III

Support for Technology Development and Transfer

In any particular country, a variety of economic, social, environmental, and institutional factors can create high barriers to technology development and transfer. These factors will be discussed under broad headings:

- Systems for providing scientific research, public health, and education,
- Economic infrastructure, such as transportation and communications networks,
- Financial, legal, and political institutions, including intellectual property rights,
- Natural resources and environmental regulations, and
- International treaties and trade policies.

Support for technology development and transfer includes contributions to reducing barriers and increasing incentives.

Research, Health, and Education Capacity

Research systems—both public and private—play a critical role in developing new productivity-enhancing agricultural technology, as well as in facilitating technology transfer and adaptation to developing countries. Scientists with knowledge of local crops and environments are crucial for ensuring the selection and development of appropriate technologies. Issues of finance and governance are relevant to the performance of agricultural research, just as they are in other areas of public investment or public policy. Developing political support for public sector agricultural research, finding the means of financing such research, and setting priorities that are reflected in the allocation of research budgets are important policies that support technology development and transfer.

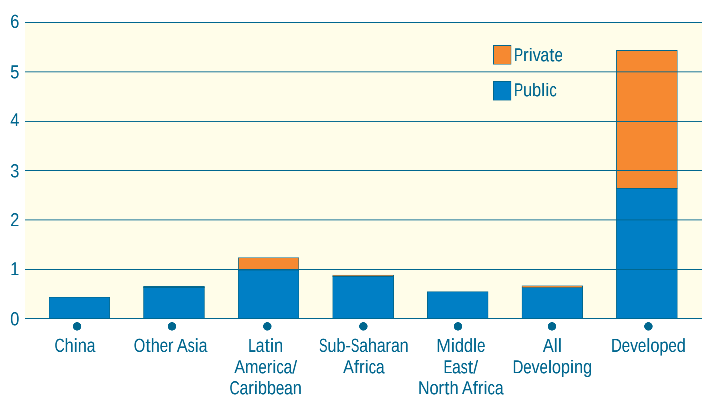
The Importance of Infrastructure

There are many characteristics of a developing country that will determine the success of technology transfer activities, business endeavors, or other ventures. The term "infrastructure" is often used to represent these characteristics. Webster's Dictionary defines infrastructure as "the underlying foundation or basic framework, and ... the permanent installations required for operation." The institutional, economic, and physical conditions of a country (its infrastructure) represent the environment in which activities can successfully take place. In the context of the role of science and technology for increasing the capacity of developing countries to benefit from global trade, there are three types of critical infrastructure:

- Research, health, and education systems
- Transportation and communication networks
- Financial, legal, and political institutions.

Agricultural R&D Expenditures as Percent of GDP, 1995

Percent of GDP



Most low-income countries do not have large financial resources to invest in the training of scientists, maintenance of research facilities, or many other components of a strong agricultural R&D program. Asian countries have been able to invest more than most countries in Africa, as is reflected by the relative levels of per capita food production in the two regions. The average level of agricultural R&D expenditure in Asia, however, is still below the world average. Since resources may not be available for domestic investment in research, there is a need to transfer technologies to increase agricultural productivity and income. But technology transfer entails more than just shipping machines, seeds, or blueprints. Experts with knowledge of their country's characteristics are needed to adapt technologies and to develop effective incentives to ensure adoption and efficient use.

Internet-Based University

A recent innovation in higher education is the development of Internet-based university programs. The earliest experiments were in business-related fields. One U.S. on-line university has about 60,000 students attending classes through the Internet, and 4,000 of these are from overseas. For some fields, particularly in the bench sciences, personal interaction and extensive classroom and laboratory time are still important for part of the training. Current on-line programs are expensive, but may be cost-effective for developing-country students, compared with international travel and time away from jobs and family.

The Consultative Group on International Agricultural Research (CGIAR)

CGIAR is an association of public and private members supporting a system of 16 Future Harvest Centers that work in more than 100 countries to mobilize cutting-edge science to reduce hunger and poverty, improve human nutrition and health, and protect the environment. The CGIAR partnership includes 24 developing and 22 industrialized countries, 4 private foundations, and 12 regional and international organizations that provide financing, technical support, and strategic direction. Individual members make voluntary contributions to the Centers and programs of their choice, allowing funds to be targeted to areas of research and regions that align with development priorities. All benefits of CGIAR research are kept within the public domain, freely available to everyone.

The 16 Future Harvest Centers of CGIAR are:

CIAT – International Center for Tropical Agriculture, Colombia

CIFOR – Center for International Forestry Research, Indonesia

CIMMYT – International Maize and Wheat Improvement Center, Mexico

CIP – International Potato Center, Peru

ICARDA – International Center for Agricultural Research in Dry Areas, Syrian Arab Rep.

ICLARM – World Fish Center, Malaysia

ICRAF – World Agroforestry Center, Kenya

ICRISAT – International Crops Research Institute for the Semi-Arid Tropics, India

IFPRI – International Food Policy Research Institute, USA

IITA – International Institute of Tropical Agriculture, Nigeria

ILRI – International Livestock Research Institute, Kenya

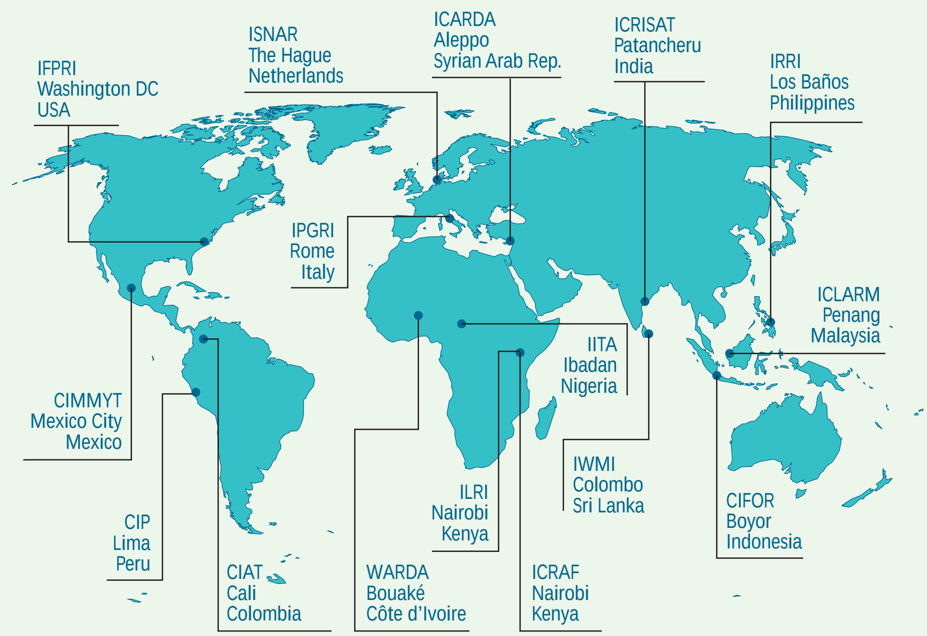
IPGRI – International Plant Genetic Resources Institute, Italy

IRRI – International Rice Research Institute, Philippines

ISNAR – International Service for National Agricultural Research, The Netherlands

IWMI – International Water Management Institute, Sri Lanka

WARDA – West Africa Rice Development Association, Côte d'Ivoire



Labor quality may vary with differences in experience and education, making investment in basic education another potential complement to investment in agricultural research.

Research infrastructure in the poorest regions can be improved through direct investment in facilities and education in the developing country, and through the support of such organizations as the World Bank, the Rockefeller Foundation, and the Consultative Group on International Agricultural Research (CGIAR). International collaboration in public agricultural research has been very successful in transferring basic and applied knowledge throughout the world.

Complementary public investments may also influence the success of agricultural research and technology transfer. A strong public health system is important to the success of new agricultural technology and to the development of agriculture generally. If the agricultural labor force is in poor health, it will be much more difficult to raise agricultural productivity with or without new technology. Malaria, tuberculosis, and other chronic diseases as well as the prevalence of micronutrient deficiencies compromise food and nutrition security.

Education is important at all levels to support the development and transfer of science and technology. In addition to the scientists directly involved in research, there is a need for trained individuals to develop and implement regulations that affect technology use. Qualified people are also needed to represent their country's interests in international negotiations. Decision-makers need the expertise to understand the positive and negative implications of their actions within the complex human and ecological environment of their country.

Labor quality may vary with differences in experience and education, making investment in basic education another potential complement to investment in agricultural research. Particularly for knowledge-intensive technologies such as precision agriculture, farmer education may be crucial to adoption. It is important that educational opportunities be nondiscriminatory, for example on gender or ethnic grounds. Women often make the agricultural production decisions, and their knowledgeable input into technology choices is essential.

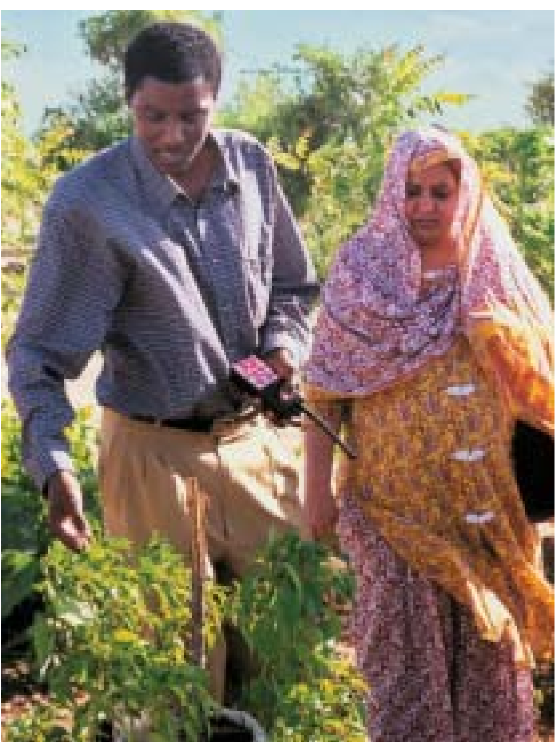
Economic Infrastructure

Economic infrastructure includes services from public utilities such as power, telecommunications, water supply, and sanitation and sewerage; and from public works and transport systems such as dams and canals for irrigation and drainage, roads, railways, airports, ports, and waterways. Infrastructure can be highly complementary to science and technology in increasing agricultural productivity, and lack of infrastructure can seriously constrain agricultural development.

For example, those countries that had poor transportation, irrigation, and financial systems did not benefit from the Green Revolution technology as much as those countries that did. Green Revolution technology was most closely associated with new crop varieties that were combined with increased use of fertilizer in areas with irrigation or more rainfall. The countries in which high-yielding varieties were most successful also had functioning roads, irrigation systems, options for credit, and markets and distribution channels.

A functioning agricultural market is dependent on a strong communication infrastructure. Rural areas rely on public information to be integrated into the national economy. Basic communication that needs to be made available includes information about health and sanitation hazards, weather, public transportation schedules, labor and market opportunities, and rights to public resources. Information from scientists and agricultural experts about production practices needs to be disseminated as widely as possible. Moreover, as farmers vary production to include horticulture, vegetables and fruits, and other products that must be delivered quickly, there is a premium on real-time information about markets.

Information and communications technology has been transformed throughout the world, by computer and Internet use and by wireless telephone technology. These innovations can help farmers in all countries by providing up-to-date market and labor information. These innovations can also serve to provide educational opportunities and timely transmission of critical information. For those farmers in developing countries with Internet access, agricultural extension information and research results can be disseminated widely. Farmers could also alert researchers to emerging pest pressures and environmental conditions. To make this technology more effective in smallholder agriculture, however, literacy and physical infrastructure, such as electrical power, must be as widely accessible as possible.



Cell Phone Use in Bangladesh

The Village Phone concept in Bangladesh was developed by a not-for-profit company called Grameen Telecom (GTC). In partnership with GrameenPhone Ltd and the Grameen Bank, GTC has established the cell phone equivalent of the public pay phone in remote areas without land-line phone service. A Grameen Bank member obtains ownership of the phone under a lease-financing program and provides the services to the people in the adjoining area. The operator receives an income from the use of the cell phone. GTC supplies the necessary hardware and provides training for operating the phone. With this service, each villager has access to labor and agricultural marketing information. Women all over Bangladesh are buying cell phones using loans from a network of microfinance loan institutions that the U.S. Agency for International Development (AID) helped establish. Grameen estimates that one Village Phone covers approximately 2,500 people in a village, and the total coverage is currently 12.5 million rural people in Bangladesh.

Domestic expertise that is fostered by strong research and education capacity will be needed to make decisions that are based on sound science and that meet the needs of the country.

Financial, Legal, and Political Institutions **(Institutional Infrastructure)**

The introduction of new technologies requires new policies to ensure health, safety, or environmental quality. Stable institutions are important for long-term planning and investment in technology development. Open and transparent investment regulations that are compatible with global trading rules will encourage both domestic and foreign investment. Perceived fairness will also encourage participation at all levels, which will encourage foreign investment as well as farm-level cooperation with technology development plans. Well-functioning markets that operate internationally and locally depend on the strength of a country's financial, legal, and political institutions. Private investment in technology development and transfer from domestic and foreign sources will not be forthcoming without a strong demand by farmers and a well-functioning infrastructure.

Financial institutions provide capital for research, physical infrastructure, and farm credit. Devising agricultural credit systems that fit the needs of smallholders has been difficult in many countries, especially those with large income gaps, complex land ownership, weak banking systems, and under-employment. This is an important barrier because many new agricultural technologies require the use of purchased equipment or inputs, making credit essential to their widespread use.

Legal institutions often reflect a country's social history. Rights and private asset ownership will determine who has access to institutional assets such as education, finances, or the right to participate in the political process. For agricultural producers in developing countries, control of land is often a critical determinant of technology adoption. Investment in agricultural technology is often related to a farmer's security of land tenure. In addition, natural resource conservation efforts with long-term benefits may be hampered without land tenure security. As mentioned above, contracts that could facilitate better access to inputs or improved markets need to be legally enforceable.

Political institutions need to be stable to support opportunities for agricultural development. Yet the political environment of a country is more than just the formal deliberations of a national leader or a legislative body. It includes the planning, administrative, regulatory, and enforcement functions that are often dismissed as "merely bureaucratic." These functions, if performed efficiently, are critical to the research, development, dissemination, and adoption of science and technology.

Development planning must have the support of government leaders and the general population so that agricultural production and environmental quality goals reflect the true needs of the country. The benefits of any development plan will increase when science and technology policies are integrated in the plan, and when there is a framework to implement the decisions. Technical support for planning from other countries may be needed, but the goals and objectives must be national.

In support of planning and implementation, there is a need for a regulatory process that is designed to protect the health and well-being of the people and the environment. The assessments of new technologies need to be done quickly and thoroughly. Domestic expertise that is fostered by strong research and education capacity will be needed to make decisions that are based on sound science and that meet the needs of the country. Regulatory frameworks and testing protocols from other countries can be used as models. Domestic scientists and technical experts, however, are needed to monitor and adapt implementation to regional circumstances.

In many countries, a tension exists between agricultural and environmental interests, even within the government. With increased understanding of the complex interactions between agricultural production and environmental assets, opportunities arise to develop a science and technology plan that supports a country's agricultural development and environmental quality goals. In some countries, there is no regulatory system within which science-based decisions can be made. Without such a system, potentially beneficial innovations and technologies are not being considered for investment or adoption.

Several specific components of the institutional infrastructure are particularly important for understanding barriers to science and technology transfer: A nation's system of intellectual property rights, access to germplasm for research, and the body of domestic agricultural policies will all influence relative prices and incentives for public and private research.

Intellectual property rights (IPR)

This is one set of legal rights of particular importance to research and technology transfer. As the United Kingdom's Commission on Intellectual Property Rights stated, "(t)he critical issue in respect of IPR is perhaps not whether it promotes trade or foreign investment, but how it helps or hinders developing countries to gain access to technologies that are required for their development." Currently, the lack of comprehensively specified and enforceable intellectual property rights constitutes a major barrier to the sharing of knowledge and technology among countries, and a disincentive to local and foreign research investment in new technologies. In general, nations that generate technology prefer strong intellectual property protection, while those that depend on imported technologies prefer few restrictions on the use and imitation of that technology.

Over the past 20 to 30 years, intellectual property systems have become increasingly important factors affecting research in industrialized countries. Intellectual property mechanisms, such as patenting, confer exclusive rights to inventions for a limited time, to offer an incentive for research and to protect private sector investment in new technologies and products by restricting the use, sale, and manufacture of these innovations. Research investment can be costly, and the probability of success low. Many firms would not risk funding research if

Local Company Sells Seeds to Small-Scale Farmers

Pannar is the oldest domestic maize seed company in South Africa, and it has just over half of the market. The privately held company has prospered because the strong South African laws protecting intellectual property rights have encouraged companies to invest in the agricultural sector. Pannar provides the latest hybrid seeds to commercial growers at competitive prices. In addition, the company has maintained cheaper maize seed products that are a generation behind the latest hybrids but are nonetheless productive under South African growing conditions. Pannar provides these seeds at affordable prices to small-scale farmers, which has increased agricultural productivity. South Africa provided the investment environment that offered incentives for private businesses to support national goals.

Plant Variety Protection

Rules and regulations governing plant variety protection, or plant breeders' rights, and patents for biological innovations differ widely among countries.

Plant Breeders' Rights in the U.S.

In the U.S., the Plant Variety Protection Act (PVPA) was adopted in 1970. The main features of plant breeders' rights legislation are the:

- definition of a distinct variety (as opposed to an "essential derivative")
- rights of farmers to save seed for their own use (or to re-sell it)
- research exemptions for use in other breeding programs
- time period covered by the grant of a certificate.

These provisions are consistent with the International Union for the Protection of New Varieties of Plants (UPOV), which took effect in 1968. In 1985, utility patent protection in the U.S. was extended to plants.

Plant Breeders' Rights Outside the U.S.

Most Western European countries passed plant breeders' rights legislation in the 1960s and 1970s. Australia and Canada adopted plant breeders' rights around 1990. Other industrialized countries have been more reluctant than the U.S. to grant patent protection to living organisms, although the European Patent Office in 1999 moved to grant patents on genetically engineered crops. Most key elements of intellectual property protection systems in Europe and Japan are similar to those in the U.S., although important distinctions remain with respect to the treatment of plants and animals and the scope of patentable matter.

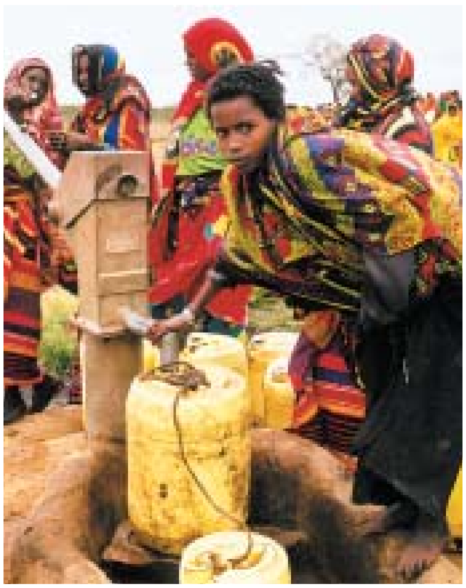
Some developing countries such as Argentina instituted plant breeders' rights as early as the 1930s, but most do not have intellectual property protection systems that are comparable to those in developed countries.

African Agricultural Technology Foundation

In concert with the Rockefeller Foundation, four agricultural technology giants, Dow Chemical, DuPont, Monsanto, and Syngenta, have agreed to share their patented technologies for free with the African Agricultural Technology Foundation (AATF). The U.S. Agency for International Development is contributing to the effort. The AATF is an experiment—a new concept designed to aid in the transfer of promising new technologies developed by the private sector to advance African agriculture. The focus will be on facilitating research on improvements in staple crops of vital importance to Africans, including cowpeas, chickpeas, cassava, sweet potatoes, bananas, and maize.

The AATF is a nonprofit organization designed to facilitate the transfer, adaptation, and adoption of agricultural technologies by small farmers in Sub-Saharan Africa. The organization is controlled by a majority African board to ensure that sustainable development and agricultural ecology goals of Africans are met. The organization's key role will be in licensing technology from the private sector and contracting with African and other organizations to ensure that licensed technology is appropriately adapted and reaches farmers.

Finding technological solutions to many of Africa's problems—such as drought, insects, and plant diseases—often involves a thicket of patent rights, licensing and cross-licensing arrangements, and private interests that run counter to solving these problems. The AATF will cut through this thicket by making royalty-free license agreements with the four firms and get the new technologies and improved seed varieties into the hands of small farmers of local staple crops.



Public Sector Intellectual Property Resource for Agriculture

An effort called the Public Sector Intellectual Property Resource for Agriculture (PSIPRA), developed by the Rockefeller and McKnight Foundations, is designed to support plant biotechnology research in developing countries. The PSIPRA will encourage public universities that license their patented agricultural technologies to private firms to retain some rights to the technologies for humanitarian purposes. In some cases, these technologies would be applied to small specialty crops. The first objective of PSIPRA is to establish a clearinghouse to facilitate access to biotechnology innovations by providing information on existing patents and emerging technologies and to provide educational and information services to help institutions implement effective licensing strategies.

Developing countries may not have the resources in research and legal infrastructure to obtain needed inputs for scientific developments.

they were unable to obtain a return on the investment. Therefore, new technologies become available earlier than they would without intellectual property protection.

While intellectual property protection has been a feature of chemical and mechanical innovation in industrialized agriculture for some time, changes in intellectual property protection that have had the greatest impact on agricultural R&D have involved biological innovation. The two major forms of protection are plant varietal protection, or plant breeders' rights, and the application of utility patents both to plants and to biological research tools.

Although intellectual property protection may speed some inventions to the market, exclusive rights to fundamental innovations may impede further technological progress. Often, technology development is cumulative, and scientific advances depend on past innovations. Restrictions on the use of innovations for research could limit future research or needed adaptations of past inventions. This barrier to research is an issue in developed as well as developing countries. Partnerships between public institutions and private companies often include provisions to grant access to public research results.

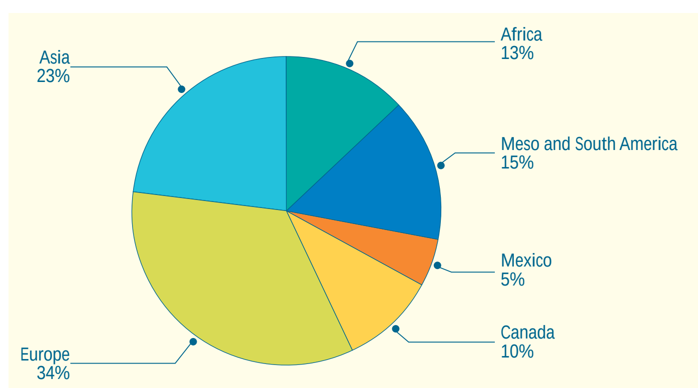
Many are concerned that private commercial research will not be done on crops that are important for local staple crops, and that public research entities will not have access to the basic discoveries necessary to develop technologies to fill smallholder needs in developing countries. For example, in the case of enhanced vitamin A rice, the innovation is based on technologies protected by around 70 patents originally held by about 30 different institutions. To use the research innovation, scientists (or their organizations) would have to negotiate with each patent holder for use of the rights. Developing countries may not have the resources in research and legal infrastructure to obtain needed inputs for scientific developments. In some circumstances, opportunities may exist to create public-private alliances and joint ventures to develop appropriate technologies in developing countries.

Germplasm access

Crop improvement through traditional plant breeding methods and modern biotechnology depends critically on crop genetic resources. Pests, pathogens, and climates change continually, so breeders need new genetic resources from which to choose desired traits. For example, germplasm is used in a research program to search for resistance to or tolerances of biotic stresses. Even though many sources of germplasm are located in developing countries, the usefulness of these resources to these countries depends on research funding and infrastructure to utilize the materials.

International use of the U.S. National Plant Germplasm System (U.S. NPGS) collection of seeds, plants, and other germplasm materials plays an important role in providing public germplasm free of charge to scientists and institutions in other countries. During the past decade, the U.S. NPGS distributed 162,673 germplasm samples of 10 major crops (barley, beans, cotton, maize, potato, rice, sorghum, soybean, squash, and wheat) to scientists in 242 countries.

International Distribution of U.S. National Plant Germplasm System Germplasm for 10 Major Crops, by Region, 1990-99



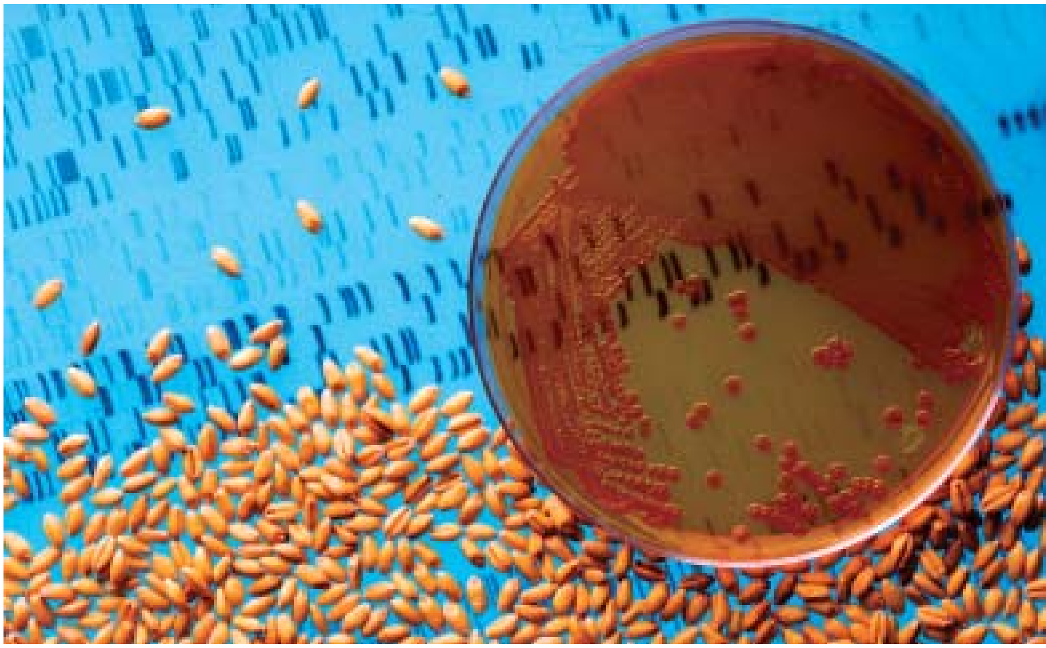
Given economic and environmental constraints on cropland expansion, the bulk of increased crop production in the future must come from increased yields on existing cropland.

The International Plant Genetic Resources Institute also shares genetic resources with the scientific community, and has helped to establish over 1,300 national and regional genebank collections. Enhanced availability of genetic resources and increased indigenous research capacity will make it easier for crops to be developed to meet the unique needs of each developing country.

Historically, plant genetic material was freely collected and shared. Developing countries—with a wealth of biological diversity in situ (in the wild and on fields)—often provided raw genetic material to public genebanks worldwide. However, international policy has moved toward a system in which countries retain rights over their own genetic resources, and the services of farmers in the selection, development, and conservation of their traditional varieties—the foundation on which plant breeding is based—are better recognized. The goals of granting national ownership to genetic resources were to provide incentives for the conservation of diverse germplasm and to address perceived economic inequities between suppliers and demanders of germplasm. This new policy approach is represented by the International Treaty on Plant Genetic Resources for Food and Agriculture, which the U.N. Food and Agricultural Organization approved in November 2001 and which now awaits ratification. This international treaty will govern international exchange of germplasm among countries participating in a multilateral system. Issues of particular interest to developed and developing countries that remain to be resolved, however, include the implementation of benefit sharing, financing conservation, and the list of crops in the system.

Domestic agricultural policies

In many developing countries, the agricultural sector makes an important contribution to the gross national product (GNP). However, domestic policies often penalize agriculture and distort markets, and may be counterproductive in the long run. Farmer and investor choices of technologies and practices are based on prices and costs. If these economic signals are distorted by fiscal or monetary policies, the technology adoption incentives will not be optimal. Market price supports, direct payments to farmers, input subsidies, agricultural taxes, or monetary and trade policies can mask the "true" prices and costs of production and product, thus distorting incentives for the adoption of technology.



Natural Resource Quality and Environmental Sensitivity

A country's natural resource base and environment are crucial factors in determining realistic sustainable agriculture development goals. Although climate and natural disasters are not under a planner's control, the vulnerability to these factors can be mitigated.

There are striking regional differences in cropland quality. Among the countries of Sub-Saharan Africa, an average of 6 percent of cropland has soils and climate that are of high quality for agricultural production. The proportion of high-quality cropland is higher in other regions, ranging from an average of 20 percent among Asian countries, to 28 percent among the countries of Latin America and the Caribbean, and 29 percent among high-income countries. In countries with poor soils and climate, basic inputs such as fertilizer and water are more important than they are in countries that are better endowed.

Given economic and environmental constraints on cropland expansion, the bulk of increased crop production in the future must come from increased yields on existing cropland. In some areas, yield increases may be constrained by soil ero-

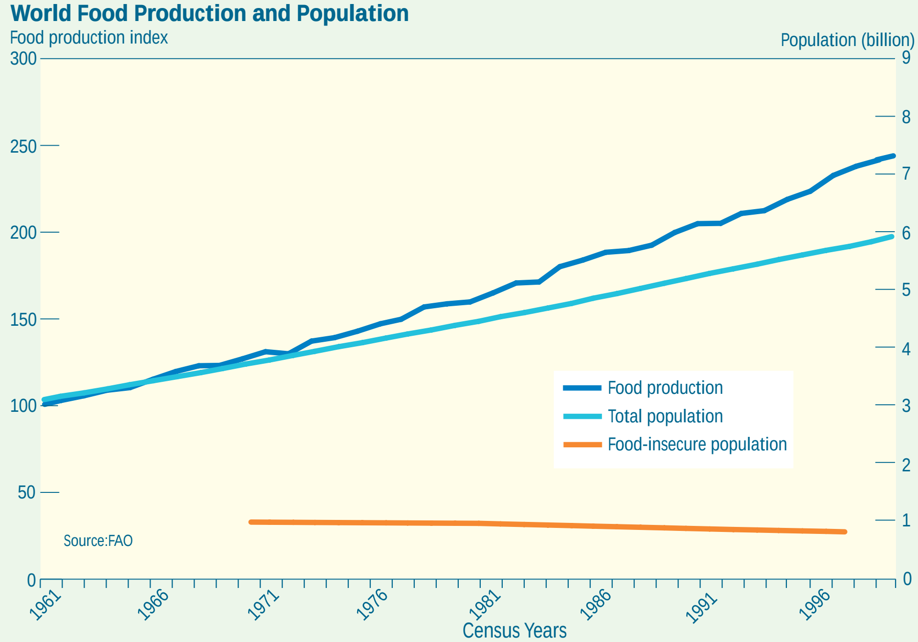
***Land degradation** refers to changes in the quality of soil and water that reduce the ability of land to produce goods and services that people value. Some forms of land degradation, such as nutrient depletion, can be halted and even reversed relatively easily, for example, by appropriate application of fertilizers. Other forms of land degradation, such as erosion or salinization, can be slowed or halted through appropriate management practices, but are generally very costly or time-consuming to reverse.*

Land Quality Affects Agricultural Productivity

Increased resource use and improvements in technology and efficiency have raised global food production more rapidly than population increases in recent decades, but 800 million people remain food insecure. Meanwhile, growth in agricultural productivity appears to be slowing, and land degradation has been blamed as a contributing factor. Estimates of land degradation's impact on productivity vary widely.

Research indicates that land degradation does not threaten productivity growth and food security at the global level. Nevertheless, problems do exist in some areas, especially where fragile resources are found along with poverty and poorly functioning markets and institutions. Recent analysis shows that potential yield losses to soil erosion vary widely by crop and region, but average 0.3 percent per year. Yield losses on such a scale could reverse recent improvements in the number of people who are food insecure. But actual yield losses are likely to be lower to the extent that farmers have incentives to adopt technologies and practices to reduce soil erosion. Also, holding other factors constant, this analysis finds that the productivity of agricultural labor is generally 20-30 percent higher in countries with good soils and climate than it is in countries with poor soils and climate. The quality of labor (measured by literacy and life expectancy), institutions (measured by the absence of armed conflict), and infrastructure (measured by the extent of roads and agricultural research expenditures) also affected agricultural productivity.

World Food Production and Population



Trade liberalization… brings about important transfers of technology, capital investment, and knowledge across borders.

sion and other forms of land degradation. Recent U.S. Department of Agriculture studies show that yield losses (or lack of gains) due to soil erosion vary widely by crop and region, and the losses critically depend on the agricultural practices that are used. To lower these losses, improvements in resource-conserving technologies in some developing countries, and in incentives to farmers to use appropriate practices, may be needed.

In developing countries, increased yields have come at the cost of negative environmental impacts. These impacts may include water pollution, salinization and land abandonment, lowering of groundwater levels, and loss of biodiversity with more uniform crops. However, large areas of environmentally fragile land, which might have been pressed into production had yields not increased in the more favored areas, were saved. Nonetheless, in recent years many developing countries, including those that have benefited the most from the Green Revolution, have been showing signs of a slowdown in agricultural productivity gains. At least part of this slowdown might be attributed to environmental problems related to intensive agriculture. Therefore, greater research emphasis on environmental concerns is increasingly important.

International Agreements and Policies

The effectiveness of a country's science and technology policy will depend, to some extent, on international agreements and policies. These international policies are largely out of the control of a single nation, but domestic policy development must take them into account. The complexity of many of these agreements, however, makes it difficult to accurately assess the extent and timing of impacts.

The World Trade Organization (WTO) is a multilateral institution charged with administering transparent rules for global trade among member countries. The WTO fosters trade liberalization that, in turn, brings about important transfers of technology, capital investment, and knowledge across borders. The WTO was established in 1995 as a result of the Uruguay Round, where countries agreed to initiate a more fair and market-oriented agricultural trading system. At the 4th Ministerial in Doha in 2001, WTO members engaged in new multilateral trade negotiations. For agriculture, the Doha Declaration calls for substantial improvements in market access, and the reduction of all forms of export subsidies and trade-distorting domestic support.

The *Agreement on Trade-Related Intellectual Property Rights (TRIPS)* was part of the WTO negotiations, and covers patents, copyrights, trademarks, industrial designs, plant varieties, and trade secrets. Several developing countries expressed the hope that scientific and technological cooperation between developed and developing countries in accordance with the provisions of the TRIPS Agreement would support public interest issues such as health, nutrition, environmental protection, and natural resource conservation in developing countries. Industrialized countries and international organizations were asked to help developing countries implement the TRIPS Agreement by 2006, but national expertise is needed to weigh the benefits and costs of each option. TRIPS will affect the science and technology that will be available to increase productivity.

The *Sanitary and Phytosanitary (SPS) Agreement* established a multilateral mechanism to protect human, animal, and plant health in WTO member countries. SPS measures are required to be based on scientific principles, and the nature and magnitude of the perceived risk must be clearly established. Technologies and practices used in the production of agricultural commodities for trade may be restricted under SPS rules. The science- and research-based requirements of the SPS Agreement can be substantial for a developing country.

The Biosafety Protocol to the United Nations Convention on Biological Diversity provides a regulatory framework for transboundary movements of living bio-engineered organisms. The Protocol requires that regulatory decisions to deny entry of a product in order to avoid or minimize potential adverse effects must be based on risk assessments and sound science. The importation and use of some biotechnology applications may be affected. The Protocol also establishes a biosafety clearinghouse to help countries assess potential risks from genetically engineered organisms. This provision may be useful in addressing the concerns of many countries that believe their current regulatory systems are inadequate to deal with the potential implications of the technology on the nation's environment. Even with a clearinghouse in place, many developing countries will need local expertise to make knowledgeable decisions consistent with national sustainable agriculture goals.