International technology transfer, which occurs when a country acquires, imitates, or adapts technology developed elsewhere, helps determine a country's level of agricultural productivity.

Private firms are becoming more important in agricultural technology transfer, a field once dominated by public sector institutions such as governments, international organizations, and universities. The growing private sector role stems from government policies that provide incentives for private sector involvement in research and technology transfer. Market conditions that have increased the demand for manufactured inputs such as farm chemicals and machinery have also helped encourage business involvement in technology transfer.

Technology transfer helps increase agricultural productivity, cut production costs, and lower consumer prices. The benefits depend on how the technology is transferred, the speed of transfer, and the degree of government policy influence on technology transfers.

Technology Increases Agricultural Productivity

Agricultural research has supplied farmers with new and improved technologies resulting in large yield increases. Agricultural production worldwide has grown 60 percent since the mid-1960's. Cereal yields have increased 65 percent. Important technological developments include hybrid seed, fertilizers, pesticides, mechanical improvements, and livestock and poultry vaccines. Research funds also contribute to improving managerial skills and developing more efficient farming systems.

Developments in biotechnology such as growth hormones, embryo transplants, gene insertion, and genetic engineering of plants and animals are expected to boost agricultural productivity even more. The Office of Technology Assessment estimates that during the next 20 years agricultural output will increase at an annual rate of 1.8 percent with over 60 percent of the gain from growth in yields per acre.

Examples of Technology Transfer in Agriculture

- **New crop varieties**
  High yielding or disease resistant strains, often genetically engineered.

- **Manufactured inputs**
  Fertilizers, pesticides, and other agricultural chemicals.

- **Machinery**
  Tractors and cultivators. Grain drying equipment and other postharvest technology.

- **Management techniques**
  Computers, financial statements, and tillage practices.

- **University research and training**
  Biotechnologies and new crop varieties. Training for scientists and farmers.

Technology transfer can be separate from trade in goods, but many technical advances, such as better tractors, seeds, fertilizers, and pesticides, are embodied in goods trade.
Public Sector Focuses on Research With Long-Term Payoffs

Public institutions conduct basic and applied research and technology transfer and participate in research partnerships with private firms.

Public sector research and technology transfer are needed when private firms are unable to recover the full costs of research and transfer. Research that is either not patentable, identified with only long-term payoffs, or difficult to ensure against failure is frequently conducted by public institutions. Research projects that do not directly yield marketable products often fit the criteria for public sector involvement. The competitive market system fails to provide the incentives for private sector research and technology transfer in these cases. Public sector transfers are financed out of general taxation. Some governments levy taxes on producers to help pay for the cost of agricultural research or extract royalties on technology-based exports.

Technology transfer in the public sector is channeled through federally supported research centers and extension services, direct aid programs, universities, and the International Agricultural Research Centers (IARC’s). IARC’s are an important and highly visible channel of public technology development and transfer.

International Agricultural Research Centers

IARC’s were originally funded by the Rockefeller Foundation in 1941 to help developing countries establish agricultural research centers. IARC’s train scientists; conduct research in crops, livestock, and farming systems; and disseminate genetic materials and scientific information. Governments, international organizations, and private companies now fund IARC’s. In 1986, the 13-member system of IARC’s spent $178.8 million on agricultural research. This is a small but important share of total global research expenditures.

IARC’s played an important role in the Green Revolution, a movement in which high-yielding varieties of wheat and rice were developed and disseminated during the 1950’s and 1960’s. IARC’s have been criticized, but their limitations in promoting agricultural growth in developing countries are not a consequence of the public nature of the transfer. Instead, IARC’s problems are related to the type of technology transferred and the research infrastructure of the adopting country. For example, the successful adoption of the crop varieties associated with the Green Revolution relies on inputs like irrigation and fertilizer often accessible only to large, successful farmers. The productivity growth that results may benefit only a small percentage of a nation’s farmers. Policies that encourage adoption by small farmers can help assure more equitable technology transfers in the future.

A critical factor in effective technology transfer is a strong local research program that facilitates technology adoption and adoption. Many countries lacked local research programs during the early years of the Green Revolution and could not absorb new technologies. Recently, countries have recognized this problem and have increased research funds in order to improve their ability to absorb new agricultural technology.

Decline In Public Funding

In the United States, funding for public sector research and technology transfer has declined in recent years. This is due in part to Federal budget cuts. Foreign agricultural aid such as food shipments and research funds has either remained stagnant or declined since 1984. Some private sector activities have supplanted public sector research and transfer.

The decline in public sector funding has motivated joint research projects between the public and private sectors. Through joint research programs, the private sector funds basic research carried out in public sector institutions. The private firm handles the manufacturing and marketing of developed products and processes. For example, corporations sometimes fund university seed research and then retain exclusive marketing rights to new varieties.

The public sector will likely retain its influential role in basic agricultural research and technology transfer. The government probably will not be able to design and implement policies that correct for all market failures associated with research and technology transfer, such as ensuring against risky research or providing incentives to conduct long-term basic research, but the public sector will continue to be involved in creating policies that facilitate transfer.
Two Channels of Agricultural Technology Transfer

Public Institutions

- Government research centers
- Extension services
- Direct aid programs
- Universities
- International Agricultural Research Centers

Private firms

- Multinational enterprises
- Licensing new production methods
- Sales of technically advanced products
- Joint ventures overseas

Public Sector Transfers Through International Agricultural Research Centers

Over a dozen international centers assist developing countries' agricultural research by:

- Training scientists
- Conducting research on crops, livestock, and farming systems
- Disseminating genetic material and scientific information

<table>
<thead>
<tr>
<th>Center</th>
<th>Expenditures</th>
</tr>
</thead>
<tbody>
<tr>
<td>International Center on Tropical Agriculture</td>
<td>21.3</td>
</tr>
<tr>
<td>International Center on the Potato</td>
<td>12.4</td>
</tr>
<tr>
<td>International Center for Corn and Wheat Improvement</td>
<td>21.4</td>
</tr>
<tr>
<td>International Board for Plant Genetic Resources</td>
<td>4.8</td>
</tr>
<tr>
<td>International Center for Agricultural Research in the Dry Areas</td>
<td>18.0</td>
</tr>
<tr>
<td>International Crops Research Institute for the Semi-Arid Tropics</td>
<td>20.6</td>
</tr>
<tr>
<td>International Food Policy Research Institute</td>
<td>4.5</td>
</tr>
<tr>
<td>International Institute of Tropical Agriculture</td>
<td>17.5</td>
</tr>
<tr>
<td>International Laboratory for Research on Animal Disease</td>
<td>9.3</td>
</tr>
<tr>
<td>International Livestock Centre for Africa</td>
<td>17.3</td>
</tr>
<tr>
<td>International Rice Research Institute</td>
<td>23.6</td>
</tr>
<tr>
<td>International Service for National Agricultural Research</td>
<td>4.4</td>
</tr>
<tr>
<td>West Africa Development Association</td>
<td>3.7</td>
</tr>
</tbody>
</table>

Private Firms' Role in Technology Transfer Is Growing

Private firms are becoming more important in agricultural technology transfer, aided by government policies and market conditions that provide incentives for private investment in research and technology transfer.

The private sector accounts for over half of total agricultural research expenditures and is a particularly important provider of technology in the fertilizer, pesticide, and farm machinery industries (table 1). These industries attract financial capital because investment in research leads to patentable products or processes that can earn profits. The private sector earns revenues from this exclusive marketing control when transferring technology overseas.

Increased demand for technology-based manufactured inputs and capital inputs such as chemicals and machinery has encouraged private sector involvement in research and transfer. This increased demand is partly due to the pervasive adoption of high-yielding crop varieties that require the intensive use of these inputs. The expansion of international agricultural production, which creates new foreign markets for technology and technology-based products, has also added to input demand.

Multinational Enterprises

Multinational enterprises (MNE's) transfer technology when parent firms locate production or research facilities in a foreign country. In the lumber, fertilizer, and chemical industries, firms often establish subsidiaries to contribute only one phase of the production process, such as raw material processing or finishing.

Subsidiaries generate two kinds of technology transfer: transfers between the parent firm and the subsidiary, and transfers between the subsidiary and other firms in the host country. This second type of technology transfer, a form of free-riding, may discourage MNE's from conducting agricultural research. If the cost of free-riding becomes too high, the public sector may intervene through policy or public sector research.

MNE's establish subsidiaries abroad to take advantage of lower production costs or to adapt products or processes to meet local production and demand requirements. MNE's selling in local markets can also avoid costly import tariffs and nontariff barriers.

But MNE's also incur costs when they transfer technology. They are:

- Development costs. Research and testing to produce the innovation.
- Adoption costs. Incurred if the MNE must adapt the process or product to meet local needs, such as soil conditions, climate, and water availability.

Technology transfer costs are lower if the technology is well understood by the transferring party, the technology is older, and other firms use similar technology in the recipient country. The most costly technology transfers occur for products and processes that are recently developed, untried, and have had limited previous diffusion.

Multinational activity is common in the farm machinery, chemical, and seed industries. The largest market for medium-sized tractors is in Europe where U.S. tractor firms have established subsidiaries. The subsidiary allows the parent company to maintain market share and at the same time avoid trade barriers on U.S.-produced tractors. In the agricultural chemical industry, MNE's have become more important because the cost of bringing a new chemical to market squeezes out smaller chemical companies.

Firms can also transfer technology without establishing overseas subsidiaries, through:

- Commercial sales of technology-based products or processes that directly transfer innovations through a new product. Commercial sales also implicitly transfer skills required for the use and service of the product or process. For example, sales of pesticides to farmers overseas require instruction in the proper application techniques.
- Joint ventures between firms. The investing firm contributes technology, capital, and marketing expertise while the recipient firm contributes knowledge of the local business climate, access to the local markets, and expertise in local adaptation of the new technology. U.S. tractor companies have joint ventures with the Japanese who produce small tractors for the U.S. market. The U.S. firm supplies knowledge about U.S. markets, and the Japanese supply the necessary technology.
The private sector's role in the development and transfer of agricultural technology will continue to increase due to rising demand for manufactured inputs. Public policy also will likely continue to create incentives for private participation in technology development and transfer. The private sector will maintain its influence in the development and transfer of agricultural chemicals and machinery technology. Joint agreements between the private and public sectors may also increase. The public sector would provide basic research, and the private sector would provide the marketing and production expertise.

What draws firms into agricultural technology transfer?

**Opportunity for profits**

**Market Factors**
- Rising demand for technology-based products.
- High yielding crop varieties use chemicals and other manufactured inputs.
- Growth in world agricultural demand.

**Policy Factors**
- Government policies encourage business involvement.
- Patent systems protect firms' rights to their innovations and to any profits that result.
- Less direct government role in technology transfer.

<table>
<thead>
<tr>
<th>Table 1--Agricultural research expenditures by U.S. industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research field</td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
</tr>
<tr>
<td>Biotechnology</td>
</tr>
<tr>
<td>Human food</td>
</tr>
<tr>
<td>Plant breeding</td>
</tr>
<tr>
<td>Pesticides</td>
</tr>
<tr>
<td>Other*</td>
</tr>
</tbody>
</table>

*Includes farm machinery and equipment, biologics, animal nutrition and feeds, plant nutrients, packaging materials, energy research, agricultural economics, natural fiber processing, and tobacco products and processing.

Patents Play Key Role in Technology Transfer

Patent protection of innovations in home countries and in foreign markets is crucial for technology transfer. The United States is encouraging other countries to improve their patent systems.

Patents are used in many countries to help encourage the development and transfer of agricultural technology. Although patents restrict access to a particular innovation, they often motivate imitative and adaptive research.

International patent agreements, which grant equal proprietary rights to nationals and non-nationals, aid transfers of agricultural technology. Public institutions and private firms obtain patents from other countries if they intend to market or license their innovations abroad. A country may grant patents to foreigners because importing technology may cost less than funding domestic research. Firms may prefer to purchase or license some innovations and pursue other, more profitable research. But countries that rely largely on imported technology may not gain the long-term benefits of establishing a domestic program, such as more successful transfer and less reliance on imported technologies.

Governments in some developing countries refuse to sign patent agreements because they believe the treaties benefit only the patent recipient. These countries must either rely on domestic research to imitate new technology or illegally appropriate technology because firms hesitate to market their products in nonsigning countries or in countries with weak patent laws. The United States, concerned by the illegal use of patented agricultural chemicals in nonsigning countries, is encouraging these countries to enter into international patent agreements. Negotiators at the current General Agreement on Tariffs and Trade (GATT) talks are considering international protection of intellectual property.

International Patent Activity

A measure of technology transfer is the share of agricultural product patents granted to non-nationals. Table 2 points out:

- Which countries lead in exporting innovations and which depend on imports.
- What type of research is the country's specialty.

The United States granted 30 percent of its fertilizer patents to individuals, firms, or institutions from foreign countries. These are technology imports. Technology exports are patents obtained in foreign countries by U.S. nationals. Of all fertilizer patents owned by U.S. individuals, firms, or institutions, 42 percent were obtained in foreign countries.

The United States and Japan grant relatively few patents to non-nationals while Canada and Brazil grant many. This reflects the strong domestic research programs in the United States and Japan. France grants more patents to West Germany than to any other country. This shows France's relatively weaker position in agricultural technology research and the similarity between the two nations' agricultural sectors.

Canada depends on the United States for agricultural technology. Because Canada and the United States produce similar commodities under similar conditions, it is not surprising that Canada is a primary market for U.S. innovations. Canada's reliance on the United States for innovations also reflects its relatively weak position in world patent ownership. Canada holds less than 6 percent of the total patents granted worldwide in agricultural fields.

The leaders in agricultural biotechnological research are the United States and Japan, accounting for over 70 percent of the total biotechnological innovation. The United States and Japan grant biotechnological patents almost exclusively to each other. For five countries—United Kingdom, France, Brazil, Japan, and Canada—the percentage of total biotechnology patents imported is greater than the percentage of postharvest and traditional technologies imported. This reflects the relative strength of these countries' research programs in traditional fields. The often prohibitive cost of developing domestic biotechnology research can result in a high level of imported biotechnology.

The United States receives foreign patent rights on a majority of its postharvest and biotechnological developments. The Japanese do not obtain foreign patent protection as often as the other countries except in three traditional agricultural categories. This may be because the Japanese develop products and processes that are not applicable in other countries.
Patents...

...grant limited monopolies and exclusive marketing rights to inventors for a period of time

...transfer technology by making details of the innovation public.

*Those who intend to market or license innovations abroad seek patents from other countries.*

*International patent agreements help foreigners gain patent protection and protect firms' patents outside the domestic market.*

**Table 2--Patent imports and exports, 1974-85**

<table>
<thead>
<tr>
<th>Country</th>
<th>Agricultural chemicals</th>
<th>Fertilizer</th>
<th>Harvesting machinery</th>
<th>Soil working and planting equipment</th>
<th>Animal husbandry</th>
<th>Postharvest technology</th>
<th>Biotechnology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imports--patents granted to foreigners by:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td>30.3</td>
<td>27.4</td>
<td>14.7</td>
<td>21.9</td>
<td>19.6</td>
<td>30.0</td>
<td>31.0</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>59.2</td>
<td>57.4</td>
<td>40.2</td>
<td>42.6</td>
<td>34.2</td>
<td>64.8</td>
<td>76.3</td>
</tr>
<tr>
<td>France</td>
<td>58.2</td>
<td>45.0</td>
<td>33.2</td>
<td>39.5</td>
<td>20.6</td>
<td>43.3</td>
<td>67.0</td>
</tr>
<tr>
<td>Brazil</td>
<td>95.4</td>
<td>63.4</td>
<td>33.1</td>
<td>31.2</td>
<td>47.8</td>
<td>56.6</td>
<td>88.0</td>
</tr>
<tr>
<td>Japan</td>
<td>35.5</td>
<td>32.0</td>
<td>18.8</td>
<td>32.2</td>
<td>60.0</td>
<td>18.6</td>
<td>27.5</td>
</tr>
<tr>
<td>West Germany</td>
<td>27.1</td>
<td>28.4</td>
<td>20.0</td>
<td>15.1</td>
<td>13.7</td>
<td>29.6</td>
<td>49.3</td>
</tr>
<tr>
<td>Canada</td>
<td>89.4</td>
<td>80.5</td>
<td>70.4</td>
<td>71.8</td>
<td>72.5</td>
<td>90.4</td>
<td>90.0</td>
</tr>
</tbody>
</table>

| Exports--patents granted by foreigners to: |          |            |                      |                                      |                 |                        |               |
| United States | 49.4                   | 42.3       | 29.6                 | 34.3                                 | 25.0            | 54.3                   | 60.6          |
| United Kingdom| 67.2                   | 50.0       | 33.0                 | 32.3                                 | 29.1            | 58.0                   | 66.4          |
| France        | 57.9                   | 42.6       | 18.5                 | 21.6                                 | 18.3            | 34.5                   | 47.5          |
| Brazil        | 58.9                   | 77.8       | 1.1                  | 12.3                                 | 20.0            | 93.8                   | 44.1          |
| Japan         | 20.6                   | 32.3       | 77.6                 | 73.0                                 | 58.9            | 15.1                   | 23.6          |
| West Germany  | 55.2                   | 42.6       | 25.5                 | 33.9                                 | 27.4            | 43.4                   | 51.7          |
| Canada        | 61.2                   | 55.1       | 45.8                 | 47.6                                 | 51.8            | 67.8                   | 62.2          |

*Brazil and Canada import a large percentage of their patents in agricultural chemicals.*

*The United States receives foreign patent rights on a majority of its developments in biotechnology.*

Table 2 adapted from W.E. Huffman and R. Evenson, "The Development of U.S. Agricultural Research and Education: An Economic Perspective." Staff Paper No. 170, Department of Economics, Iowa State University. 1987.
Economic and Political Policies Influence Technology Transfer

Government policies, including some such as domestic agricultural policies that are not intended to influence international technology transfer, can help or hurt the transfer process.

**Fiscal Policy**

Fiscal policies encourage domestic private research through tax credits or subsidies that lower research costs. General taxation can be used to fund research, or specific taxes can be levied on producers to help defray the cost of public research. Tax credits can support research-oriented firms during the early stages of growth or periods of unanticipated shocks. Tax policies may also limit or encourage multinational investment.

Interest rates can contribute to the level of technology transfer. The low interest rates of the early 1970's allowed developing countries to borrow capital instead of relying on foreign investment, thus allowing them to pursue an independent course in purchasing technology. The debt crisis of the 1980's may encourage countries to re-examine the benefits of foreign investment as a means of gaining access to new technologies instead of borrowing capital.

**Trade Policy**

Trade policies, including subsidies, quotas, and tariffs, affect the transfer of technology and technology-based products. Many countries use these policies to protect domestic industries. India limits imports of commercial seeds, a restrictive policy designed to encourage local research. While domestic seed companies may benefit, India's farmers are denied access to seed varieties that could increase productivity.

Trade policies also affect technology transfer indirectly, depending on whether they protect domestic industries or promote exports. Export expansion policies such as tax incentives and export subsidies often raise productivity growth as countries adjust to the rigor of international competition. Import substitution, the policy of protecting industries that produce goods that compete with imports, may limit productivity growth by reducing competitive pressures through tariffs and quotas.

**Agricultural Policies**

Agricultural policies that support specific crops can create incentives to adopt, develop, or transfer technologies that reduce the cost or increase the yield of those crops. For example, in the United States, agricultural price supports are capitalized into land values, making land more costly. Higher land prices increase the demand for inputs such as fertilizers and pesticides that use land intensively. Commodity price policies also encourage research on the crops covered in the program.

In many developing countries, input use is directly subsidized through agricultural policy. Subsidies encourage farmers to adopt production methods that use more of the subsidized input or produce new crops that utilize the subsidized inputs.

**Legislative and Judicial Policy**

Legislative and judicial action has affected the patentability of some products and processes. In 1984, the Supreme Court ruled in *Diamond v. Chakrabarty* that microscopic organisms were patentable. This decision encouraged private sector research in biotechnology because inventors of new products and processes can obtain exclusive marketing rights.

The Plant Variety Protection Act (PVPA), which grants rights similar to patents, is an important catalyst for private sector seed research. The U.S. Department of Agriculture has granted 1,582 PVPA certificates, mostly to U.S. firms (table 3). Before passage of the PVPA, many plant breeders worked for small seed firms or public sector institutions. Many seed varieties were in the public domain and freely traded among researchers and farmers.

Private firms now can patent seed varieties and earn profits from product development. Large chemical and pharmaceutical firms have acquired smaller seed companies since the PVPA passed in 1970. Much seed and biotechnology research at universities now is funded by private corporations who retain the exclusive marketing rights to developed products and processes. This exclusivity frequently constrains universities in sharing research with each other and the public.
Policies Affecting Technology Transfer

Patents

Trade policies
• Tariffs
• Quotas

Agricultural policies
• Subsidies on commodities produced
• Subsidies on inputs for production

Fiscal and monetary policies
• Tax credits
• Interest rates
• Exchange rates

Regulations on foreign investment and multinationals

Table 3--U.S. plant variety protection certificates, 1971-86

Private firms use a U.S. law to protect their rights to market improved varieties of plants they develop. The public sector and foreign firms hold only a small percentage of these certificates.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Issued</th>
<th>Public origin</th>
<th>Foreign origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field crops</td>
<td>805</td>
<td>15.4</td>
<td>0.8</td>
</tr>
<tr>
<td>Grasses</td>
<td>173</td>
<td>14.1</td>
<td>31.2</td>
</tr>
<tr>
<td>Vegetables</td>
<td>534</td>
<td>1.9</td>
<td>6.0</td>
</tr>
<tr>
<td>Flowers</td>
<td>70</td>
<td>NA</td>
<td>14.2</td>
</tr>
</tbody>
</table>

NA = Not applicable.

Table 3 adapted from W.E. Huffman and R. Evenson, "The Development of U.S. Agricultural Research and Education: An Economic Perspective." Staff Paper No. 170, Department of Economics, Iowa State University. 1987.
Transfers of new technology can increase output, decrease output price, and affect a country's balance of agricultural trade. The size of the economic effect depends on a country's share of world production and export markets, the sensitivity of supply and demand to changes in commodity prices, and the speed of technology transfer.

Using the United States as an example illustrates how technology adoption and transfer can affect a technology exporter and importer. First, consider adoption of a new agricultural technology by U.S. producers only. Technology in the foreign country remains fixed. The new technology raises U.S. output and lowers commodity prices. Consumers in both the United States and the rest of the world benefit from lower food prices. The more responsive demand is to price, the more producers gain from adopting new technology. Ultimately, producers' gains are capitalized into the value of fixed assets, primarily land, so that landowners benefit over the long run.

If the United States can maintain its technological lead, it can benefit from lower prices, increased exports, and a larger share of the world market. At the same time other forces erode the technology-induced competitive advantage. Lower commodity prices discourage U.S. production, relative to the level attained directly after technology adoption. A U.S. agricultural trade surplus can put pressure on the exchange rate which appreciates to restore balance of payments equilibrium. The stronger dollar discourages exports and reduces the trade surplus.

When technology used in the United States is transferred abroad, the temporary U.S. competitive advantage erodes as foreign producers benefit from lower costs of production. Productivity grows and supply expands in other countries. Consumers worldwide benefit from lower commodity prices. The growth in foreign production either decreases the demand for U.S. commodities or increases the level of foreign exports—both of which reduce U.S. market share.

To regain their trade advantage, U.S. producers must adopt more technology. This technology treadmill effect can result in a cycle of technology adoption, increased supply, and lower prices. The length of time U.S. producers maintain a competitive advantage depends on the speed of technology transfer. If foreign competitors are adept at importing and adopting new technology, the United States will be able to preserve its competitive advantage for only a limited time.

International technology transfer raises income and fosters economic growth in the adopting country, an important issue for developing countries. Countries that can expand their export base earn much needed foreign exchange to repay foreign debts and purchase imports. Growth in developing countries, enhanced by technology transfer, raises income and increases the total demand for other goods produced in developed countries.

Policies Complicate Economic Effects

Fiscal, monetary, and agricultural policies frequently complicate the economic changes caused by technology transfer. Exchange rate policies can affect the degree of technology transfer and the subsequent competitive position of a country. If the foreign country maintains an overvalued exchange rate, a common practice in many developing countries, it can worsen its competitive position. Policies subsidizing inputs used in the production of the technology-based export can improve the competitive position of a country by decreasing the cost of production. Agricultural price supports can also distort the effects of technology transfer. For example, U.S. domestic prices can be maintained through price supports even though world commodity prices fall. Total income to the U.S. farm sector declines as the United States loses its share of world exports. The income loss forces some farmers out of the sector, but fewer than otherwise would have been the case because the Government maintains domestic prices above the new lower world price.

Technology transfer can contribute to the decline in the U.S. trade position, although the drop in U.S. agricultural exports during the early 1980's was also due to a strong dollar and world recession. For example, new rice varieties developed by the IARC's along with investment in irrigation facilities allowed Indonesia to change from a major rice importer to an exporter, primarily at the expense of U.S. and Thai growers.
Rapid adoption of soybean production in South America has undercut U.S. dominance in world soybean trade. Countries specializing in processing raw materials (imported or domestically produced) have gained from the transfer of processing technologies. In forestry, for example, the U.S. exports raw lumber to both Japan and West Germany, who use superior processing technology to produce plywood and veneers. These value-added products are then sold worldwide at a considerable profit to the Japanese and West Germans.

To lessen any adverse effects of private technology transfers, such as the loss of export market share, countries can impose royalties on exports of technology or technology-based goods. Technology transfers can also be restricted through trade policies. These strategies compensate or protect domestic producers from the damaging effects of technology transfer, but they also may impede agricultural productivity growth in the rest of the world.

Economic Effects of Technology Transfer

New agricultural technologies boost output and reduce prices. The first country to adopt gains an advantage in world markets. Technology transfer spreads the gains to other countries.

...worldwide economic gain results:

- Net importers can reduce imports and potentially become exporters.
- Prices fall, benefiting consumers worldwide.
- Efficiency of the farm sector rises.
- Firms involved in technology transfers profit.

...these economic benefits carry some potential costs:

- New competition hurts trade balance of other countries.
- Producers earn less.
- Less efficient farmers are left behind.
- Profits may be sent overseas.

...but technology transfer's net effects generally are positive for the U.S. economy and the world.
In this report...

Private firms are becoming more important in agricultural technology transfer, which occurs when a country acquires, imitates, or adapts technologies that were developed in another country. New crop varieties, farm chemicals, and farm operating systems are some of the advances spread through technology transfer. This report discusses the implications of and reasons for the private sector’s expanding role in agricultural technology transfer, a field that once was dominated by public sector institutions such as governments, international organizations, and universities.

For more Information...


Also see...


Acknowledgments...

The author thanks Vicky Salin for editing this bulletin and John Reilly for his valuable assistance.

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