beneficiaries participated in project design, but only 1 in 10 succeeded when they did not.

Some jurisdictions have gone further in harnessing opportunities for participation. The city of Porto Alegre, Brazil, has pioneered a system of participatory budgeting that gives citizens a direct say in expenditure evaluation and allocation. Assemblies across the city account for and evaluate performance from past years; set priorities in education, health, transport, taxation, city planning, and urban development; and then elect representatives to a citywide participatory budget council. Through systematic evaluation of the relative needs of various regions and discussion of allocation criteria, the budgeting council establishes the city's investment plan. It is estimated that, in 1996, nearly 100,000 people, or about 8 percent of city residents, were involved in some stage of the budget deliberations. The changes have increased the resources available for investment; early reforms improved the efficiency of tax collection and were attended by the introduction of additional local taxes. By better identifying priorities and more effective means of investment, the participatory process put these resources to better use. The results have been striking. By 1996, sewerage services had been extended to 98 percent of households (up from half in 1989). Half the city's unpaved roads were paved. And the number of students enrolled in primary and secondary school doubled.

Threats and opportunities

Narrowing knowledge gaps and addressing information problems are clearly important, but neither is easy. Indeed, we know that these gaps and problems will persist, even in the industrial countries. For example, governments can never be sure of the long-run environmental impact of actions taken today. Nor will governments know fully how information failures will influence policy outcomes, even for policies that on the surface have little to do with information.

One challenge for governments everywhere, therefore, is to recognize the persistence and universality of knowledge gaps and information problems. The resulting uncertainty calls for caution and experimentation whenever possible. It should also induce a modicum of humility among those who offer policy advice—and a modicum of caution in those who receive it. Both should recognize that local conditions matter for the success of programs, that people on the ground have the most knowledge of local conditions, and that the challenge of knowledge for development is to combine local knowledge with the wealth of experience from around the world.

The challenge of recognizing the limits of what we know applies to our understanding of knowledge itself—and to this Report. The study of knowledge for develop-

ment is a new field where much remains to be done. There is ongoing controversy, for example, about how to measure knowledge. Without a standard measure, we cannot determine whether knowledge gaps are growing or shrinking. Similarly, we lack a measure of a society's ability to address information problems and the resulting market failures. Finally, although the Report identifies many policies to improve the application of knowledge for development, additional work is needed. We hope that this Report will provide a starting point for future research on these and other unanswered questions about knowledge for development.

Yet governments and citizens in developing countries cannot wait for this analysis to be completed. The global explosion of knowledge presents urgent threats and opportunities. The globalization of trade, finance, and information flows may be making it easier in principle to narrow knowledge gaps between countries, but the accelerating pace of change in the industrial countries means in many cases a widening gap in practice. Modern life's disruption of traditional communities is dissipating informal channels of information exchange and only slowly supplying new institutions in their place. And some information problems, such as those associated with global financial flows, have been worsened by recent trends.

For developing countries, then, the global explosion of knowledge contains both threats and opportunities. If knowledge gaps widen, the world will be split further, not just by disparities in capital and other resources, but by the disparity in knowledge. Increasingly, capital and other resources will flow to those countries with the stronger knowledge bases, reinforcing inequality. There is also the danger of widening knowledge gaps within countries, especially developing ones, where a fortunate few surf the World Wide Web while others remain illiterate. But threat and opportunity are opposite sides of the same coin. If we can narrow knowledge gaps and address information problems, perhaps in ways suggested by this Report, it may be possible to improve incomes and living standards at a much faster pace than previously imagined.

Each country and community must address these challenges in its own way, taking into account the many ways in which knowledge is acquired, and the variety of institutions that can help to mitigate information failures. Poor people, who are hurt most by knowledge gaps and information problems, stand to gain the most from development strategies that take these problems into account. Knowledge of how to treat common illnesses and improve crop yields is critical, but the power of knowledge goes beyond the impact of specific techniques. As people grasp the ways in which knowledge can improve their lives, they are encouraged to seek out new knowledge and become agents of change themselves.