IV. Enhancing the Infrastructure

The recent outbreak of foot-and-mouth disease in Europe has heightened U.S. awareness of the infrastructure that protects the integrity of the food and agricultural system.

U.S. agriculture is hugely successful at delivering abundant, affordable, safe, and nutritious food. Nothing has been more important to this success than an extensive physical and institutional infrastructure—in effect, the backbone of the food and agricultural system.

The agricultural infrastructure includes all of the basic services, facilities, equipment, and institutions needed for the economic growth and efficient functioning of the food and fiber markets. This requires investment in services to protect farmers, ranchers, and consumers from the threats of crop and animal pests and foodborne diseases. It demands a strong commitment to the research and cooperative extension system that undergirds production, marketing, food safety, nutrition, natural resource conservation, and all other functions of USDA agencies.

Like every infrastructure, that of the agriculture and food system requires periodic review, ongoing reinforcement, and appropriate modernization just to keep pace with continuously emerging and often unique challenges, and rapidly changing conditions. The system must be prepared to meet our future needs, which may be strikingly different than those we see today.

A responsive infrastructure requires adequate resources in place ahead of time, and access to cutting-edge science, technology, and information. The infrastructure cannot function at its best if it must always play catch-up. At the same time, funds are not limitless. To make the best use of our resources, we must inventory current services and facilities and prioritize what needs to be upgraded and enhanced.

USDA and its cooperators have historically invested in the "bricks and mortar" needs of the infrastructure. Maintenance and renovation of scientific facilities, farm service centers, and testing laboratory and inspection facilities, for example, are ongoing needs. They are necessary but not sufficient to face the future and adapt to changing circumstances.

The existing infrastructure is now being challenged in radically changed market and institutional contexts, calling for very different approaches than in the past. First, the various sectors of the food economy—from producers to processors to retailers—are more interconnected than ever before, and grow more so every day. For any new policy to succeed, it must have input and cooperation from every link in the food chain. Second, crop or animal diseases that demand infrastructural support are increasingly global and require coordinated solutions. Third, recent increases in intellectual property protections and advances in biological science have prompted the private sector to more actively invest in the knowledge base and technological underpinnings of the food system. Stronger private sector incentives imply more opportunities for effective partnerships between the public sector and industry in solving problems.

These contextual changes mean the United States must think differently about the agricultural and food system infrastructure. The Federal Government must partner with other participants in the food chain, including private companies and consumers; public, university, and

private scientists; State governments; and international bodies that promote effective forums for global cooperation. A cooperative approach requires new ways of doing business, new approaches to problem solving, and new institutional arrangements that meet the interests of various groups while advancing the public good.

Major areas in which innovative thinking about the food and agricultural infrastructure needs to take place are: our responsiveness to pest and disease threats; assurance of food safety; sustaining and building the data, information, and scientific bases on which good decisionmaking relies; and delivering services to rural America.

Responding to Pest and Disease Threats

The recent outbreak of foot-and-mouth disease in Europe has heightened U.S. awareness of the infrastructure that protects the integrity of the food and agricultural system. Science, technology, and intergovernmental cooperation are key to keeping crop and animal pests and diseases out of the United States, and to managing the pest and disease challenges we face inside our borders.

Crop Pests and Diseases

Crop yield losses caused by insects, weeds, and diseases are U.S. farmers' oldest challenge, but these take new forms all too often. The prevention and control of crop pest and disease outbreaks present many special challenges to the agricultural infrastructure. Uncertainties about the establishment, spread, damage, and movement of pests and diseases and commodities across State and international boundaries create the need for a flexible and responsive, area-based infrastructure.

Invasive crop insects, weeds, and diseases are particularly elusive in this age of extensive international trade. Of recent concern are Karnal bunt wheat fungus, the glassy-winged sharpshooter that transmits Pierce's disease to grapes, plum pox, citrus canker, Mediterranean and Mexican fruit flies, and leafy spurge on grazing land. Each of these invasions has consequences for acreage, yield, prices, trade flows, and costs of government compensation programs.

The scientific and regulatory infrastructure are essential to ensure the prevention or exclusion of invasive pests and diseases, early detection of pests and diseases that have entered, and rapid control or eradication measures for pests and diseases that have become established. International cooperation must also be heightened to control or prevent the spread of invasive pests and globally spreading diseases. New bio-science and information technologies must be enlisted to increase the efficiency and cost-effectiveness of these programs.

Federal and State Governments have a major role in preventing and controlling invasive crop pests and diseases, and Federal and State agencies work closely to support research and technical assistance. A number of Federal laws govern policies and actions. The Plant Protection Act, passed by Congress in 2000, provides one clear statute for plant health activities, from regulating imports to certifying exports, and includes emergency authority to deal with plant pest and disease outbreaks. It provides a model for the type of modernized, flexible authorities that are needed in the animal disease area as well.

Plant pest and disease issues also call for innovative approaches to industry, government, and university collaboration. One such approach pertains to Pierce's disease, fatal to grapes, for which there is no effective treatment. Pierce's disease poses an increasingly serious threat to the table, wine, and raisin grape industries, but an impressive research and education effort is underway in California, enlisting the California Department of Food and Agriculture, the University of California, USDA, and industry groups. The Pierce's Disease Control Program relies on a task force which, through its research subcommittee, coordinates research priorities, raises research funds, and fosters collaborations among researchers on both understanding and treating the disease and controlling its insect hosts.

Despite good models and spectacular successes in defending America's borders from invasive pests, we must maintain vigilance in surveillance systems.

Livestock Pests and Diseases

The outbreak of foot-and-mouth disease (FMD) in Europe drove home the global nature of livestock disease. In addition to strengthening border controls, USDA has sent dozens of veterinarians to Europe to study and help contain the disease. While FMD is not a human health risk, it is difficult to overstate its potential harm to the U.S. livestock sector should an outbreak occur after a 72-year absence.

The emergence in Europe of Bovine Spongiform Encephalopathy, or BSE, has disrupted markets in the European Union. Although there have been no U.S. cases, BSE has become the business of government science and regulatory systems. The agricultural research system is working hard to determine the nature and transmission of BSE and to improve

detection and diagnostic tools. Early detection is essential, not only to eradicate a disease disastrous for the animals afflicted and ruinous to their producers, but also to prevent hazardous products from entering the food chain. Thus, our research on BSE benefits both animal health and food safety.

FMD and BSE, while much in the news, are not the only or even biggest threats to U.S. livestock production and exports. Other potentially costly livestock diseases include Newcastle's disease (avian), cattle tick fever, and hog cholera. To guard against animal disease outbreaks, we must invest in new tests, devise new diagnostics and systems of detection, and better ascertain pathways of disease transmission. Projects that modernize animal health diagnostic, surveillance, and research facilities must be prioritized and, if crucial, receive adequate funding and construction authority.

Further investigation is needed of methods that prevent rather than merely detect and contain animal pest problems, animal disease, and animals acting as carriers of human pathogens. Among those approaches warranting closer examination are good animal husbandry to improve the health and sanitary conditions of animals, and the use of vaccination, antibiotics, or other medicines. Hazard Analysis and Critical Control Points (HACCP) might also assume a stronger role to control disease at major checkpoints and pathways.

The international nature of animal disease—including more than 50 diseases not known to exist in the United States—clearly calls for vigilance in border protection and quarantine systems. An integrated, cooperative approach to addressing emerging animal disease issues worldwide is needed. This means working with other countries to use sound science and to recognize economics as the basis for prioritizing emerging disease issues, identifying disease pathways, monitoring disease outbreaks, harmonizing inspections and regulations at ports before diseases break out, and evaluating economic and trade implications of alternative approaches to animal disease management in a global context. The ongoing activities of the Codex Alimentarius Commission and the International Office of Epizootics are good models for concerted effort.

Ensuring Food Safety

The past decade has seen many efforts by the Federal Government, State partners, and the private sector to promote safer food—implementation of HACCP inspection systems for meat, poultry, seafood, and juices; public and private partnerships to improve food safety education and knowledge among consumers; increased efforts to promote good manufacturing practices for fresh produce; and increased monitoring of the safety of imported foods. HACCP is clearly working, reducing the incidence of *Salmonella* on raw meat and poultry—by as much as half on raw chicken. Federal agencies are coordinating to increase basic research on food safety, and to intensify surveillance of foodborne illness outbreaks. Improved animal production systems, better pathogen control during processing and distribution, and increased education on food safety issues and on food handling and preparation practices for consumers and food retailers all help to strengthen the food safety system.

Nonetheless, America's familiarity with health risks from foodborne microbial hazards has increased in recent years. Widely publicized outbreaks of foodborne illness—traceable to such sources as *E. coli* O157:H7 in hamburger, *Listeria monocytogenes* in hot dogs, and *Salmonella* in poultry and eggs—have raised the public's concerns about risks from microbial pathogens in food. Although preliminary evidence suggests the number of illnesses caused by some pathogens (notably *Salmonella*) may be decreasing, food safety systems are confronting an array of emerging pathogens such as *Cyclospora*, *Cryptosporidium*, and new strains of *Salmonella*. Emerging pathogens mean that food safety and animal health systems to protect the food supply must be continually reassessed and updated. New science is needed to ensure that any new regulations are sound, and alternatives warrant scrutiny, as well, for their cost-effectiveness.

Continued basic research is needed to evaluate the incidence of current and emerging hazards, identify and quantify the chronic compli-

cations that these acute foodborne illnesses can cause, and identify which foods are causing the illnesses. Over two-thirds of foodborne disease-related deaths are caused by pathogens of unknown origin, or by human exposure through unknown food sources. Better understanding of the basic science of food safety is therefore needed to help design appropriate interventions and to set priorities for further risk reduction.

Proper design and implementation of new food safety policies must be based on the best available science. This is especially important in an international context. Risk assessment and risk management approaches to define appropriate interventions to prevent contamination require state-of-the-art science to ensure that our risk reduction efforts are both effective and cost-efficient.

While the objective of food safety policy remains safeguarding public health, we can never completely eliminate foodborne health risks. Resources devoted to improving food safety are not unlimited and must compete with other pressing public health needs. More effort is needed to rank the relative food-safety risks from multiple sources, including microbial, chemical, and other food- and water-related hazards. Science-based risk assessments can help set priorities for further risk reductions. Economic analysis of the benefits and costs of risk reduction can enable the maximum net benefit to society while minimizing the regulatory burden on the private sector.

Where possible, Federal policies and programs must be coordinated and integrated to reduce duplication of effort, regulatory burden, and program cost. This is especially important in food safety, where regulatory responsibility is divided among several Federal agencies (USDA, FDA, EPA) and where many actors play a role in research, development, and implementation of food safety policies. The Federal Government already facilitates this coordination through such structures as the President's Food Safety Council, the Joint Institute for Food Safety Research, and the Joint Institute for Food Safety and Nutrition. Close coordination across agencies must continue.

More attention needs to be given to identifying appropriate roles for government, industry, and consumers. Where, when, and how to intervene in private markets to promote social goals such as improved food safety are crucial decisions. Simply put, we cannot just regulate our way out of problems. Private firms, responding to consumer demands for safe food, can voluntarily adopt management procedures to control pathogens all along the food chain, exert control at a key stage, or invest in research and development for new equipment or management systems. Dissemination of publicly funded research results to private stakeholders and partners hastens the diffusion of new food safety technologies (such as rapid tests for microbial contamination).

Policies that promote innovations in new technologies and food production systems can help minimize the regulatory burden of food safety regulations. Public education has a key role, too. While the public cannot be expected to become food safety experts, they should understand the basic issues and food safety rules. Public information campaigns can play an important role in educating foodservice workers and consumers about safe food handling.

In several States, quality assurance plans illustrate government, industry, scientists, and consumers coming together to develop voluntary agreements on guidelines for safe food production and sound environmental practices. In California, plans were developed for strawberries, eggs, produce, and dairy—without additional government regulation.

Building the Knowledge Base

Every aspect of the infrastructure and the food system it supports is fed, fundamentally, with new knowledge, through research and development, data collection, and information dissemination.

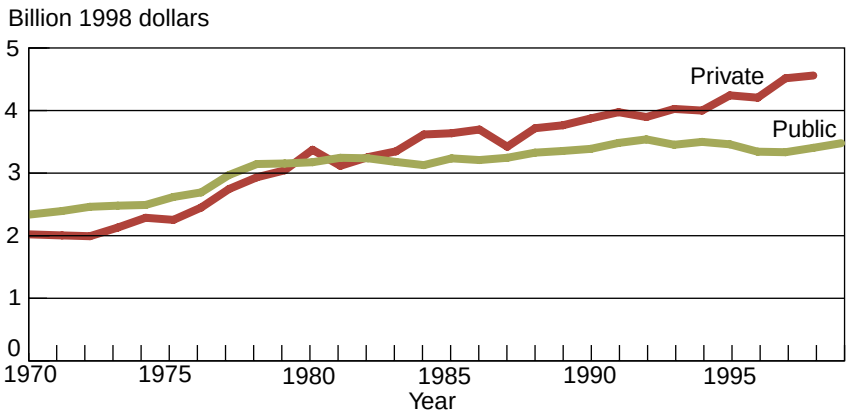
Scientific Research and Development

Investments in agricultural research and technology development (R&D) have driven remarkable rates of agricultural productivity over the last 50 years. U.S. agricultural productivity has outdistanced most other industrial sectors of the economy, with an estimated 40- to 60-percent return on public sector investment. We must now ensure that the research infrastructure is appropriately oriented to confront new challenges to the food system with equal success. Determining how public agricultural research fulfills its longstanding role as producer of knowledge for the public good requires more complex and strategic decisionmaking than just a decade ago. The science base also depends increasingly on the effectiveness with which public, private, and university partners collaborate, creating synergies and mutual benefits by combining the relative strengths and interests of each.

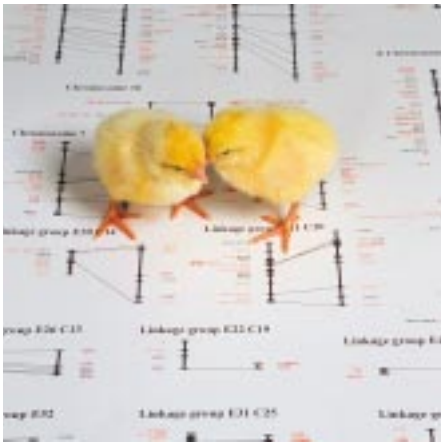
Since the mid-1980s, the level of public funding for agricultural R&D has leveled off in real (inflation-adjusted) terms (figure 17). This trend calls out for a review in light of the changing conditions and emerging problems that have pressing needs for new and improved knowledge—areas including environmental quality, food safety, diets and health, and pest and disease management. Any review should consider other government funding for health and environmental research that also supports agriculture. The potential for accomplishing public research goals has never been greater because of developments in genomics and gene mapping, computational and information technologies, and better understanding of environmental systems. But misplaced priorities may undermine this potential.

It is also important to note changing incentives for private sector research and what they imply for the public sector role and for public-

Figure 17
Agricultural Research Funding in the Public and Private Sectors



Public numbers based on USDA Current Research Information System, Inventory of Agricultural Research, various years.



private partnerships. In contrast to the leveling-off in public R&D funding, research expenditures by the private food and agricultural industry tripled in real terms between 1960 and 1996, from about $1.3 billion to $4 billion. This trend follows from the expansion of laws providing intellectual property protections, which enhanced the ability of private firms to profit from agricultural research. At the same time, advances in biotechnology—for example, fast and accurate "DNA fingerprinting" to identify patented DNA sequences—have strengthened companies' ability to protect their intellectual property. In the last 10 years especially, the rate of patent application and patent granting for biological inventions has exploded, particularly for genetically engineered plants and animals as well as for individual genes with specific uses or "utilities."

The expansion of private research incentives allows public research to refocus on areas of benefit to society that in and of themselves are unlikely to be a focus for private endeavors. These needs include fundamental science and applied work in environmental quality (such as managing livestock waste, enhancing water quality, and mitigating soil degradation), food safety, plant and animal disease, and nutrition and health. These orientations are especially needed to support the new challenges to the regulatory systems of USDA and other Federal environmental, health, and safety agencies.

Carving out distinctly public sector research for the public good is now difficult because some knowledge or biological tools necessary to the task are increasingly patented by private firms. Public sector and university projects are often complicated by the need for researchers to negotiate licensing agreements with private firms. Such situations can be mitigated through new and creative institutional arrangements. The

Environmental Quality Research

The successful use of buffers to protect environmental quality is based on an extensive history of research and cooperation between scientists and farmers. Buffers restore land closest to streams, rivers, and other vulnerable waterways with plantings of native vegetation. These natural buffers protect stream water by capturing much of the sediment, nitrogen, phosphorus, and other agricultural chemicals borne in runoff or ground water. As a result of research at USDA's Agricultural Research Service (ARS) and other institutions, the National Conservation Buffer Initiative program was established by the Natural Resources Conservation Service in 1997. The National Conservation Buffer Team has representatives from Federal and State Governments, farming groups, environmental groups, and industry.

ARS research continues to seek ways for farmers to maximize the returns from the investment in buffers, whether grass hedges, filter strips, or forest buffers. Such research includes determining the best grasses for use in grass hedges, measuring sediment loss and buffer use under different tillage systems, and helping farmers adapt buffer conservation strategies to their regions' specific soils, climate, topography, and hydrological patterns. Scientists can even simulate the movement of water, nutrients, sediment, and carbon in runoff or ground water passing through a buffer, using software called REMM—Riparian Ecosystem Management Model.

focus of any new form of collaboration, however, must increasingly facilitate cooperative research projects with multiple, complementary outcomes for public and private participants.

Strengthening research partnerships also requires ongoing review of the research portfolio in terms of the complement of funding vehicles to support extramural (primarily university) research. Universities in the land-grant system have also historically provided the State-based partnership for the Federal agricultural research effort because of their connections to State and local issues and constituent needs, and their provision of a geographic base for disseminating research findings to States' farmers, communities, households, and consumers.

A balanced portfolio for supporting university research, including competitive grants and formula funds, sustains the dual university role: conducting much-needed basic research to support the agricultural and food system and partnering with Federal scientists. Competitive grants, which have been much slower to emerge in food and agriculture than in other areas of science such as medicine, should increase, but without sacrificing the partnership support that formula funds provide. Whereas formula funds encourage recipient institutions to undertake major mission-oriented applied research and relieve scientists of the burden of seeking grants, competitive grants are the best means USDA now has to expand the pool of topnotch scientists conducting basic research relevant to the agricultural and food system. Our failure to fully exploit opportunities through competitive grants—used widely throughout the rest of the science community—jeopardizes our continuing ability to bring the best and newest science to meet agriculture's challenges and advance its future.

Data and Information Needs

Associated with, but distinct from scientific R&D, is the continued need for public sector provision of objective, consistent data and information to level the basis for decisionmaking among participants in the food and agricultural system.

The Department of Agriculture spends about $550 million each fiscal year on statistical programs, half of which represents the costs of direct data collection. The Natural Resources Conservation Service (soil, snow, and watershed surveys) and the National Agricultural Statistics Service (crop and farm surveys) collect most USDA data. Over and above the $550 million inventoried in major statistical programs, the Agricultural Marketing Service is involved in collecting market data. The Grain Inspection, Packers and Stockyards Administration also collects data to investigate allegations of potential violations of the Packers and Stockyards Act of 1921 in the livestock, meatpacking, and poultry industries and, on a more limited

An Agriculture Infrastructure Investment Fund

Innovative investment strategies will be necessary to assure adequate and timely response to needed changes in the infrastructure undergirding a rapidly evolving food and agricultural system. One possibility would be the creation of an "Agriculture Infrastructure Investment Fund," which could be empowered to accept contributions from other governmental and private sources to projects of mutual interest. The Fund could also be empowered to retain receipts gained from the disposition of unneeded property in order to finance future infrastructure investments.

basis, to assess structural change in these industries. It is important to ensure that these historical programs are aligned with future data and information needs.

Structural changes in the food system suggest that new and different types and sources of data may be needed. For example, as less and less data on livestock prices were obtained through the "spot" market (because of the prevalence of contracting), there was a move to mandatory livestock price reporting. Mandatory reporting calls for a large quantity of meat product retail prices, data that are not currently collected by USDA or any other Federal agency.

Concentration and vertical integration in other agricultural sectors raises questions about the utility and validity of traditional spot-market price data, and may make it increasingly difficult to collect adequate information on such variables as production costs and farm income. There is a growing need to collect data and conduct research and analysis that will help market participants adjust to market changes and to contribute to more informed public policy deliberations relating to structural change. This will require knowing more about supply chain linkages. However, less public information is available about increasingly private market transactions. This dilemma may suggest the need for new authorities for data collection and research to identify appropriate government roles for monitoring and oversight.

Finally, as the nature of government services adapts to accommodate changes in the food and agricultural system, the standards for previously collected information may be inadequate for future decisionmaking. This could be the case, especially, in using "representative" or aggregate information when examining policies that need to be tailored to different types of producers or environmentally specific characteristics. Data linking environmental and natural resource quality to information on farm practices are becoming especially critical, though such data remain scarce.

Principles for Infrastructure Policy

- **Focus on a broader infrastructure.** Provide a longer term view of the requirements for a healthy and prosperous farm and food system to ensure that it continues to enjoy widespread consumer confidence and support. This entails refocusing institutions and continuing judicious investment for the entire system, including refurbishing and modernizing the infrastructure that underpins the farm, food, and trading system.
- **Recognize our new operating environment.** Our farm sector and food system operate today in a new and evolving business and social environment. It is a competitive, consumer-driven environment, global and rapidly changing with enormous implications for the place and role of the farm sector in the overall food system. It is highly interdependent, blending the efforts of many industries to add value to farm sector products.
- **Enhance pest and disease prevention for plants and animals.** From farmers to consumers, our food system depends on strong pest and disease prevention and eradication programs.
- **Build on current success in providing safe food for all Americans.** Emerging pathogens mean that our food safety systems must be continually assessed and updated in order to maintain consumer confidence in our food supply.
- **Anticipate future infrastructure needs.** Building new and different capacities for accomplishing priorities requires a long-term view with a process for anticipating change.
- **Base decisions on science.** Regardless of good intentions, no authorized program, no mandate, no request or emergency need can be carried out unless the appropriate research base, scientists, laboratories, methods, data and information, institutions, and technologies are available. New science is needed to ensure that any new regulations, in food safety, animal and plant health, environment, or other areas, are sound and cost-effective.
- **Capitalize on the unique public sector role in agricultural research and extension.** The private sector is playing an ever-larger role in agricultural research and information provision. Limited public sector research funding thus needs to be devoted to fundamental scientific discovery and questions that the private sector has no incentive to pursue, but that could lead to the betterment of society.
- **Recognize the importance of competition in the market for research.** Maintaining competitive research funding increases the likelihood that the best minds of the country will be applying themselves to important public sector research issues.
- **Recognize the importance of collaboration.** Collaborations involving public agencies, private companies, universities, and consumers are an important means for meeting the interests of various groups while advancing the public good.