Special Article

New Technology Raises Food System Productivity in APEC Economies

The fundamental challenge facing the Asia-Pacific Economic Cooperation (APEC) region in the long term will be raising food system productivity to keep pace with population growth and rising affluence. The world will have to produce 40 percent more grain by 2020, of which 25 percent is needed to meet population growth and the balance to meet worldwide demand for a more diverse and resource-intensive diet.

Only about one-fifth of the increase in grain production is likely to come from expanding land under cultivation. Technology, therefore, will play a key role in raising yields at the farm level and reducing losses, enhancing quality and freshness, and increasing the speed of delivery to consumers. These developments also promise to widen consumers' choices and raise nutrition levels.

Technology development and its application in the food system depend on several diverse elements, including strong public commitment, public and private sector linkages, and a variety of supportive programs and policies such as education, infrastructure development, and extension services. Often, commitment to the development and application of new technology is related to overall economic development. But even in the less developed parts of the APEC region, there is a definite commitment to new technology, reflected in the creation of institutions and in government budgetary commitments.

Some APEC members, such as Singapore and Taiwan, are staking their futures on becoming centers of technology development. Singapore, a small city-state of 3 million people, has supported research leading to the development of high-yield, disease-resistant crops, poultry, livestock, and fish, and has created the Institute of Molecular Agrobiology (IMA), the Bioprocessing Technology Centre (BTC), and the Agri-Bio Park to provide infrastructure for tropical agrotechnology. In 1995, the Chinese Taipei government included biotechnology in a list of 10 important industries eligible for special government assistance, and a special task force in the Ministry of Economic Affairs has helped the private sector invest US$700 million (NT$23.1 billion) in biotech and pharmaceutical projects.

Biotech Beefs Up Traditional Plant Breeding

The APEC region has a long tradition of contributing to research on plant breeding. Three international experiment stations in the region—IRRI (International Rice Research Institute) in the Philippines, CIMMYIT (International Maize and Wheat Improvement Center) in Mexico, and CIAT (International Center for Tropical Agriculture) in Colombia—developed important hybrid grain varieties in the 1960's and 1970's that have been widely adopted and have contributed to the near doubling of global grain yields between 1970 and 2000. The APEC region, a heavy rice-producing part of the world (about 60 percent of the world total), saw average rice yields increase from about 2 tons per hectare in 1970 to 3.6 in 2000.

William Coyle

More than 5,000 new crop varieties have been developed in *China*, where agricultural R&D focuses on increasing production. An important example is hybrid rice, which has helped double production since 1970.

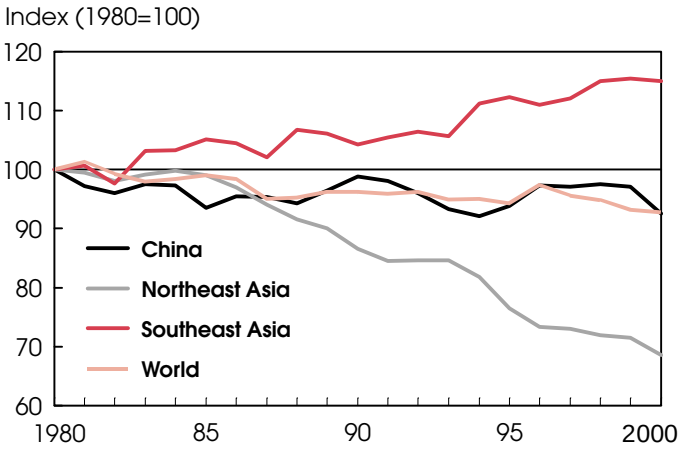
Plant breeding efforts in *Indonesia* have succeeded in developing a number of new rice varieties with higher yields and shorter maturation periods, allowing the harvesting of two to three crops per year. Besides rice, plant breeders in Indonesia have given special attention to soybeans and corn. Tissue culture has been widely used for the propagation of bananas and ornamental plants such as orchids. The Indonesian government has also sponsored the development of gene banks for preserving existing plant varieties.

In *Malaysia*, plant breeding continues to incorporate desirable characteristics into new plant varieties of fruits such as durian, papaya, pineapple, and citrus as well as rice and maize. *Mexico* has concentrated on the diffusion of improved grain varieties and hybrids, not just for increasing yields but also for encouraging better tolerance of pests and/or adverse weather conditions, particularly in drought-prone areas.

This article is based on *Pacific Food Outlook, 2000-01*, a report released at the APEC Ministerial Meeting in Brunei, November 12-14, 2000.

Special Article

Grain Area Is Decreasing in Some APEC Regions and Globally



Source: U.S. Department of Agriculture.
Northeast Asia includes Japan, Korea, and Taiwan; Southeast Asia includes Indonesia, Malaysia, the Philippines, Thailand, and Vietnam.

Economic Research Service, USDA

More recently, biotechnology is ushering in a new era of plant breeding through genetic modification or engineering. The availability of new biotech methods may help offset diminishing returns from traditional plant breeding programs and help meet rising demand for greater quantities of food from continuing world population growth and dietary upgrading. New pest-resistant and herbicide-tolerant crops offer lower input costs and, sometimes, higher yields.

As of 1999, five principal biotech crops—soybeans, corn, cotton, canola, and potatoes—were being commercially cultivated in eight countries (Argentina, Australia, Canada, China, France, Mexico, Spain, and the U.S.), five of which are APEC members. More than two-thirds of global biotech production is in the U.S., and makes up a significant share of U.S. planted area in soybeans, cotton, and corn.

An international consortium (China, France, Japan, Korea, Taiwan, Thailand, and the U.S.) is laying the groundwork for developing and refining genetically modified rice varieties. The group has invested heavily in efforts to decode the rice genome. Building on this research, the public and private sectors have already developed a number of rice varieties with distinctive characteristics, some of which will benefit production, others consumers. Most publicized is "golden" rice, developed by European researchers and incorporating beta carotene, a source of vitamin A. Vitamin A deficiency is an important health issue in low-income areas of the APEC region.

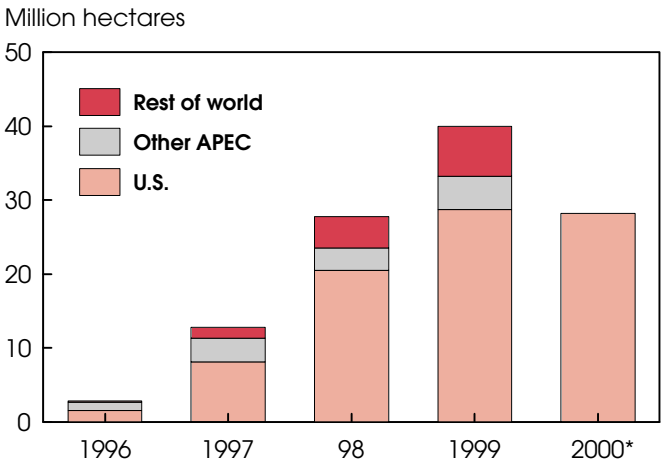
While the agronomic benefits of genetically modified crops may result in increased production and downward pressures on world prices, pressures in some markets to segregate biotech commodities may result in increased trade uncertainty and higher marketing costs. For example, in some parts of the APEC region, there are strong demands from consumer organizations for labeling biotech products. Additionally, adequate procedures for detecting the presence of biotech commodities and assessing possible risks are not available in many of the region's developing economies.

A regional bloc in the Asia-Pacific region, ASEAN (Association of South East Asian Nations), is promoting the establishment of a National Authority on Genetic Modification (NAGM) to monitor biotech products in the 10 ASEAN member countries. Each member will establish its own NAGM—representatives from national agencies involved in agriculture, trade, economics, environmental protection, health, and other disciplines—which will review and approve proposals related to the release of agricultural biotech products, provide public access to information on planned releases, and ensure guidelines are consistent with regional and international practices.

The Expanding Role Of Information Technology

Use of information technology (IT)—including hardware, software, communication devices, and the Internet—is becoming commonplace in both food production and marketing in the developed APEC economies as well as in urban areas of the less developed economies. IT makes markets more efficient by collecting and disseminating information and data—e.g., weather forecasts and real-time market news and prices—that improve farm-level decisionmaking, facilitate online marketing for businesses and consumers, and enhance communications and processes throughout the supply chain. Incorporating IT into the food supply chain provides farmers with greater access to markets, market participants with increased flows of information, businesses with opportunities for enhanced efficiency, and consumers with better services.

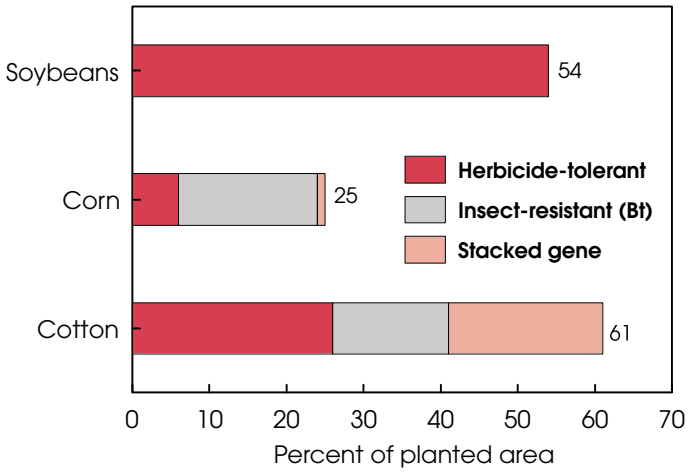
Global Area Planted to Biotech Crops Is Increasing



* Estimate available for U.S. only.
Source: C. James, "Global Review of Transgenic Crops," The International Service for the Acquisition of Agri-biotech Applications, ISAAA Briefs, 1997

Economic Research Service, USDA

Biotech Varieties Amount to More than Half of U.S. Soybean and Cotton Planted Area in 2000



Source: National Agricultural Statistics Service, USDA.
Economic Research Service, USDA

Virtual marketplaces for farmers can facilitate purchasing farm inputs, supplies and equipment, and crop insurance products, as well as marketing livestock and crops. Virtual markets can transmit product information, prices, and delivery options from participating suppliers; cash grain bids from competing buyers; or other kinds of information via user-friendly but secure systems. Web sites for conducting farm-related business online are being organized by major U.S. agriculture-related companies, as well as by local farm cooperatives and retailers.

APEC economies are investing in a variety of electronic systems to facilitate transactions on the Internet. For example, Taiwan's Council of Agriculture (COA) has allotted US$50 million (NT$1.5 billion) to a 5-year development plan to build an agricultural marketing system on the Internet. The Philippines Department of Agriculture has established the online National Information Network (NIN) to facilitate communication among researchers, policymakers, and extension agents, who in turn communicate with end users. The network includes supply and demand data and price trends; product standards and consumer safety data; and credit services. FoodConnect Australia enables agri-food businesses to trade and exchange company information and product specifications electronically in both the domestic and global markets. A key feature of the system is provision of export documentation for marketing offshore.

Auctions via the Internet bring purchasers and sellers together in a virtual marketplace. In the U.S., Internet auctions have provided a convenient market for some agricultural producers. However, Australian producers using remote electronic marketing systems for livestock and wool have encountered some difficulties in developing adequate product descriptions for trading, and they indicate that cost savings have been small relative to traditional marketing systems.

Supply chain management to expedite customs clearance and track cargo is essential to cutting delivery time and reducing marketing losses. Canada's ACROSS Customs Clearance System, which combines electronic data interchange (EDI) with bar-coding technology, promises to speed customs clearance and reduce transportation time and costs for shipments into Canada.

Preclearance of goods entering Canada, and a complementary Canadian Customs initiative that uses Automatic Vehicle Identification (AVI) technology, will speed the movement of truck traffic across its borders. Canada, Mexico, and the U.S. are testing an AVI pilot project that allows trucks equipped with transponders to pass through border crossings without stopping. When that technology is in place, only trucks that do not meet preclearance requirements and those chosen for random checks will have to stop for inspection, a boon particularly for shippers of perishable food products.

Sophisticated bar-coding will make massive quantities of data available to customers and carriers, and enable containers and vehicles, not just packages, to be tracked. The next step in transportation tracking is a reusable, affordable, electronic "smart stamp" that contains information on the shipment, along with a battery and an antenna, in a casing the size of a large postage stamp. The electronic stamp attached to a package transmits data to a nearby scanner to improve tracking and reduce transportation labor costs.

The consumer marketplace is undergoing a revolution in the more developed areas of the APEC region. For example, in Australia, several operational retail food internet sites provide information to consumers largely by suppliers advertising products and by providing access to small business marketers. On a larger scale, two of Australia's major supermarket chains, Woolworths and Coles Myer, are developing sites where consumers can order products for home delivery at a specified time.

Information Technology Is More Accessible in the More Developed Economies of the APEC Region

	Personal computers 1998	Internet service-providers July 1999
	Per 1,000 persons	*Per 10,000 persons*
Hong Kong/China	254.2	142.8
Korea	156.8	55.5
Singapore	458.4	322.3
China	8.9	0.5
Indonesia	8.2	0.8
Malaysia	58.6	23.5
Philippines	15.1	1.3
Thailand	21.6	4.5
Viet Nam	6.4	0
Papua New Guinea		0.5
Japan	237.2	163.8
U.S.	458.6	1,508.8

Source: Asia Development Bank, 2000 annual report.
Economic Research Service, USDA

Special Article

Biotech Highlights in APEC Economies

Australia is closely examining the potential for genetically modified crops, but their studies remain at the trial stage for most products. To date, Australia has conducted some 70 field trials of biotech crops, primarily cotton, canola, clover, and field peas. In 1999, almost 30 percent of Australia's total cotton area—an estimated 120,000 hectares—was sown with insect-resistant (Bt) varieties. In September 2000, the commercial release of herbicide-tolerant (Roundup Ready) cotton was approved.

The Office of the Gene Technology Regulator in Australia manages potential risks to consumers and the environment from genetic manipulation, and establishes appropriate safeguards. The Australia-New Zealand Food Authority requires mandatory labeling of biotech foods "in circumstances where the nature of the food has been significantly changed with respect to its nutritional quality, composition, allergenicity, or end use."

Canada's competitive biotech strength lies in development and commercialization of canola. More than 50 percent of canola acreage now is in biotech varieties. Canada has a number of plant biotech startups (Performance Plants, Prairie Plants, SemBioSys, DNA Landmarks), in addition to the large multinational seed companies.

In ***Chile***, initial biotech research efforts were in potatoes, but current efforts are in the fruit sector. No commercial product developed from local research is yet available.

The use of insect-resistant cotton in ***China*** has expanded to 400,000 hectares in 2000. In addition to cotton, China is commercially producing biotech varieties of tomatoes, sweet peppers, and petunias. Rice, soybeans, potatoes, corn and colored cotton are in the field trial stage.

Following the required review by ***Japan's*** Agricultural Standards Research Committee and a 1-year moratorium, biotech labeling is scheduled to begin in Japan in April 2001. Carnations are the only biotech crop being commercially produced; rice, tomatoes, melons, broccoli and cucumbers are in the development stage.

Since 1991, ***Korea*** has introduced several biotech crops into field trials, including herbicide-tolerant rice and insect- and virus-resistant cabbage, as well as virus-resistant red peppers, cucumbers, and potatoes. Korea will implement biotech labeling in June 2001.

The current ***New Zealand*** government opposes the use of genetic modification in all forms, even in field trials. A Royal Commission of Inquiry into genetic engineering has been established to investigate this topic further. Their findings are due in May 2001.

Peru's Ministry of Agriculture is developing virus-free potatoes and strawberries. Efforts are also directed at protecting Peru's diverse germplasm.

There has been no commercial production of biotech crops in the ***Philippines*** to date. Strong environmental activist groups, however, have asked the courts to prohibit the field testing of Bt corn and vitamin A-enriched rice.

Likewise, ***Thailand*** so far has no commercial production of biotech crops. Varieties of tomatoes, cotton, and corn are in the field trial stage and papaya and chili peppers are in the development stage. Some processed food products in Thailand are facing resistance from foreign buyers—e.g., canned tuna packed in soybean oil derived from imported biotech soybeans and meat from poultry fed imported corn and meal from biotech material. An agricultural declaration ratified in January 2000 limits the use of biotech seeds in Thailand to research purposes and prohibits commercial sale. Field tests of biotech cotton are under way.

The ***U.S.*** is the world leader in commercial production and in use of biotech crops, but evidence indicates that the rate of biotech adoption in the U.S. slowed in 2000. Uncertainty about the marketability of biotech crops has increased, in part because some large food processors—e.g., J.R. Simplot (potatoes), Frito-Lay, and Gerber—do not purchase biotech products, and some important foreign markets have labeling requirements (e.g., the EU) or will impose them in the near future (e.g., Japan and Korea).

Australian winemakers have invested heavily in Internet marketing. For example, Cellarmasters' online sales reached US$61 million (A$95 million) in 1999 and the company's goal is a 20-percent online sales share by 2001. Fosters Brewing Group has reportedly invested US$62 million (A$100 million) in international Internet operations and a Californian wine club.

If, as some believe, a technology starts having a significant effect on productivity when it reaches a 50-percent penetration rate, many APEC economies have a long way to go but a large potential for future benefits. Rapid growth in Internet use in Asia is projected, but online communication is still very limited, particularly in China and Southeast Asia. Internet usage is much more common in the developed economies and in the city-states of Hong Kong/China and Singapore. In rural areas of developing economies, however, Internet access is less likely, except where large national and multinational agribusinesses are located—e.g., Dole, Del Monte, and San Miguel operations in the Philippines. Rural usage remains heaviest in the U.S., where the number of farms with Internet access doubled between 1997 and 1999 (*AO* September 2000). As many as 43 percent of U.S. farms with annual sales over $100,000 and 85 percent of U.S. farmers between the ages of 25 and 45 reported Internet access.

Increasing Efficiency & Cutting Waste

Increasing the efficiency of the food system is another significant way technology can raise the quantity and quality of the food supply. Developed market consumers require 10,000 gross daily calories to support a 3,000-calorie-a-day diet. Some of the loss can be attributed to grain conversion in meat production, but a majority stems from waste and inefficiencies in the food system, including significant losses at the household level. Post-harvest losses are a problem across the APEC region (*AO* September 1999), with most losses in low-income economies occurring along the food supply chain—e.g., spoilage during transportation because of lack of refrigeration—but occurring at the end of the chain in high-income economies—e.g., waste and spoilage in homes and at food service establishments.

The combination of Asia's largely rural population and prospects for rapid urbanization in the next 20 years suggests a crucial need for developing and adopting marketing innovations to increase efficiency of food delivery. New technologies being applied in the region reduce processing, handling, and transportation costs, as well as cut delivery times and extend the shelf life and storability of food products.

In North America, transportation and logistics innovations have become commercially feasible. New intermodal technologies—such as double-stacking rail containers, reinforced trailers that are pulled directly by locomotives, and more fuel-efficient rail power—are now potentially cost competitive because lower trade barriers have increased cross-border trade and made economies of scale possible.

In packaging, consumer demand for easy-to-open, well-labeled, portable, environmentally friendly packaging has given rise to various types of resealable packages. In particular, the popularity of plastic "zipper" technologies is growing rapidly. Use of flexible polymer packaging has soared because of advantages to both consumers and food processors.

The meat processing industry is undergoing a large-scale shift to case-ready flexible packaging. This promises to reduce costs, contamination, and food losses throughout the supply chain. A combination of breathable films and new sealants now make it easy to achieve a 3-week shelf life for perishable products. Cans, glass jars, and boxes will lose share to flexibles, which offer fewer problems with broken seals, sharp edges, and breakage.

A joint venture between Meat New Zealand and private industry has developed the world's first robotic technology for meat processing. Future meat processing plants are expected to combine manual operations with automated, robot-assisted sections and fully robotic operations. Research is continuing into machine vision systems that locate large pieces of carcass, grasp individual pieces with a robot-mounted gripper, and move the pieces to the boning room for further processing.

In an effort to expand the reach of chilled food exports, New Zealand has developed a process that not only extends the chilled storage life of a product, but also improves the product by enhancing its color, flavor, and tenderness. Equipment and packaging have been developed to allow a wide range of products to be packed, from carcasses and large cuts to case-ready retail packs. In the case of fish, bulk fillets or whole fish can be processed along with retail-ready packs.

In lower income parts of the APEC region, such as Indonesia, a wide range of food processing technology is employed, from simple, traditional methods used by small enterprises and home industry to modern high-tech methods used by big national and multinational corporations. Although the market share of modern supermarkets and superstores offering modern processed foods has grown very fast in major cities in recent years, traditional markets offering traditionally processed foods are still dominant in both urban and rural areas of the country.

Regional Outlook For Food System Technologies

For many years, policy reform and strong economic growth in the APEC region have succeeded in reducing the percentage of the population identified as hungry. Technology advances alone will not end hunger, but they will bring increased efficiency to complement those efforts.

Adoption of biotech seed for food crops is limited beyond the U.S., and there is considerable uncertainty about future biotech adoption. Even in the U.S., the move by several agribusinesses to limit their purchases of some biotech products suggests uncer-

What is APEC?

APEC began in 1989 as an informal grouping of 12 market-oriented Asia-Pacific economies with the goal of better managing the growing interdependence in the Pacific region and sustaining economic growth. APEC provides a forum for ministerial-level discussion and cooperation on a range of economic issues, including trade promotion and liberalization, investment and technology transfer, human resource development, energy, telecommunications, and transportation. APEC's 21 member economies accounted for 40 percent of global trade in 1998, and about two-thirds of U.S. farm exports.

Members and dates of joining:

1989	Australia, Brunei, Canada, Indonesia, Japan, Malaysia, New Zealand, Philippines, Singapore, South Korea, Thailand, United States
1991	China, Hong Kong/China, Taiwan
1993	Mexico, Papua New Guinea
1994	Chile
1998	Peru, Vietnam, Russia

Special Article

tainty about these commodities that could continue at least in the short term, or until stronger scientific evidence offsets consumers' wariness. Many of the developing economies in the region are likely to continue with the more traditional yield-enhancing technologies in agriculture. A brighter outlook for nonfood biotech commodities is evidenced by the expanded use of insect-resistant (Bt) cotton in Australia, China, and the U.S.

Use of the Internet in the less developed economies of the APEC region's food system is still in the early stages; in the developed economies, 50 percent or more of the population enjoys Internet access. Projected rates of adoption of IT in some of the less developed parts of APEC such as China are rapid but still at a very low level. Modest infrastructure requirements of IT make it accessible to less developed areas, and adoption is likely to have an expanding and positive impact on efficiency in the region's food system, in both developed and less developed areas.

Technologies related to marketing and processing food products, in combination with IT, are likely to be key to the outlook for the region's food supply system, particularly in supporting the rapid process of urbanization in Asia. Urban population in the APEC region now surpasses 1.1 billion—more than 45 percent of the region's total population—and is growing at twice the overall rate of population growth. Meeting the food needs of these vast urban areas, particularly in the less developed parts of the region, will depend on adequate investment in food distribution systems, food processing capacity, storage and marketing facilities, and innovations that make these systems more efficient. AO

William Coyle (202) 694-5216, Brad Gilmour (Agriculture and Agrifood Canada), and Charles Handy
wcoyle@ers.usda.gov

To order a copy of the report, *Pacific Food Outlook, 2000-01*, contact the U.S. National Committee for Pacific Economic Cooperation at www.pecc.org/food. Cost is US$20.00.

ERS
ECONOMIC RESEARCH SERVICE
U.S. DEPARTMENT OF AGRICULTURE

search
New ERS Website go

user-friendly navigation | powerful search engine | enhanced features & services | syntheses of research & analysis

2001 . . .
A New ERS Website

Coming in January—a completely redesigned, re-engineered ERS website. Users will find the same timely, comprehensive economic analysis on agriculture, food, the environment, and rural development, presented in an improved, streamlined format with enhanced information and features.

- **More user-friendly navigation.** Find exactly what you need more easily and quickly.
- **A powerful search engine.** Search by topic, or use an advanced search feature for more specific information.
- **Enhanced features and services.** Easily locate upcoming events and publications, ERS experts, and new and newsworthy ERS research products. Customize your ERS e-mail subscriptions.
- **Syntheses of specific ERS research.** Visit briefing rooms for an in-depth, synthesized discussion of ERS research on a wide range of individual topics, along with access to publications, data, and related information sources.
- **Easily accessible data.** Access data re-engineered for ease of location and use; databases on major commodities and trade allow users to retrieve data by commodity, country, and time period.

latest publications

latest data products

resources

services

More . . .

Find a wealth of economic analysis on issues ranging from the World Trade Organization...to farm business concerns such as risk management and farm structure...to food safety, environmental policies, and the economy of rural America.

key topics:
many to choose from go

how to:
to help you go

Visit the ERS website in 2001 and explore the contents

www.ers.usda.gov