



The Science Source for Food,
Agricultural, and Environmental Issues

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Moderator

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Plenary Lectures

Food Security: Domestic and International Dimensions

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Foreword

At the February 1994 CAST Board of Directors meeting, the board adopted a new Strategic Plan for CAST, which included among other approaches, CAST sponsored conferences and workshops. The board later authorized development of a conference to address international food safety, sufficiency, and security issues.

An eminent group of international experts was chosen to participate. Their presentations or summaries of their presentations are included in this proceedings. The rapporteurs wrote summaries of the respondents' presentations. All participants reviewed the proofs. The CAST Executive and Editorial Review committees reviewed the final draft. The CAST staff wrote the summaries and provided editorial and structural suggestions and published the report. The speakers are responsible for the content of their individual presentations.

On behalf of CAST, we thank all individuals who gave of their time and expertise to prepare this report as a contribution by the scientific community to public understanding of the issues. We also thank the employers of all participants, who made the time of these individuals available to CAST. The members of CAST deserve special recognition because the unre-

stricted contributions that they have made in support of CAST also have financed the preparation and publication of this report.

This report is being distributed to all conference participants, donors, and attendees, as well as to members of Congress, the White House, the U.S. Department of Agriculture, the Congressional Research Service, the Food and Drug Administration, the Environmental Protection Agency, the Agency for International Development, and the Office of Management and Budget, and to media personnel and institutional members of CAST. Individual members of CAST may receive a complimentary copy upon request for a \$3.00 postage and handling fee. The report may be reproduced in its entirety without permission. If copied in any manner, credit to the authors and to CAST would be appreciated.

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The Council for Agricultural Science and Technology's (CAST) conference addressing international food safety, sufficiency, and security issues was an exciting and enlightening experience for all participants and attendees. CAST thanks the Conference Planning Committee for planning and organizing the conference and the following cooperating organizations who assisted in producing a successful conference: the Il-

linois Farm Bureau, the Institute of Food Technologists, and the International Food Information Council. Gratitude is expressed to the donors and attendees who provided the support necessary to convene such a notable group of individuals. We also thank the speakers, moderators, respondents, and rapporteurs listed in the proceedings for their participation.

Intrepretive Summary

New and changing circumstances require examination of policy options by governments, agribusinesses, food producers and processors, and consumers.

A November 1997 conference sponsored by CAST explored complex relationships among food safety, sufficiency, and security on a global and United States (U.S.) basis.

Food Security: U.S. Dimensions

The U.S. population is complacent with the quantity of their food supply, but less so with its quality. Having the best food supply in the world is not good enough; they worry increasingly about food safety and nutritional content as well as about water quality. They are environmentally minded but lack knowledge about agricultural production practices. They want some regulation in the food production/safety arena but also want to remain internationally competitive.

Biotechnology offers enormous potential for benefiting humankind. Well-focused research and new forms of collaboration among people and institutions are needed to address the larger questions of food safety regulations. A high level of leadership from the food industry will continue to be needed.

Microbial pathogens dominate food safety concerns in the 1990s, and consumers need information on the risks involved.

Food Security: International Dimensions

It is impossible to separate U.S. food security issues from international ones. The situation differs on each continent.

- **Asia** has a much larger fraction of the world's population than of its arable land. Projections suggest crop yields in **China** might be increased considerably. If **India's** current economic growth accelerates, diets may change there and India will be placing even greater demand on the world food system. Asia in general is likely to import great-

er quantities of food.

- **Africa** has experienced rapid population growth and slow economic growth. Its per capita food production has declined for three decades. For various reasons, it is not currently profitable for farmers to adopt improved technologies in many parts of Africa. Still, Africa could produce much more of its own food supply, though it will continue to be a net food importer well into the twenty-first century.
- **Western Europe's** expected growth in food consumption is limited. Agricultural productivity there is high; however, intensive crop and livestock production has led to adverse environmental consequences. Partly because of reduced export subsidies, agricultural export prospects will be limited.
- In **Central and Eastern Europe**, agricultural productivity has been low by international standards relative to its potential. Privatization has begun and eventually this region will play an important role in addressing world food needs.
- **South America** has the largest arable land area available for agricultural production relative to its population without causing deforestation or other environmental damage. But distribution of wealth is more skewed there than in other regions of the world. If the poor's income there increases, a larger proportion of their production will be consumed internally. Nevertheless, the continent likely will supply a much larger volume of agricultural exports in the next century.
- **Australia and New Zealand** historically have been strong agricultural exporters, and they are expected to continue in this role, although with limited expansion potential.
- **North America** has a mature, high-income, slowly growing market for agricultural output. However, agriculture here also is undergoing significant changes. Canada will become an even larger exporter of both bulk commodities and higher-valued products. In the United States, 1996 agricultural policy changes increased farmers' planting flexibility and responsiveness to world market

demand. A larger fraction of its meats and other animal products likely will be exported in the future.

Hunger and Poverty

The real food crisis today is *hunger caused by poverty*. Despite a 55% increase in worldwide food production from 1970 to 1995, the number of malnourished people worldwide dropped by only 15%, and 800 million people (an estimated 20% of the world's population) remain hungry. The International Food Policy Research Institute, the Food and Agriculture Organization of the United Nations, the World Bank, and the U.S. Department of Agriculture (USDA) make the following projections.

- The supply of food will have to increase by 30 to 50% to meet demand in the year 2020.
- Population growth and economic growth will determine demand for food.
- The world's farmers will be able to respond to the challenge and expand production to meet this growing demand.
- Food production is expected to increase both in absolute terms and on a per capita basis.
- Production will not grow equally throughout the world; much of the capacity to expand the supply of food will be in North America and other major grain-producing regions.
- Trade in food will become increasingly important in balancing regional differences between supply and demand.

In Africa, parts of Asia, and in the Near East, the absolute number of hungry people will increase, though the proportion of the population that is undernourished will decline.

In subSaharan Africa, the proportion of malnourished children will decline by only 3% between 1990 and 2020—during the same time period the global production of food will have increased by 30 to 50%. Not only food supply but food **security** must be addressed.

Four principles must guide thinking about food security.

1. **Food security is about people, not about commodities.** Chronically hungry people are very poor and usually landless. Women and girls suffer disproportionately. *When food is in short supply, women eat last.* Sometimes, the hungry are victims of war and social disruption. The real food issue is *access*. Increased food production is

not enough.

2. **There will be no long-term solutions without short-term solutions.** Today's hunger leads to tomorrow's hunger. While we are waiting for the long-term benefits of overall economic growth, of research, of investments, a vicious cycle of intergenerational hunger continues. Hunger passes from hungry mother to malnourished child, as maternal malnutrition virtually guarantees that children will suffer stunted growth, susceptibility to disease, and intellectual impairment. This damage is irreversible; the harm caused by early malnutrition or undernutrition cannot be offset by adequate nutrition later. This is a vicious cycle, and a great burden on society.
3. **Investment is needed in people as well as in increased production.** Employment creation is a key element in the attack on hunger. Strengthening the infrastructure is essential, as is supporting education—especially of girls, because it decreases the birth rate.
4. **Investment in women, for today and for tomorrow, is particularly needed.** Women must be supported as agents of social change. More than 80% of the food in Africa is grown by women. Yet they still find it difficult to gain access to basic requirements such as credit, fertilizer, technology, and land.

Potential Solutions

In November 1996, the World Food Summit Declaration and Plan of Action reaffirmed the right of access of everyone to a safe, nutritious, adequate food supply. Their goal is to decrease the number of undernourished people by one-half by no later than the year 2015.

The World Food Programme has spearheaded the U.N.'s largest relief effort to date. The needs of countries negatively affected by El Niño also are being considered. Local solutions to food insecurity can be identified, provided that (1) the people involved are consulted, (2) the value of their knowledge is recognized, and (3) external knowledge is used to complement local knowledge. In addition, global food availability might be increased in the following ways.

- The land area planted can be modestly increased, as can yield per hectare.
- To alleviate food insecurity internally, developing countries might increase agricultural productivity and/or economic development activities in rural areas, invest in agricultural research, and refrain from implementing "cheap food" policies.

- Good national policy should include a transparent legal framework, gender equality, environmental protection, and attention to susceptible populations.
- South America, North America, and Eastern Europe should effectively use available arable land, increase investment in agricultural research, and disseminate information.
- Declining food aid must be restored to previous levels to support countries that cannot afford to participate in the international market.

Quality and Safety: Challenges and Solutions

Three forces drive change in U.S. food safety: (1) globalization of the food supply, (2) a shift in food safety focus during the 1990s from chemical residues to microbial pathogens, and (3) emergence of hazardous analysis critical control point (HACCP) principles as a conceptual framework for food safety across the world's regulatory agencies.

Three trends shape the future:

1. greater reliance on "systems" approaches;
2. a proliferation of food safety standards; and
3. a greater role for scientific and technological solutions, e.g., wider use of pasteurization and the public's willingness to consider a role for food irradiation.

Microbial pathogens are likely to dominate food safety concerns in the future; consumers will need information on risks involved.

The food industry must produce a safe, high-quality product. The government must support infrastructure and reassure consumers by playing advisory, regulatory, and enforcement roles. The infrastructure must address inspection, testing, and certification methods. End-product testing is not the solution to effective regulation. The market of the importing country must not become a dumping ground for inferior products.

Food safety regulations should be based on science. A 1994 CAST report recommended that

- food safety policy should be based on risk assessment,
- the food safety information database should be expanded to include the incidence of foodborne disease by pathogen and by food,

- control practices should be applied from food source to consumption, and
- the public should be educated regarding safe food handling.

Significant change has occurred; *E. coli* O157:H7 made the issue real for the U.S. public and provided the impetus for change.

- In 1993, the USDA required safe handling labels that address storage, cooking, and holding practices for raw meat and poultry products.
- In 1994, the USDA initiated a monitoring program for *E. coli* O157:H7 in ground beef.
- In 1995, the Centers for Disease Control and Prevention, the USDA, and the Food and Drug Administration initiated a project to collect more precise information about the incidence of foodborne illness.
- In 1996, the USDA published its landmark rule requiring all plants that slaughter and process meat and poultry to implement a means of preventing contamination from pathogens and other hazards. The rule also sets in-plant performance standards for *Salmonella*—the first time the USDA has set a performance standard for a broad range of raw meat and poultry products.
- A farm-to-table approach to food safety has been adopted by government agencies, professional groups, academia, and industry.
- At the transportation to retail level of the farm-to-table chain, standards governing the safety of foods during distribution are being developed.
- At the retail level, the federal government is working to ensure the adoption of science-based standards and to foster preventive approaches.
- In 1997, President Clinton announced measures to modernize food inspection and manufacturing procedures, increase research into foodborne pathogens, create an early warning system for foodborne outbreaks, and strengthen coordination among federal, state, and local food safety agencies.
- The President also announced his intention to send Congress legislation giving the U.S. Food and Drug Administration (FDA) additional authority regarding imported produce and other foods.

The Food Quality Protection Act of 1996 strengthens the U.S. pesticide regulatory system, addresses risks and the need for residue limits, and lends consistency to the regulatory process. But foodborne dis-

ease and drinking water contamination are increasing concerns in the United States. The health of the environment is also an issue. Organic agriculture also needs expanded research. Science also must address the effect on human health of anabolic hormones and potential foodborne diseases such as bovine spongiform encephalopathy. Lack of early, decisive action on such issues can have far-reaching ramifications.

International Trade and Safety

Food safety policies must work in concert with an open market philosophy. The Uruguay Round of the General Agreement on Tariffs and Trade (GATT) addressed rules for agricultural trade, including the need to lower barriers and expand access. The Codex Alimentarius Commission of the United Nations is working to establish food safety standards. The move toward international standards will help to avoid trade disputes, thereby providing a safer and more abundant food supply worldwide.

Research in the Twenty-First Century

Technologies must add to rather than deplete the earth's resources, be environmentally friendly, apply to farms of all sizes, and be sparing of capital, management, and nonrenewable resources. Stable, high-yield production is needed. Some conventional research priorities that will require increased attention include plant and animal breeding and resistance to environmental stress; improved efficiency of production of crops and livestock; pest management; human, animal, and plant health; weather and climate; irrigation and water management; soil and fertilizer management; environmental quality; aquatic food

sources; postharvest losses and storage; basic biological research; integrated production systems; market expansion; food policy issues; and information systems.

Two newer areas of research needing increased support are biotechnology as a tool to maximize productivity and development of new food plants by genetic engineering to help prevent diet-related diseases of humans.

Recommendations

- Health issues should be increasingly emphasized in research.
- Appropriate technologies, resource inputs, and economic incentives should address worldwide food shortages.
- The level of agricultural research funding relative to other research priorities must be bolstered, particularly for production-oriented and multidisciplinary research.
- Balance is needed in funding basic versus production-oriented research.
- Citizens should inform state and federal legislators of the importance of increasing agricultural development and research funding.

General Conclusions

The answer to the challenges of global food security is to get the policies right, thereby unleashing the creativity and inherent entrepreneurship of the private sector in all nations. If that is done on a global basis, the capacity to provide the world with an adequate diet can be achieved. Only with knowledge and commitment can the world be fed, the disease risk in food consumption minimized, and the environment protected.

Summary

Introduction

Changing circumstances—free trade agreements, trade barriers, food safety, historically low grain stocks, food access and distribution, environmental quality, soil and water conservation, fish and wildlife, per capita income, and population growth rates—require examination of policy options by governments, agribusinesses, food producers and processors, and consumers.

A conference sponsored by CAST (Council for Agricultural Science and Technology) in cooperation with the Illinois Farm Bureau, the International Food Information Council, and the Institute of Food Technologists addressed these concerns on November 2–4, 1997, in Chicago, Illinois. The conference

- explored complex relationships among food safety, sufficiency, and security on a global and U.S. basis; and
- enhanced understanding of the issues related to developing an environmentally responsible system for enhancing the production, safety, distribution, and access to a global food supply for an increasing population.

Food Security: U.S. Dimensions

The U.S. population is comfortable, understandably even complacent, with the quantity their food supply, but less so with its quality. While they recognize they have the best food supply in the world, they are not certain that it is good enough. The *E. coli* O157:H7 outbreaks and the Alar scare with apples are but two examples. They also worry increasingly about nutritional content as concern about diet-related illnesses increases. Water quality is yet another concern.

People in the United States are not especially concerned about the price of food. They are environmentally minded, but many do not really understand agricultural production practices. Their lack of knowledge results in more worry than action. They

are correct in fearing that the market will not always satisfactorily address their concerns, which is why they want a certain amount of regulation in the food production/safety arena regarding agricultural chemicals, fertilizers, food processing, pollution control, nutritional labeling, and the like. But at the same time they do not want too much regulation, and they want to remain internationally competitive.

Biotechnology offers enormous potential for benefiting humankind, but humans are naturally resistant to change. In the meantime, one need only visit a U.S. supermarket and compare it with another almost anywhere else in the world to recognize how truly fortunate U.S. residents are in their food supply.

Well-focused research and new forms of collaboration among people and institutions in government, industry, academia, and public health and consumer communities are needed to address larger questions such as modernization of food inspection, processes, fragmentation of the federal food safety system, and better linkage of the U.S. food safety system with that of the rest of the world. A high level of leadership from the food industry will continue to be needed because the industry has product-specific experience and the role of government is inherently limited.

Microbial pathogens are likely to dominate food safety concerns in the 1990s, and consumers will need information on risks involved.

At the national level, food security is typically a problem of availability. Agricultural research should be the first avenue for addressing that problem.

Food Security: International Dimensions

It is impossible to separate U.S. food security issues from international ones. Each country should use its arable land as much as possible without wasting resources. The situation differs on each continent.

- **Asia** has a much larger fraction of the world's population than of its arable land. Projections suggest that, with technological advancement, crop yields

in **China** might be increased considerably. If **India's** current economic growth accelerates, diets may change there and India will be placing even greater demand on the world food system. Asia in general is likely to import greater quantities of food.

- **Africa** has experienced rapid population growth and slow economic growth. Its per capita food production has declined for three decades; its agricultural productivity is naturally limited. For various reasons, it is not currently profitable for farmers to adopt improved technologies in many parts of Africa. Still, Africa could produce much more of its own food supply, though it will continue to be a net food importer well into the twenty-first century.
- **Western Europe's** expected growth in food consumption is limited. Agricultural productivity there is high; however, intensive crop and livestock production has led to adverse environmental consequences. Animal welfare regulations are also an issue in some countries. Partly because of reduced export subsidies, agricultural export prospects will be limited despite increased import demand by other countries.
- In **Central and Eastern Europe**, agricultural productivity has been low by international standards relative to its potential. As economies of these countries have moved toward a market system, privatization has begun. Eventually, this region will play an important role in addressing world food needs.
- **South America** has the largest arable land area available for agricultural production relative to its population without causing deforestation or other environmental damage. But distribution of wealth is more skewed there than in other regions of the world. If the poor's income there increases, a larger proportion of their production will be consumed internally. Nevertheless, the continent likely will supply a much larger volume of agricultural exports to Asia and elsewhere in the next century.
- **Australia and New Zealand** historically have been strong agricultural exporters, and they are expected to continue in this role, although with limited expansion potential.
- **North America** has a mature, high-income, slowly growing market for agricultural output. However, agriculture here also is undergoing significant changes. Canada will become an even larger exporter of both bulk commodities and higher-valued products. In the United States, 1996 agri-

cultural policy changes increased farmers' planting flexibility and responsiveness to world market demand. A larger fraction of its meats and other animal products likely will be exported in the future.

Poverty

Food insecurity is caused mainly by poverty. Some 1.3 billion people subsist on an income of less than \$1 per day, and 80% of the poor live in rural areas. Because poverty cannot be resolved by focusing exclusively on agriculture, off-farm employment opportunities are necessary. Urbanization cannot be reversed, but it might be slowed by a much larger investment in infrastructure, education, and health care, as well as by employment and enterprise growth. In turn, agriculture will benefit. Even the poorest developing countries have the potential to ensure food security and reduce migration from rural areas to cities if the proper technological choices are made.

Population worldwide continues to grow, but the growth rate is not as fast as once expected. Broad-based economic growth is occurring that is equipping millions of poor people with the purchasing power to upgrade the quality of their diets, especially in urban areas. The combined effects of population and income growth are expected to double global food consumption in the next 30 years.

Supply and Hunger

The food crisis of today is more one of hunger than of supply. Despite a 55% increase in worldwide food production from 1970 to 1995, the number of malnourished people worldwide decreased by only 15%, and 800 million people (an estimated 20% of the world's population) remain hungry. The International Food Policy Research Institute (IFPRI), the Food and Agriculture Organization of the United Nations (FAO), the World Bank, and the U.S. Department of Agriculture (USDA) expect the following projections.

- The supply of food must increase by 30 to 50% to meet anticipated demand in the year 2020.
- Two factors will determine the demand for food: population growth and economic growth.
- The world's farmers will be able to respond to the challenge and expand production to meet this demand.
- Food production will increase both in absolute terms and on a per capita basis.
- Production will not grow equally throughout the

world; much of the capacity to expand the supply of food will be in North America and other regions that are already major grain producers.

- Trade in food will become increasingly important in balancing regional differences between supply and demand.

Hunger likely will be worst in subSaharan Africa and parts of South Asia, especially Bangladesh. In Africa and the Near East, the absolute number of hungry people will increase, though the proportion of the population that is undernourished will decline.

There will be only minimal progress in reducing the number of malnourished children under age five. In subSaharan Africa, the proportion of malnourished children will decline by only 3% between 1990 and 2020—during the same time period the global production of food will have increased by 30 to 50%. To address this crisis, not only food supply but food **security** must be addressed.

Four principles can guide thinking about food security:

1. **Food security is about people, not about commodities.** We must consider who is hungry, and why: Chronically hungry people are very poor and usually landless. Millions of families live so close to the margin that even short-term problems can undermine their food security. Women and girls suffer disproportionately. *When food is in short supply, women eat last.* Because hunger is found widely in semiarid, economically marginal regions where the infrastructure is weak and marketing costs are high, transport and storage needs must also be addressed. Sometimes, the hungry are victims of war and social disruption. The true food issue is *access*.
2. **There will be no long-term solutions without short-term solutions.** Hunger marginalizes people. Hungry infants—if they survive—become unhealthy children. Early malnutrition does irreversible damage. An estimated 50% of disease-related mortality among infants could be avoided if infant malnutrition were eradicated. Approximately 31% of preschool children in developing countries are exposed to sickness and possibly death because they are malnourished. People cannot eat retroactively. The harm caused by early malnutrition or undernutrition cannot be offset by adequate nutrition later. Children who do survive a hungry childhood begin adult life preprogrammed for chronic illness and unable to fully realize the potential of what is often their only
3. **Investment is needed in people as well as in increased production.** Employment creation is a key element in the attack on hunger. Strengthening the infrastructure is essential, as is supporting education—especially the education of girls, because it decreases the birth rate.
4. **Investment in women, for today and for tomorrow, is particularly needed.** Women must be supported as agents of social change. More than 80% of the food in Africa is grown by women. Yet women still find it difficult to gain access to basic requirements such as credit, fertilizer, technology, and land. However, food can be more easily targeted to reach women than almost any other type of development assistance.

In fiscal year 1996, the United States spent \$1.2 billion on food aid for developing countries—a significant sum. But the same year, the United States spent \$38 billion on its domestic food assistance. The USDA's most optimistic current scenario is that almost four times as much food aid will be needed ten years from now *merely to maintain current levels. Yet food aid is declining alarmingly.*

At the 1974 World Food Conference in Rome, experts concluded that increasing food production at the national level was no guarantee of food security at the local level. Consensus was quickly reached that agricultural growth in developing countries will not eliminate rural poverty through a trickle-down effect. To address rural poverty alleviation directly, the International Fund for Agricultural Development (IFAD) was established.

IFAD's philosophy is that local solutions to food insecurity can be identified, provided that (1) the people involved are consulted, (2) the value of their knowledge is recognized, and (3) external knowledge is used to complement local knowledge. A move away from large-scale improvement projects such as dam-build-

asset—their labor. There may *be* opportunities—training, clinics, education, new technology—but the hungry cannot take advantage of them. Chronic hunger is part of a cycle of low productivity, ill-health, and indebtedness.

The assumption that long-term solutions always are better than short-term responses must be reexamined. Long-term food security cannot be built without breaking the cycle of intergenerational hunger and without acknowledging that hunger is a poverty trap. Tomorrow's hunger is linked to today's hunger, and they must be addressed in tandem.

ing to smaller-scale projects involving the ultimate beneficiaries has been successful.

It also must be remembered that conflicts that appear to be ethnic or religious often have roots in economic deprivation or food insecurity. In many countries, feeding the people who have migrated from rural areas to the cities is already a crucial issue. In unstable developing countries, governments must take action to check the rise in food prices. Even if a country is able to import adequate food supplies, distribution to masses of unemployed people presents a major challenge.

Potential Solutions

In November 1996, The World Food Summit Declaration and Plan of Action reaffirmed the right of access of everyone to safe, nutritious, adequate food. It focused on seven topics: (1) policy environment, (2) poverty eradication and access to adequate food, (3) sustainable increases in agricultural production, (4) contribution of trade to food security, (5) preparation for food emergencies, (6) optimal investment in human resources, and (7) monitoring of the implementation plan. However, priorities will differ by region.

The Plan of Action set a goal of decreasing the number of undernourished people by one-half by no later than the year 2015. This goal led to the U.S. Action Plan on Food Security to strengthen government, private sector, and other organizational efforts to decrease hunger and malnutrition.

The World Food Programme has spearheaded the U.N.'s largest relief effort to date. The needs of countries negatively affected by El Niño also are being considered.

To address the broad food crisis adequately, however, the focus must be placed on people, not food. The immediate problem is not food supply but hunger. Responses to the international food security crisis must be integrated. Focus must be shifted from production to the causes of hunger—poverty and lack of economic integration. Poor people need carefully constructed assistance programs that focus on their particular needs. Food aid must be decentralized and economically integrated to address the rural poor's situation. Private investment must be incorporated into public initiatives. The distortions food aid creates in the market must be lessened and eventually eliminated. Aggregate numbers produce averages; thus, the international food security crisis cannot be solved without looking at statistical outliers.

There exists a great deal more high-productivity technology than currently is being utilized for optimal

benefit. In addition, cuts in research funding and other impediments are limiting the implementation of research results, sometimes when researchers are on the brink of technological breakthroughs. Intellectual property must be protected to enhance technology transfer to the private sector.

Because a larger proportion of the world's food is likely to move through international trade in the next century, it is more important than ever that governments avoid discrimination against their agricultural sectors in public policy making.

Increasing agricultural productivity will not, by itself, solve the problem of rural poverty and food insecurity. Moreover, there is a limited amount of additional viable agricultural land worldwide. Yet, global food availability might be increased in the following ways.

- The land area planted can be modestly increased; also, yields per hectare should be increased and postharvest losses decreased.
- To alleviate food insecurity internally, developing countries might increase agricultural productivity and/or economic development activities in rural areas, invest more in agricultural research, and refrain from exploiting farmers with "cheap food" policies.
- Good domestic policy should include a transparent legal framework, gender equality, environmental protection, and attention to susceptible populations.
- Although Asia and Africa are expected to contribute heavily to increased pressure on the food supply, South America, North America, and Eastern Europe should be able to meet this demand if they make effective use of the available arable land and increase investment in agricultural research. Effective interpretation, presentation, and dissemination of information are critical among those involved in food production.
- Food aid also has been decreasing because of a decrease in government stock surpluses. Higher levels must be restored to support poor countries that cannot afford to participate in the international market.

International Food Security Conclusions

Global supply and demand is the subject of countless sophisticated analyses that often fail to incorporate the human sufferings of those whose right to food is denied. Chronically hungry people are very poor, usually landless, and disproportionately female. Early

malnutrition or undernutrition must be addressed by breaking the cycle of intergenerational hunger. Education and employment is vital in the fight against hunger.

Hunger will be worst in subSaharan Africa and parts of South Asia. Although referring to Africa, a statement in 1994 by IFAD President Fawzi Al-Sultan applies to many developing nations. “We can invest now in sustainable development, or pay later for the emergency relief of starving populations, for the resolution of civil conflicts, and for the relocation of millions of refugees—fundamental challenges to the international community arising from the dangerous convergence of poverty and dwindling natural resources.”

Quality and Safety: Challenges and Solutions

Worldwide Issues

Food safety, security, and sufficiency are not new issues, but *they are linked in new ways that transcend national boundaries*. Our current food supply is truly global, a fact that presents both benefits and opportunities. Expansion of international trade is essential to meeting the world’s need for food.

Trade also is linked to food safety issues as exporters recognize that buyer confidence in a commodity is a critical factor. In turn, national and international food safety also are inextricably linked.

Three **forces** now drive change in U.S. food safety: (1) globalization of the food supply, (2) a shift in food safety focus during the 1990s from chemical residues to microbial pathogens, and (3) emergence of hazardous analysis critical control point (HACCP) principles as a conceptual framework for food safety across the world’s regulatory agencies.

Three **trends** shape the future: (1) greater reliance on “systems” approaches; (2) a proliferation of food safety standards, both voluntary and mandatory, e.g., the U.S. administration’s overall effort to improve oversight of imported produce; and (3) a greater role for scientific and technological solutions, e.g., wider use of pasteurization and the public’s willingness to consider a role for food irradiation. Inconsistency and fragmentation in the federal system for research, inspection, and outbreak management are being addressed, and collaboration and coordination are improving.

According to a 1989 Food and Agriculture Organization (FAO) Finland-supported study, problems with

imported food products that are detained or rejected have been difficult to address for the following reasons.

- Few countries maintained records of detention or rejections. Consequently, there was little analysis of reasons for detention or rejections.
- Few countries made detention or rejection information available to other countries, including the country whose products were being detained.
- Importing countries failed to inform exporting countries of their entry requirements.
- Import entry requirements differed from country to country and required continuous review for unannounced changes in procedures.
- Exporting countries lacked measures to assure compliance with importing country requirements.
- Export certificates were confusing, nonstandardized, and issued by different agencies in different countries.

International Trade and Sustainability

Open markets are necessary, and food safety policies must work in concert with the open market philosophy. Safety, security, and sustainable agriculture are closely entwined in the context of international trade, and the health of the environment is an important issue. The Food Quality Protection Act of 1996 strengthens the U.S. pesticide regulatory system, addresses risks and the need for residue limits, and lends consistency to the regulatory process. Organic agriculture also needs expanded research.

International Trade and Standard Setting

The Uruguay Round of the General Agreement on Tariffs and Trade (GATT), which began in 1986, led to significant changes in the global regime, in part by establishing the World Trade Organization (WTO). It also established the Application of Sanitary and Phytosanitary Measures (SPS) and the Technical Barriers to Trade (TBT) Agreements, which minimize discriminatory and adverse trade effects by requiring that WTO members base national measures on international standards. The TBT was designed to prevent national or regional technical requirements from functioning as unscientific, unjustified trade barriers in the areas of quality provisions, nutritional requirements, labeling, and analysis methods. More attention is being given to risk-based inspection systems, emphasizing the concept of “equivalency.” The success of this approach will depend in part on improved

record keeping.

The Joint FAO/World Health Organization (WHO) Food Standards Program and the Codex Alimentarius Commission (CAC) were established in 1962 to protect consumers' health while encouraging fair trading practices. The Joint FAO/WHO Expert Committee on Food Additives and JOINT FAO/WHO Meetings on Pesticide Residues now provide scientific advice that forms the basis for development of food safety recommendations used in international trade. The role of the CAC is to develop harmonized international food standards and codes of practice by narrowing differences in interpretation; their role has been strengthened by the SPS Agreement. These standards also serve as reference points in trade dispute resolution. The move toward international standards will help to avoid trade disputes, thereby providing a safer and more abundant food supply worldwide.

Specific work by the CAC in 1997 included development of an action plan that reflects recommendations of the Joint FAO/WHO Expert Consultations on Risk Assessment and Risk Management. Risks need to be communicated to consumers more clearly by objective reporting. The Codex Alimentarius can satisfy the need for standards, and the FAO can provide specific project guidance.

Changing Roles of Government and Food Industry

The food industry must produce a safe, high-quality product. The government must support the infrastructure and reassure consumers by playing advisory, regulatory, and enforcement roles. The infrastructure in turn must be designed to address inspection, testing, and certification methods. End-product testing is not the solution to effective regulation. The market of the importing country must not become a dumping ground for inferior products.

Harmonization

National food control systems should be based on a statutory framework to encourage fair trade practices and stimulate development of industry and trade. Science-based quality control also promotes consumer acceptance. Harmonization of standards is needed to reduce trade restrictions; transparency and equivalency are needed between systems.

Recent Progress

Food safety decisions have implications for the environment, animal health, international trade, and the economic health of industries.

A 1994 task force report issued by CAST offered 15

recommendations for decreasing foodborne illness. They included the following.

- Food safety policy should be based on risk assessment.
- The food safety information database should be expanded to provide more complete information on the incidence of foodborne disease by pathogen and by food.
- Control practices should be applied from food source to consumption, including the incorporation of HACCP principles.
- The public should be well educated regarding safe food handling and the relative and changing risk status of individuals.

This report was vital in helping to build a scientific case in support of change. Although the scientific community has known for some 20 years about the importance of pathogenic microorganisms as a public health threat, real change has occurred only in the past four to five years. *E. coli* O157:H7 made the issue real for the U.S. public and provided the impetus for change in the United States including the accomplishments listed below.

- In 1993, the USDA issued a rule requiring safe handling labels that address storage, cooking, and holding practices for raw meat and poultry products.
- In 1994, the USDA initiated a monitoring program for *E. coli* O157:H7 in ground beef.
- In 1995, the Centers for Disease Control and Prevention (CDC), the USDA, and the U.S. Food and Drug Administration (FDA) initiated a Sentinel Site Surveillance project, now known as FoodNet, to collect more precise information about the incidence of foodborne illness, especially illness caused by *Salmonella* and *E. coli* O157:H7.
- In 1996, the USDA published its landmark rule requiring all plants that slaughter and process meat and poultry to implement HACCP systems as a means of preventing contamination from pathogens and other hazards. To ensure that HACCP systems are working as intended, the rule also sets in-plant performance standards for *Salmonella*, and testing will be conducted to ensure those standards are being met. This is the first time the USDA has set a performance standard for a broad range of raw meat and poultry products.
- A farm-to-table approach to food safety has been adopted by government agencies, professional

groups, academia, and industry. For example, the USDA is working with producer groups to develop and encourage measures to reduce food safety hazards associated with animals presented for slaughter.

- At the transportation to retail level of the farm-to-table chain, standards governing the safety of foods during distribution are being developed to emphasize time and temperature control.
- At the retail level, the federal government is working to ensure the adoption of science-based standards and to foster HACCP-type preventive approaches.
- In 1997, President Clinton announced measures to modernize food inspection and manufacturing procedures; increase research into foodborne pathogens; create an early warning system to detect and respond to foodborne outbreaks; and strengthen coordination among federal, state, and local food safety agencies.
- The President also called for additional actions to improve the safety of domestic and imported fresh fruits and vegetables and to give FDA additional authority regarding imported fruits, vegetables, and other foods.

Efforts to attain food security at the global level also must address whether the world's farmers can provide two or three times as much food as today *without having a negative impact on the environment or the social fabric of the people*.

Quality and Safety Conclusions

Food safety regulations should be based on science. Science must address various complex issues such as the effect on human health of anabolic hormones and potential foodborne diseases such as bovine spongiform encephalopathy. Lack of early, decisive action on such issues can have far-reaching ramifications. Foodborne disease and drinking water contamination are increasing concerns in the United States; internationally, food safety is integral to helping poor countries become more self-reliant.

Well-focused research and new forms of collaboration among people and institutions in government, industry, academia, and public health and consumer communities are needed to address larger questions such as modernization of food inspection, processes, fragmentation of the federal food safety system, and better linkage of the U.S. food safety system with that of the rest of the world. A high level of leadership from the food industry will continue to be needed because

the industry has product-specific experience and the role of government is inherently limited.

Microbial pathogens dominate food safety concerns in the 1990s, and consumers need information on risks involved. The recent problem on the eastern shore of Maryland with *Pfiesteria piscicida*, which has killed tens of thousands of fish, is a good example of a multifaceted issue with public health, environmental, and economic implications. To date, there is no evidence that ingestion of *P. piscicida* or its toxins poses a risk to humans, but based on sales of fish and seafood, it is clear that the public fears that there may be a food safety problem.

Consumer education and input is increasingly important as decision makers at governmental and industry levels are faced with new challenges in ensuring the safety and quality of the food supply. Pesticide residues, heavy metals, other chemical contamination, and mycotoxins disrupt trade and cause losses of income and food. New products and food processing technologies also pose challenges, as do increased antibiotic resistance among foodborne pathogens and the overall increase in food imports and exports.

International trade in food alone during 1996 was estimated in excess of \$300 billion dollars. This number will continue to grow modestly as a result of consumer demand. Manufacturing and processing technology are responsible for dramatic increases in food trade, as are transportation and loosening of certain trade constraints. But as volume of trade increases, so does the potential for problems.

Agriculture Research in the Twenty-First Century

Challenges

As the world population approaches 6 billion in the year 2000, agriculture will be challenged as never before. From 70 to 80% of the world's population still exists on a substandard diet, and 10% are near starvation.

The United States must not become complacent and neglect necessary research. We need to sustain and increase yields, preserve soil fertility, use natural resources more prudently, minimize adverse environmental impacts of farming, develop more healthful food products, and compete economically in world markets.

Research Planning

Technologies must add to, rather than deplete, the earth's resources. As the United States shifts to more scientifically, technologically, and biologically based agriculture, some conventional research areas that will require increased attention include plant and animal breeding and resistance to environmental stress; improved efficiency of production of crops and livestock; pest management; human, animal, and plant health; weather and climate; irrigation and water management; soil and fertilizer management; environmental quality; aquatic food sources; postharvest losses and storage; basic biological research; integrated production systems; market expansion; food policy issues; and information systems.

Two newer areas deserving special emphasis are biotechnology and development of new food plants by genetic engineering to provide better prevention of diet-related diseases.

Diet and Health Issues

Human health issues will become increasingly important, consumer-driven areas for research. Diet-related diseases should be targeted, and disease-inhibiting or provoking properties of foods also need to be studied so that the effects of such properties might be appropriately enhanced, reduced, or otherwise modified.

Research Conclusions

Appropriate technologies, resource inputs, and economic incentives can address worldwide food shortages. The level in agriculture research funding relative to other research priorities must be bolstered, particularly for production-oriented and multidisciplinary research. Balance is needed in funding basic versus production-oriented research. All concerned citizens should inform state and federal legislators of the importance of increasing agricultural development and research funding.

General Conclusions

The challenges of global food security differ greatly from those facing the United States. Adequacy of supply is one primary example. As developing nations' populations rise, policy dilemmas arise if agricultural production does not increase accordingly. In some cases, neither bolstering production nor increasing imports is a desirable option.

However, in some parts of the world, developing nations are moving away from socialist economics to market-oriented systems. Much of Latin America has followed this trend, as has Asia, Eastern Europe, and the former Soviet Union. But distortions still exist in international trade. The "playing field" for agricultural trade is growing more level, and as a result, efficiencies will emanate throughout the food chain, allowing the world to feed more people than ever before. Now that agriculture has penetrated the global negotiating agenda, continued improvements can be expected. But commitment is needed by those who will benefit from more open markets, and diligence and effort will be necessary by governments, farm groups, consumers, and all other potential beneficiaries of expanded trade.

Even meeting all these needs will not solve all the problems. Developing nations must eliminate the distortions in their own economic systems, and all nations should participate in the removal of global distortions. Competition should foster efficiencies in food production, processing, and distribution. Having an adequate food supply at an attractive price will not suffice if purchasing power is absent—which is still the case in many parts of the world.

The short-run solution is humanitarian aid. But a long-term response is also needed. Economic growth will be needed to ameliorate or eliminate the problem. Developing countries are still short on purchasing power in the aggregate, and income distribution also leaves pockets of hunger. But there is not much reward for attempting to equitably redistribute a pie that is simply too small.

The answer is to get the policies right, thereby unleashing the creativity and inherent entrepreneurship of the private sector in all nations. If that is done on a global basis, the capacity to provide the world with an adequate diet can be achieved. Only with knowledge and commitment can the world be fed, the disease risk in food consumption minimized, and the environment protected.

1 Food Safety: Domestic and International Dimensions

Dr. Catherine E. Woteki

Introduction

It's a pleasure to be here with you today at your conference on food safety, food sufficiency, and security. Secretary Glickman sends his regrets and best wishes for a successful conference. The interrelationships between these important food-related issues is something I have thought about many times, both from a domestic and an international perspective. I appreciate the opportunity you have provided for government, industry, and others to discuss these issues in an open forum.

I also appreciate the ongoing work of the Council for Agricultural Science and Technology (CAST) in helping public policy decision makers understand scientific research that affects food, agricultural, and environmental issues. It is of utmost importance to me, and to Secretary Glickman, that we base public policy decisions on sound science, and therein lies the rub. The real challenge comes in translating scientific information into public policy. Conferences such as this one provide us with an opportunity to discuss important food related issues so we can determine solutions, and implement those solutions, together.

Food Safety

Of course, food safety is the issue with which I am most directly involved in my current position, and it is a topic that CAST has addressed many times. In 1994, CAST issued a task force report entitled *Food-*

borne Pathogens: Risks and Consequences. In that report, CAST made a number of recommendations for reducing foodborne illness. Let me mention just a few here today.

- Food safety policy should be based on risk assessment.
- The food safety information database should be expanded to provide more complete information on the incidence of foodborne disease by pathogen and by food.
- Control practices should be applied from food source to consumption, including the incorporation of Hazard Analysis Critical Control Point (HACCP) principles.
- The public should be well educated regarding safe food handling and the relative and changing risk status of individuals.

The CAST task force report was extremely important, in concert with recommendations from other expert groups, such as the National Academy of Sciences, in building a scientific case in support of change that would better address pathogenic microorganisms in the food supply. Unfortunately, despite the fact that the scientific community has known for some 20 years of the importance of pathogenic microorganisms as a public health threat, real change has occurred only in the past four to five years.

The agent for real change was not a scientific report, but a 1993 outbreak of foodborne illness attributed to *E. coli* O157:H7 in undercooked hamburgers. That outbreak was a defining moment in the history of pathogen reduction because it took the scientific information on paper and made it real for the American public. That outbreak, tragic as it was, was not the largest outbreak in U.S. history. But this pathogen scared people, because it didn't take much to make someone sick, and children were particularly susceptible. And the food source implicated—hamburgers—was a traditional, all-American meal.

The tragic outbreak provided an impetus for change that has permitted the United States Department of Agriculture (USDA) to take the expert scien-



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tific advice that it already had and accomplish quite a bit. Let me review some of those accomplishments with you.

- In 1993, USDA issued a rule requiring safe handling labels that address storage, cooking, and holding practices for raw meat and poultry products.
- In 1994, USDA declared *E. coli* O157:H7 as an adulterant when present in raw hamburger and initiated a monitoring program for the pathogen in ground beef.
- In 1995, the Centers for Disease Control and Prevention (CDC), USDA, and the Food and Drug Administration (FDA) initiated a Sentinel Site Surveillance project, now known as FoodNet, to collect more precise information about the incidence of foodborne illness, especially illness caused by *Salmonella* and *E. coli* O157:H7. The program collects foodborne illness incidence data from seven sites around the country.
- In 1996, after a thorough public process, USDA published its landmark rule on Pathogen Reduction and HACCP. The rule requires all plants that slaughter and process meat and poultry to implement HACCP systems as a means of preventing contamination from pathogens and other hazards. To make sure HACCP systems are working as intended, the rule also sets in-plant performance standards for *Salmonella*, and we will conduct testing to ensure those standards are being met. Indeed, this is a very significant step, because it is the first time USDA has set a performance standard for a broad range of raw meat and poultry products. We will begin implementing these two provisions of the rule in January 1998, starting with the largest plants.
- We have also adopted a farm-to-table approach to food safety, and we are making progress by working closely with other government agencies, professional groups, academia, and industry. For instance, at the animal production level and at intermediate stages before the slaughter plant, USDA is working with producer groups to develop and encourage measures to reduce food safety hazards associated with animals presented for slaughter. We believe that the voluntary application of food safety assurance programs, based on HACCP principles, has a role in reducing risks.
- At the transportation to retail level of the farm-to-table chain, we are working with FDA to develop standards governing the safety of foods during distribution. We are placing particular emphasis on time and temperature control as a means of minimizing the growth of pathogenic microorganisms.
- At the retail level, we are working again with FDA, and with state officials, to ensure the adoption of science-based standards and to foster HACCP-type preventive approaches—largely through the Food Code process.
- We have also made progress in educating consumers about food safety. In June, USDA, in cooperation with FDA and the CDC, sponsored a conference to share information on changing food safety behaviors. And just one week ago, we announced a new food safety education campaign, the result of a unique public-private partnership consisting of industry, government, and consumer groups, that urges all Americans to “Fight BAC!™”. . . that’s B-A-C. . . and reduce foodborne illness by confronting foodborne bacteria.
- The high priority being given to food safety is evident in the fact that this year, President Clinton announced two major food safety initiatives. The first, which was announced in January, includes measures to modernize food inspection and manufacturing procedures, increase research into foodborne pathogens, create an early warning system to detect and respond to foodborne outbreaks, and strengthen coordination among federal, state, and local food safety agencies. The Partnership for Food Safety Education, which developed the “Fight BAC!™” campaign, was launched in conjunction with this presidential initiative. Indeed, this initiative addresses the recommendations that CAST made in the 1994 report.
- And on October 2, the President called for additional actions to improve the safety of domestic and imported fresh fruits and vegetables. He announced his intention to send to Congress legislation giving FDA additional authority regarding imported fruits, vegetables, and other foods. He also directed FDA to work with USDA, and in close cooperation with the agricultural community, to issue guidance on good agricultural practices and Good Manufacturing Practices (GMPs) for fruits and vegetables.
- Together, these steps are significant. And they sound an awful lot like the recommendations contained in the 1994 CAST report.

Safety, Sufficiency, and Sustainable Agriculture

I believe we are making good progress in our efforts to reduce foodborne illness. For the future, however, we need to work harder to understand the complex interrelationships that exist between the three “S’s”—safety, security, and sustainable agriculture—both on a domestic and global basis. USDA uses the term “food security” to include the availability of sufficient quantities of food, access to adequate resources to acquire food, and utilization of the food through adequate diet, water, sanitation, and health care.

All of our food safety decisions have other implications, whether they involve the environment, animal health, international trade, or the economic health of industries. We cannot consider food safety issues in a vacuum.

The recent problem with *Pfiesteria piscicida* on the eastern shore of Maryland, which has killed tens of thousands of fish, is a good example of a multi-faceted issue with public health, environmental, and economic implications. Manure from chickens is being singled out by environmentalists as the source of pollutants causing the problem. Farmers are asking: if they cannot use poultry waste as fertilizer on crops, what else can be done with it? And the seafood industry is attempting to maintain public confidence in its products at a time when there remain many questions about the public health implications of the problem. To date, there is no evidence that ingestion of *P. piscicida* or its toxins poses a risk to humans, but based on sales of fish and seafood, it is clear that the public fears that there may be a food safety problem.

You will see all three of these issues—food safety, food security, and sustainable agriculture—receiving high level attention by USDA now and in the future. The fact is, safe food is of little importance to those who don’t have enough food to eat. And our ability to produce enough food will be severely compromised if we don’t take care of the environment on which we depend to produce that food.

World Food Security

Regarding world food security, Secretary Glickman led the U.S. delegation to the World Food Summit, which was held last November in Rome, Italy. At that summit, 186 countries adopted the Rome Declaration and World Food Summit Plan of Action, which set the goal of reducing the number of undernourished people by half no later than the year 2015 and identified actions that nations should take to achieve that goal.

The United States subsequently adopted the goal as a domestic target as well, and has embarked on the development of a U.S. Action Plan on Food Security to strengthen what the U.S. Government, the private sector, nongovernmental organizations, and other sectors are doing to reduce hunger and malnutrition both at home and abroad.

Food and water safety will, no doubt, be important components of that action plan. While the U.S. food and water supplies are among the safest in the world, we recognize that public health problems such as foodborne disease and drinking water contamination are an increasing concern. And these concerns are not limited to certain segments of the population; they affect us all. Internationally, food safety will be an integral part of actions developed to assist countries with poor food security to become more self reliant.

Sustainable Agriculture

Food safety is also linked to the health of the environment. Policies that support farmers taking more sustainable approaches, such as restrained use of pesticides and the introduction of integrated pest management, benefit food safety as well because they help to reduce food contamination due to potentially harmful levels of chemical residues.

The Food Quality Protection Act of 1996, which strengthens the U.S. pesticide regulatory system, offers us unprecedented opportunities to provide greater health and environmental protection, particularly for infants and children, as well as for other vulnerable populations. It establishes a single, health-based standard for all pesticide residues in all foods. It provides for a more complete assessment of potential risks, with special protections for potentially sensitive groups such as infants and children. It places stringent conditions on the consideration of benefits in setting pesticide residue limits and expands consumers’ “right to know” about pesticide risks and benefits. Overall, it establishes a more consistent, protective regulatory process, grounded in sound science and adaptable to future advances in scientific understanding.

To promote sustainable agriculture, we also need to expand research into organic agriculture and integrated pest management, provide education in sustainable agricultural practices, and educate consumers about food and agricultural systems to enable them to make better choices about food consumption.

International Trade

As the theme of this conference suggests, food-related policies have international as well as domestic dimensions. We recognize that open markets help to improve the availability of food worldwide, and we must ensure that our food safety policies, and the food safety policies of other countries, do not unfairly close these markets.

The Uruguay Round of the General Agreement on Tariffs and Trade (GATT) established rules and commitments for agricultural trade, and these agreements are now the framework for ongoing efforts to lower trade barriers and expand access to world markets. Countries must ensure that their sanitary and phytosanitary measures are based on science and risk assessment principles.

The USDA is committed to ensuring the steps it takes domestically to improve food safety are consistent with international food safety policies. The Pathogen Reduction and HACCP rule and our increasing focus on risk assessment, for example, are both consistent with GATT.

This commitment to consistency in international food safety policies is reflected in the active role the United States plays in the Codex Alimentarius Commission. The work of the Commission is critically im-

portant in establishing international food safety standards. We are increasing the resources we devote to Codex activities, and we recently selected a new Codex manager, Edward Scarbrough, who reports directly to my office.

We believe the move toward international standards, and the establishment of domestic policies that are consistent with international policies, will help to avoid trade disputes, particularly those that are not really about food safety but about protecting national trade interests. And in the end, this translates to a safer and more abundant food supply world-wide.

Closing

In closing, I believe it is obvious that decisions affecting food safety, food security, and sustainable agriculture are closely intertwined on a domestic as well as international level. USDA's strategy in all three areas is being closely crafted with these interrelationships in mind. And USDA is developing these strategies through a completely public process—a process in which we encourage groups such as CAST to become involved.

I look forward to working with all of you on these important food-related issues in the months and years to come.

2 Food Safety: Domestic and International Dimensions

Excerpts of Dr. Arpad Somogyi's Presentation

Ideally, food safety regulations should be based on science. But in reality, domestic regulations are the end product of equal parts science, law-making, and social values. International regulations, by contrast, are based on science and law, with social values serving to construct artificial trade barriers. One example of science-based regulation is in the Uruguay Round of the General Agreement on Tariffs and Trade (GATT), which is enacting science-based sanitary and phytosanitary measures (known as the SPS Agreement) to protect human and animal health.

Science is of the utmost importance in formulating measures to address various complex food safety issues. Below are examples.

1. There is no scientific evidence that nitrate is detrimental to adult human health. Nitrate is converted to nitrite in the stomach, constituting an effective antibacterial strategy. In people consuming increased amounts of vegetables containing high levels of nitrate, cancer incidence is lower. But the nitrate also combines with amines and amides to form nitrosamines, which are known carcinogens.
2. Bovine spongiform encephalopathy (BSE) was first reported in the United Kingdom in the early to mid-1980s. Another 170,000 cases have since

been reported in the United Kingdom. Apparently, species barriers have broken down; BSE is now thought to originate in sheep, infecting cattle that are fed sheep meat and bone meal, although researchers do not know the causative agent. Scientists assume that it can be passed to primates—including humans—as well. But because clinical signs are not perceptible in animals at early stages of infection, the disease's introduction into the human food chain cannot be prevented.

Lack of early, decisive action by regulators has far-reaching ramifications. Because the British beef ban was impossible to enforce, some cases of BSE have now occurred on the European continent.

In addition, humans in their twenties are contracting a variant of Creutzfeldt-Jakob Disease (vCJD). The entire European continent has been affected by the potential of exposure. The first case in humans, thought to be contracted from consumption of meat and bone meal, was diagnosed in Belgium this week (early November 1997). Although vertical transmission is a possibility, predicting the spread of BSE is difficult because there are no screening methods. Moreover, previous predictions have proved wrong.

3. There is no scientific information to support the argument against using anabolic hormones.



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3 Food Safety 1997—Driving Forces and Emerging Trends

Dr. Michael R. Taylor

Introduction

The Council for Agricultural Science and Technology deserves our thanks for convening this meeting at this time. Food safety, food sufficiency, and food security are not new issues, but they are linked together today in new ways. And, to an extent unprecedented in human history, they are issues that transcend national boundaries.

It is almost a worn-out cliché by now, but we do have a global food supply. This is an established fact, and there is no turning back, nor should there be any turning back. The growing international trade in food is a good thing for people in all walks of life all around the world.

Trade expands access to the foods consumers need and want and helps keep prices competitive. It provides the food industry with new incentives to innovate—to produce better quality products at better prices—knowing the rewards that can come with access to large international markets. And the expansion of trade in an increasingly free market for food is, I believe, essential to meeting the world's need for a sufficient and secure food supply.

Trade also is linked to food safety. Countries are increasingly alert to possible risks associated with imported foods, and exporters know that buyer confidence in the safety of a food commodity or product is one of the essential tickets to success in the interna-

tional marketplace.

One consequence of this link between food safety and trade is that it is almost impossible to talk about the domestic dimensions of food safety, which is my assignment today, without also talking about the international dimensions of food safety, which is Mr. Lupien's assignment. And I will not attempt to avoid the international dimension.

What I will do is talk about three forces that are driving change in food safety in the United States. The first of these is the globalization of the food supply and food safety. The second is the shift in our food safety focus during the 1990s from chemical residues to microbial pathogens. And the third force is the emergence of HACCP as the conceptual framework—the governing philosophy—for food safety within much of the food industry and among the world's major regulatory agencies.

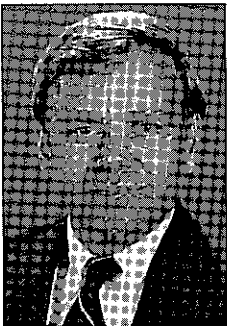
I will then talk about three major trends in food safety—the direction of the changes that are being driven by these forces. But first, let us examine the forces driving change.

Forces Driving Change

Globalization

The first trend—globalization of the food supply—begins, of course, with the growth in trade I have already mentioned. A few illustrative and familiar facts make the point. Over half of the seafood consumed in the United States is imported. Americans depend on imports from Latin America to meet their needs for fresh produce during winter months. American exports of agricultural commodities reached \$60 billion in 1996, and they will drive future growth in American agriculture. Finally, many countries in both the developed and developing world absolutely depend on imported commodities and products to meet basic food needs.

With the globalization of trade comes the globalization of food safety. Food safety problems—and solutions—are no longer contained within a single coun-



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tion of Hazard Analysis and Critical Control Points (HACCP) as the framework for USDA's inspection of meat and poultry.

try's borders, and even the perception of a food safety problem can affect the flow of trade.

Finally, the new trade agreements create a global framework for international trade that explicitly recognizes the critical link between food safety and trade. The agreements respect the right of member states to determine the level of food safety protection appropriate for their populations, while encouraging international harmonization of food safety standards based on the principle of equivalence. The United States and its major trading partners are now obligated to consider the acceptability of each others' food safety standards.

The food supply is irretrievably global, and, as I will describe in a moment, this fact has important implications for food safety in the United States.

Microbial Pathogens

The second force driving change in food safety is the shift in public focus and attention to microbiological hazards. If food additives and environmental contaminants were the issues of the 1970s and pesticides were the issue of the 1980s, microbial pathogens are the issue of the 1990s. Chemical residues in food still deserve careful attention, but public concern about microbial pathogens is different and will, I believe, be more lasting and influential.

This is because the potential harms from microbial pathogens are acute and demonstrable rather than chronic and speculative, and there are no simple or permanent solutions. Chemicals can be banned, but harmful bacteria cannot be ordered off the face of the earth, and the capability to control microbiological hazards is widely dispersed throughout the food system. These facts mean that today's food safety "story"—the story of foodborne pathogens—will recur frequently in the nation's media, with the problem and the search for solutions being documented repeatedly in many different contexts.

Sustained media and public attention on any subject is a powerful force for change in American society, and this will continue to be true for food safety.

HACCP

The third force driving change on food safety is the emergence of HACCP as the conceptual framework for food safety in the United States and around the world. HACCP is embraced by much of the food industry as its tool of choice for building safety into food production processes. HACCP has also been adopted as a regulatory tool for meat, poultry, and seafood pro-

cessing operations in the United States, and it is recognized as a regulatory standard by Codex and individual countries elsewhere in the world. And the HACCP "philosophy" has infiltrated much of contemporary thinking on food safety within governments and segments of the food systems—from farm to table—that have not traditionally thought in terms of process control.

Thus, hazard analysis, risk-based prevention, a systems approach to food safety, and other HACCP-like concepts are being applied in a variety of ways across the farm-to-table continuum to improve food safety.

Trends Shaping the Future

If globalization, a new focus on microbial pathogens, and HACCP are the forces driving change in food safety, what does that future look like? What food safety trends will shape the future?

I see three major trends:

- much greater reliance on "systems" approaches to food safety at the plant and company level, at the farm-to-table food system level, and at the level of government oversight;
- the proliferation, in many forms, of "standards" for food safety; and
- a greater role for scientific and technological solutions.

Let me briefly discuss each of these trends.

Systems

The first trend—toward systems approaches to food safety—is driven principally by HACCP and today's focus on microbial pathogens. At the operating plant level, HACCP is itself inherently a systems approach to food safety. HACCP goes beyond the traditional reliance on good manufacturing practices that can be carried out, disconnected from one another, to a system of overall process control that recognizes at least the potential interconnectedness—for food safety purposes—of everything that happens in a food manufacturing setting. This is why HACCP principles call for a HACCP plan that reflects a hazard analysis of the food manufacturing process as a whole and includes the controls appropriate at each step in the process to minimize hazards. HACCP is a systems approach.

The HACCP concept of risk-based process control, coupled with today's focus on microbial pathogens, is also driving us powerfully and inevitably toward sys-

tems approaches outside processing plants. I am referring here to the search for farm-to-table solutions to food safety problems. It is simply impossible to embrace the HACCP philosophy and not look for opportunities to minimize hazards wherever they may arise and can be effectively controlled.

And this is especially true, obviously, with regard to hazards posed by microbial pathogens. Unlike their chemical counterparts, microbial pathogens have the unfortunate tendency to grow, if conditions permit, at any stage from the farm to the table. On the bright side, while chemicals are often difficult to remove once they contaminate a food, bacteria on many foods can be killed at various points along the way or at the time of preparation.

So it is inevitable and essential that we think in terms of food safety systems that extend well beyond the processing plant. And we are already doing that. Vertically integrated food companies have been doing it for years. Agricultural producers are examining how to enhance the food safety elements of their quality assurance programs. Food service operators and retailers are imposing food safety-oriented purchase specifications on their suppliers, recognizing that they and their suppliers are part of one food safety system.

And the government is gradually moving toward this broader systems approach. This is evidenced by the joint FSIS and FDA initiative on transportation and storage, the agencies' emerging farm-to-table approach to egg safety, and the emphasis the federal government is placing on state and local adoption of the Food Code and consumer education.

Although the food industry and the government realize that we will not achieve our food safety goals by focusing solely on processing establishments and both are moving toward a "farm-to-table" systems approach, there is much to learn and do to convert this aspect of the systems approach to reality. This element of the systems trend is still in its early stages.

The trend toward systems approaches to food safety is also evident at the level of government oversight. This aspect of the trend is being driven in part by the risk-based HACCP philosophy but also by budgetary and international pressures.

The organizational and programmatic fragmentation in the federal government's food safety program is well known. It extends to the distribution of the regulatory and policy functions across at least four agencies—FDA, FSIS, the U. S. Environmental Protection Agency (EPA), and CDC—and to the sharing of the food safety research function across, by one count, more than 20 agencies. It is impossible to think about food safety in scientific terms and to believe that

the program should be driven by considerations of risk and public health and, at the same time, believe we have the optimal "systems" approach in the federal government's program.

This seems especially true if we look at resource allocation within and among the agencies. Pizza is my favorite example. Pepperoni pizza plants are inspected every day by USDA, and this is after USDA has already inspected each carcass during slaughter and the processing of the raw meat into pepperoni. Cheese pizza plants, on the other hand, which are under FDA's jurisdiction, are inspected once every few years, at best. I think I am safe in saying that food safety resource allocation in the federal government is not as public health- and risk-driven as it might ideally be.

The fragmentation in the federal system also has international implications. We are obligated to work toward harmonization of our system with the systems of our trading partners, consistent with maintaining our desired level of food safety protection. The key harmonizing principle is "equivalence." But, on such fundamental issues as the nature of inspection, how can we harmonize with other countries when we are inconsistent within our own programs in ways that may not have an adequate scientific or public health justification?

This problem of inconsistency and fragmentation in the federal system is not new to anyone, including the people responsible for running the system, and I believe that we are beginning to address the problem in serious ways. There has been in recent years a high level of collaboration among the agencies on HACCP and other food safety initiatives, and the President's National Food Safety Initiative, which Congress is in the process of funding, stresses much greater coordination among the agencies on such matters as research, inspection, and outbreak management. This is a very good start, and the initiative also includes a strategic planning process that is intended to examine some of the fundamental organizational and programmatic issues I have mentioned.

It is easy to describe the problems in the current system. It is hard to determine the right solutions. I do believe, however, that we are on a track toward addressing them, in a way that will make the federal system of food safety oversight more of a true system.

Standards

The second major trend I want to describe is the trend toward more explicit and more frequent articulation of standards for food safety. I am using the

term “standards” here in the broadest possible sense, and I do not limit it to mandatory standards set by regulatory agencies.

HACCP is itself a kind of standard—the seven HACCP principles and all that go with them embody a standard of care for food safety process control. HACCP also will drive the development of standards, using that term again in the broad sense. The critical controls that companies develop and validate in accordance with HACCP principles are a kind of standard. They represent what the company has judged to be an adequate degree of control to minimize a particular hazard. Some standards of this kind are very familiar and widely accepted: times and temperatures for thermal processing, for example. As HACCP is applied in new situations, however—such as in slaughterhouses or in the production of fresh produce—it will be necessary to consider what constitutes an adequate control or controls. What is the appropriate standard of care in these situations with respect to each of the potential hazards?

HACCP also is driving government development of standards in varying forms, including “voluntary” guidance and mandatory legal standards. HACCP is not, of course, an end in itself; it is a means to an end. From the government’s perspective, HACCP is a means for achieving a level of food safety performance that satisfies a company’s legal obligation to produce safe food, as spelled out in the various food safety statutes and via implementing regulations. It is a strength of HACCP that it focuses attention on the specific hazards that are of greatest potential significance, but this focus also compels government, as well as the industry, to consider what constitutes an adequate level of performance with respect to those hazards.

The results of this focus so far have included USDA’s development of model HACCP plans as guidance for the industry, its regulatory performance standards for reducing the incidence of *Salmonella* contamination in slaughter plants, and its effort to articulate in performance standard terms the basis of HACCP plans for judging the adequacy of cooked beef with respect to control of microbial pathogens. The trend as HACCP implementation goes forward will be, I believe, toward additional government-generated performance standards.

The globalization phenomenon I have discussed, and in particular the move toward international harmonization, is also driving the trend toward standards. If, in the spirit of harmonization, we are to judge whether a Codex standard or the standard adopted by a trading partner provides a level of protection equivalent to our own, we must know what our

level of protection is. And this will inevitably lead to pressure for the United States to articulate that level of protection in the form of some kind of standard.

The most dramatic evidence of this phenomenon is the President’s recent announcement of an initiative to improve oversight of imported fresh produce. This is part of the administration’s overall effort to improve food safety and also to assure the public that the expansion of trade will not jeopardize food safety. The produce initiative includes the development of guidance for safe agricultural production practices that imports will be required to meet. This amounts to a new standard for fresh produce, although it will be technically a voluntary standard. To hold imports to a particular standard of care, however, the United States is obligated under the trade agreements to hold domestic produce to the same standard. Thus, the new guidance also will create what amounts to a new standard of care for producers in the United States.

Science and Technology

The third and final trend I would like to discuss is also well under way and very familiar to this audience. It is the trend toward greater reliance on scientific and technological solutions. Like the other trends I have discussed, this trend is also driven in large part by HACCP. At a philosophical level, HACCP stands for the proposition that we should use the best science and technology that is available and can be feasibly applied to identify and minimize potential food safety hazards.

At a practical level, HACCP provides the analytical framework for gauging where technological control measures can best be applied to minimize hazards—not as a silver-bullet solution to complicated problems but as part of an overall system of process control. One of the greatest strengths of HACCP, in my view, is that it is a vehicle for harnessing the best that science and technology have to offer to improve food safety.

The evidence of the science and technology trend is all around us. The meat industry is moving on its own to adopt steam pasteurization and other technologies proven effective in reducing harmful bacteria on carcasses. The juice industry is calling for wider use of pasteurization to address the problem of potential contamination with *E. coli* O157:H7. The public health community is recognizing the need to revisit the possible role of irradiation as a food safety tool. Both industry and government are considering the role microbial testing can play as a HACCP verification tool and as a means of better managing and containing

contamination incidents, such as the one that struck Hudson Foods not long ago. And the President's National Food Safety Initiative is heavily weighted toward research, risk assessment, and improved epidemiological surveillance—key elements of the scientific infrastructure essential to a successful HACCP-based food safety program.

This trend toward greater emphasis on science and technology should—and I believe will—continue.

Working Toward the Future

If the forces driving change in food safety are globalization, pathogens, and HACCP, and if the trends towards systems, standards, and science define where we are headed in the future, what will it take to be successful when we get there? I can think of four things, or rather four categories of things, that we need to be working on.

First is really well-focused research coupled with some serious brainstorming to apply the knowledge we have. It is one thing to recognize that the trends are moving us in the direction of systems, standards, and technology. It is another thing to know how to do these things well. How do we identify and control hazards in a truly farm-to-table food safety system? What do we need to know scientifically to set the right standards for process control and for controlling specific pathogens? What is the best use of microbial testing in food safety systems? What techniques will work to prevent and remove bacterial contamination of fresh produce?

These are just some of the questions that are important to the future and that will require research and serious brainstorming to answer. HACCP is a great concept. But it will be only as good in practice as the science and technology that it calls forth and harnesses to improve food safety.

Second, success in the future will require new kinds of collaboration among people and institutions in government, industry, academia, and the public health and consumer communities. One of the lessons of the last several years is that there is considerable common ground among the diverse interests having a stake in food safety. The subject is difficult, and there will always be conflicting interests and differences of opinion, but everyone wants a food safety system that works effectively and efficiently to make food safe, and there is increasingly wide acceptance of the science-based prevention strategy embodied in HACCP. Developing the systems and the standards required to put this strategy into practice will, however, take collaboration among segments of the food system and

with interests outside the food system beyond anything that has occurred before. No one person or group has all of the knowledge and all of the perspective required to find and implement good solutions to our food safety challenges.

The third ingredient for future success is a willingness to tackle some big questions. How do we modernize food inspection for a future grounded in HACCP? How do we address and solve the problems that flow from fragmentation and inconsistency in the federal food safety system? How do we relate the U.S. food safety system to the rest of the world so that the United States can continue to be a world leader in food safety and in the international food trade? Forces are at work—globalization and trade pressures, budgetary pressures, and pressures to improve the functioning of the food safety system—that can force on us answers to these questions. Far better that the food safety community tackle these questions now and create the solutions that can be successful for the long-term future.

Finally, I believe that success in the future requires a high level of leadership from the food industry. This is nothing new. The food industry has historically taken the lead in developing the scientific foundation and standard for food safety and pushing for appropriate government oversight. This has been the case over the years in many contexts, including food additive safety, low-acid canned foods, plant biotechnology, and adoption of HACCP. Agricultural producers are taking similar initiatives in food safety today.

Such industry investment and leadership on food safety is critical because the food industry has the product-specific experience and expertise to know what works, and it has an enormous day-to-day operating stake in the safety of its products and in the public's confidence in those products.

Industry leadership is also important because the government's role is inherently limited. I say this as a person who understands and values the important role government plays in food safety. But the fact is that, in today's dynamic food safety climate, the government in its regulatory role inevitably lags behind the emerging state of the art.

Government can codify and mandate some reasonable approximation of what is appropriate and feasible at any given time, but the government did not invent HACCP and it will not, in all likelihood, invent the scientific, technological and process control solution to tomorrow's food safety challenges. The food industry and the broad scientific community will do that.

And food industry leaders will be implementing the

solutions, as they have in the past, before the government is able to mandate them. It is this kind of leadership, as much as anything, that will drive progress

on food safety.

Thank you for having me here. I look forward to the discussion.

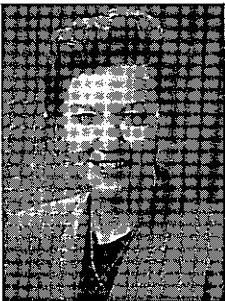
4 Food Safety: Domestic Dimensions

Summary of Respondents' Presentations

Introduction

The globalization of the food supply now taking place affords many benefits and opportunities. International trade provides food to meet basic requirements and gives consumers year-round access to a wider variety of foods. It also raises some potential food safety issues and risks.

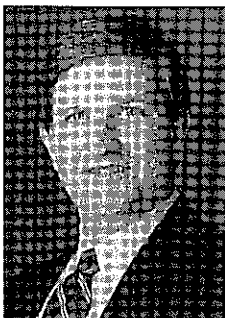
Respondents



Dr. Catherine E. Adams is Director, Quality and Food Safety, Pizza Hut, Dallas, Texas. She was formerly Director of Worldwide Quality Systems for the Campbell Soup Company and Assistant Administrator of the USDA Food Safety and Inspection Service.



Dr. Michael P. Doyle is Director of the Center for Food Safety and Quality Enhancement and Head of the Department of Food Science and Technology at the University of Georgia, Athens. Dr. Doyle served on the task force that prepared the 1997 CAST report, *Foodborne Pathogens: Risks and Consequences*.



Mr. David B. Schmidt is Vice President, Food Safety of the International Food Information Council, Washington, D.C. Mr. Schmidt served as Director of External Affairs for the Food Safety and Inspection Service of the U.S. Department of Agriculture during the Bush Administration.

There are three forces driving changes in food safety: (1) globalization of the food supply, (2) a shift in focus from chemical to microbial hazards in food, and (3) the emergence of HACCP as a standard practice in the food industry. Increased international trade has been made possible by implementation of new trade agreements that oblige each signatory to accept the food standards of its trading partners. Several agencies in the United States oversee various facets of food safety. Lack of harmonization of regulation and inspection procedures has negative implications in the international trade arena. It is also a problem in the coordination of domestic food safety.

Three trends seem to be dominating changes in our approach to food safety: (1) greater reliance on systems approaches, (2) a proliferation of standards, and (3) greater reliance on science and technology for solutions. Our future success will require (1) a focused research effort; (2) collaboration and better communication between industry, academia, and government communities; (3) willingness to tackle the big questions such as improvement of the food safety inspection system; and (4) leadership by the food industry.

Issues and Needs

Hazard Analysis Critical Control Point System (HACCP)

HACCP is not only an important tool but also a philosophy. HACCP can work, and it needs to be embraced by the industry. The focus is not on the final product but on the processing steps upstream. As a framework, HACCP can be integrated effectively into other quality control and assurance programs such as

Rapporteurs

Dr. Steven Anderson, Georgetown University, Washington, D.C.
Dr. Eldon E. Ortman, Purdue University, West Lafayette, Indiana
Dr. Rodney J. Brown, Utah State University, Logan

ISO 9000. HACCP is based on a flexibility to adapt, change, and improve, and it requires strong leadership for successful implementation. Science and new technologies can be applied within the HACCP framework to improve on current safety measures.

Microbial Pathogens

Microbial pathogens dominate the food safety stage in the 1990s. The real threats they represent are replacing perceived risks from the previous two decades. The hardiness and virulence of organisms such as *E. coli* O157:H7 pose new challenges for food safety. Food inspection needs to be redesigned, and the visual inspection systems of the past must be replaced by science-based monitoring. To be effective, the system must extend all the way from the farm to the consumer. Irradiation may be an important food safety tool in the future, but it still needs to be approved for use on many foods and accepted by consumers. The challenges are immense and the solutions difficult; many gaps need to be addressed in the food safety industry to reduce illness caused by foodborne pathogens.

Consumer Education

Consumers need critical information about risks and specific information about the pathogens associated with foods, how best to control these pathogens, and the ramifications of illness. There is a need to increase awareness of food safety through the news media and the "FightBac" partnership for food safety education. Incorporation into nutritional education vehicles, such as *The Food Guide Pyramid* (U.S. Department of Agriculture, 1992) and *Dietary Guidelines for Americans* (U.S. Department of Agriculture and

U.S. Department of Health and Human Services, 1995), may afford broader exposure for food safety issues. Exposure to food safety in the classroom will require innovative approaches to weave food safety education into existing curricula. Because food safety issues are prominent in the public eye, now is the time to educate the public and integrate the food safety message into nutrition information.

Solutions

Several solutions were identified to improve food safety in the future. New tools such as HACCP and other technologies can be plugged into the long-standing food safety regulatory structure. The food safety message can be integrated into nutritional education vehicles such as *The Food Guide Pyramid* and the dietary guidelines for the year 2000. Irradiation should be implemented as an additional food safety technology. Industry, government, and academics need to act in concert to support approval of this technology. A forum should be established in which interested parties can discuss food safety technologies and develop strategies for implementation. Overall, there must be an openness and willingness to listen and implement change.

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5 Food Quality and Safety: International Dimensions

Mr. John R. Lupien¹

Introduction

Delegations from 186 countries including many heads of state and governments attended the World Food Summit in November 1996. The World Food Summit adopted a Declaration and Plan of Action that reaffirmed the right of everyone to have access to safe and nutritious food, consistent with the right to adequate food and the fundamental right of everyone to be free from hunger. This basic right of the consumer to a safe and wholesome food supply is recognized by all governments and the food industry. It is clear that consumers' basic rights include a healthy and safe supply of food, protection of economic interests, and the right to be properly informed and have their opinions heard. The influence of public opinion on food control issues highlights the need for the transfer of accurate information to the consumer and open communication for exchange of views on both food quality and food safety issues.

This communication process is becoming increasingly important as decision makers at the government level and representatives of the food industry are faced with many challenges in ensuring a high-quality, safe food supply. Many problems of food quality continue to disrupt trade and cause losses of food and income. Food safety problems related to pesticide residues, heavy metals, industrial chemicals, radionu-

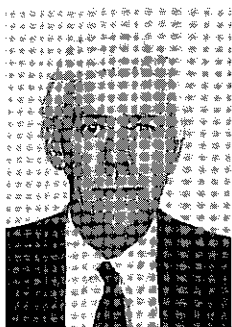
clides, and mycotoxins continue to cause concern. In addition, new challenges to food quality and safety programs include the emergence of new pathogens, new food products and food processing technologies, increasing antibiotic resistance among foodborne pathogens, and the increase in food imports and exports.

It is estimated that international trade in food alone during 1996 was in excess of \$300 billion in U.S. dollars, with continuous but modest growth predicted for the next few years. The continuous growth in international trade in food has been linked to the following: increases in personal income; consumer demands to broaden the range and variety of foods available in domestic markets; and diffusing the risk from fluctuations in domestic food production as well as for enabling a higher level of efficiency in global food production. Agriculture is often the mainstay of national economies, thus making trade of food a significant economic factor.

The dramatic increase in international trade of food has been brought about by many factors, particularly advances in food manufacturing and processing technology leading to increased product shelf-life and product security. Rapid transportation and improved shipping and handling methods have reduced shipping time and distance barriers, allowing traders access to new and distant markets for their products. In addition, the overall impact of the Uruguay Round Agreements and regional trade arrangements have reduced many tariff and subsidy related constraints to free trade, encouraging increased production and export from the countries with the most cost-effective production means. This has provided developing countries with increased opportunities to compete in international food trade. It has also presented new challenges in assuring the quality and safety of domestic exported food supplies.

While recognizing that technological advancements have, without a doubt, improved food quality and safety, the trading of food in today's global trading environment, one where there are virtually no boundaries, has also given rise to problems and cause for concern. Food products shipped today from one part of the

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world can be in a country on the other side of the world within a few days. Furthermore, mishandling of a good-quality food during transportation and storage may render it spoiled or unsafe by the time it reaches the final consumer. As the volume of food traded increases, the potential increases for exposing consumers in one country to the food quality and safety-related problems of other regions of the world.

To protect consumers' health, ensure fair food trading practices, and prevent commercial fraud, national governments establish food quality and monitoring systems for imported foods based on food quality and safety laws and regulations. Food control agencies of importing countries generally apply regulations that give them authority over such things as food safety, hygiene, quality, packaging, labeling, handling, and storage. In general, these regulations include precise requirements that must be met if food products are to be admitted into the importing country.

Food Quality and Safety Problems

If we look at the reasons for detention and rejection of imported food products, we find that most detention and rejections occur for reasons that are both avoidable and preventable and not related to highly technical requirements. In 1989, FAO, with the support of the government of Finland, conducted a study to determine the existing state of the food import and export trade, to identify the problems, and to determine the common causes for detention and rejections.

The study found a number of administrative and procedural deficiencies that impaired the process of the food trade and resulted in unnecessary detention and rejections of food consignments.

- Few countries maintained any records of detention or rejections; consequently, there was little analysis of the reasons for the detention or rejections.
- Few countries made detention or rejection information available to other countries, including the exporting country whose products were being detained.
- Importing countries failed to inform exporting countries of their entry requirements.
- Import entry requirements differed from country to country and required continuous review for unannounced changes in procedures.
- Exporting countries lacked food control measures to assure compliance with importing country re-

quirements.

- Export certificates were confusing, nonstandardized, and issued by different agencies of government in different countries.

In fact, the United States continues to be the only regular source of information on the quality and safety levels of imported food in international trade through its monthly reports on detention and rejections. This report is now available on the web site of the U.S. Food and Drug Administration Office of Regulatory Affairs (http://www.fda.gov/ora/ids/ora_ids_homepage.html). The data from the FDA detention list for the period July 1996–December 1996 for imported foods from various regions of the world are illustrated in Table 1. It is not difficult to see that a majority of the detention and rejections are still not due to highly technical food safety reasons.

From these reports, it remains obvious that exporting countries can avoid and prevent many of the import detention and rejections by strengthening their good manufacturing practices and assuring appropriate food handling, labeling, and storage practices. In taking into account the economic damage caused by current trade problems, it is useful to consider the immediate loss related to an import rejection, the effect on price offered for future shipments, and the problems that can be caused by similar, undetected shipments that reach consumers.

Changing Role of Government and Food Industry

The problems in international trade just described highlight the need for the production of food in a hygienic and controlled environment, which can be achieved through the application of quality assurance and risk-based hygiene control systems based on current knowledge of known problems specific to certain processes. This may be effected through the application of Good Agricultural and Good Manufacturing Practices, together with quality assurance systems that include safety procedures such as HACCP.

The implementation of such controls will assist food processors in achieving their main objective of meeting consumer demand by producing high-quality, safe food. The change in emphasis from end-product testing to the application of quality assurance during production, processing, packaging, and distribution is broadly accepted as beneficial to food industry. It leads to improved competitiveness, improved quality, reduction in cost of production and wastage, and satisfac-

tion of consumer demands.

Complementary to this responsibility and onus on the food industry to produce a safe, high-quality product is the provision of a national food control system by the government to provide a supporting infrastructure and assume an advisory and regulatory role and, when necessary, food law enforcement. Governments and food control agencies need to reassure consumers that they have set and will enforce limits for the quality and safety of foods. They need to work in a cooperative and collaborative manner with food processors, with clear definitions of responsibilities to be implemented by a trained and skilled workforce.

Furthermore, successful food trade relies on the ability and competence of the food control infrastructure to assure the quality and safety of exports through appropriate inspection, testing, and certification methods. On the other hand, where foods are imported, the government must assure the consumer of the safety of these products and ensure that their domestic market does not become a dumping ground for inferior or poorer quality foods.

Harmonization of National Food Control Systems

National food control systems to protect consumers against health hazards and fraudulent practices should be based on a statutory framework supported by administrative officers, inspectors, and analysts

with adequate laboratories and other facilities needed for effective administration of these laws and regulations.

The proper implementation of such a law will encourage fair trade practices through compliance with the basic provisions of the law and with standards and other regulations promulgated under the law. This will protect the honest manufacturer and dealer against unfair competition. It will also stimulate development of the food industry and trade, since quality control along sound scientific lines tends to promote better consumer acceptance of foods.

Trade restrictions can occur where there are differences in the requirements or procedures of food control systems between countries. These differences may extend to requirements for monitoring and sampling, detection and analytical methods, and application of standards and food safety requirements. First, each government must ensure that the legislative base of its food control system is adequate and that the requirements are scientifically based. It is obvious that there is a need for harmonization of standards, application of food safety standards based on science and a risk-based approach, and the establishment of equivalency between systems.

To address the need for transparency and equivalency between systems, governments must look toward the international arena to ensure that their requirements are harmonized and science based.

Table 1. U.S. Food and Drug Administration data on reasons for import detention for the regions of Europe, Asia, Africa, and Latin America and the Caribbean (July–December 1996)^a

	Africa		Latin America and the Caribbean		Europe		Asia		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Food Additives	1	0.5	18	1.0	27	4.0	169	5.0	215	3.5
Pesticide residues	0	0.0	562	25.5	18	3.0	9	0.5	589	9.5
Heavy metals	0	0.0	184	8.5	16	2.5	44	1.5	244	4.0
Mold	11	6.5	249	11.5	11	2.5	22	1.0	313	4.5
Microbiological contamination	79	47.0	220	10.0	103	16.0	488	15.0	890	14.5
Decomposition	4	2.5	115	5.5	8	1.0	353	11.0	480	7.5
Filth	32	19.0	640	29.0	104	16.0	1,156	36.0	1,932	31.0
Low acid canned food	4	2.5	66	3.0	197	30.5	509	16.0	776	12.5
Labeling	12	7.0	96	4.5	138	21.5	365	11.0	611	10.0
Other	25	15.0	34	1.5	27	4.0	94	3.0	180	3.0
Total No. of reasons(contraventions cited) for detentions	168	100.0	2,184	100.0	649	100.0	3,209	100.0	6,210	100.0
Number of consignments detained	144		2,031		620		2,906		5,701	

^aAdapted from U.S. Food and Drug Administration Office of Regulatory Affairs. Online. U.S. Food and Drug Administration. Internet. Available: http://www.fda.gov/ora/ids/ora_ids_homepage.html. October 1997.

International Trade

The Uruguay Round agreements and decisions on multilateral trade have led to significant changes in the global trade regime for both merchandise and services trade, and particularly for agriculture, which was included for the first time in a significant way in such negotiations. The discussions included negotiations on reducing nontariff barriers to international trade in agricultural products.

The conclusion of the Uruguay Round included the establishment of the World Trade Organization (WTO) in 1995 and two binding agreements: the Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement) and the Agreement on Technical Barriers to Trade (the TBT Agreement). Both agreements have a variety of implications for the work of the Codex Alimentarius Commission.

The Uruguay Agreement on Sanitary and Phytosanitary Measures introduces new disciplines in this increasingly important area. It is designed to minimize the discriminatory and adverse trade effects of such measures. The SPS Agreement confirms the right of WTO member countries to apply measures necessary to protect human, animal and plant life, and health provided that "such measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade."

It requires that, with regard to food safety measures, WTO members base their national measures on international standards, guidelines, and other recommendations adopted by the Codex Alimentarius, where they exist. The SPS Agreement states that measures taken that conform to international Codex standards, guidelines, or other recommendations are deemed to be appropriate, necessary, and nondiscriminatory. Furthermore, the SPS Agreement calls for a program of harmonization of national requirements based on international standards.

The objective of the TBT Agreement is to prevent the use of national or regional technical requirements, or standards in general, as unjustified technical barriers to trade. The agreement covers all types of standards, including aspects of food standards (except those requirements related to Sanitary and Phytosanitary measures) and a very large number of measures designed to protect the consumer against deception and economic fraud.

The aspects of food standards it covers relate specifically to quality provisions, nutritional require-

ments, labeling, and methods of analysis. The agreement basically provides that all technical standards and regulations must have a legitimate purpose and that the impact or cost of implementing the standard must be proportional to the purpose of the standard. It also places emphasis on harmonization of standards through the use of international standards.

Relevant International Standard Setting Activities

The worldwide recognition of the importance of international trade in food and the need to facilitate this trade through prevention of such problems described above—and at the same time ensure the quality and safety of food for the world consumer—led to the establishment of the Joint FAO/WHO Food Standards Programme and the Codex Alimentarius Commission (CAC) in 1962.

The objectives of the Programme are to protect the health of consumers and to ensure fair practices in the food trade; to promote coordination of all food standards work undertaken by national governments, international governmental, and nongovernmental organizations; to determine priorities and initiate and guide the preparation of draft standards through and with the aid of appropriate organizations; to finalize standards; and, after acceptance by governments, publish them in a Codex Alimentarius (Latin for "food code") either as regional or world-wide standards.

The Codex Alimentarius is a collection of internationally adopted food standards, maximum residue limits for pesticides and residues of veterinary drugs, and codes of practice. The Codex Alimentarius also includes provisions related to the basic composition, hygiene, and nutritional quality of raw, semiprocessed and packaged foods; provisions for food additives; residues of pesticides and veterinary drugs, of industrial chemicals or naturally occurring contaminants; labeling and presentation; and methods of analysis and sampling.

In undertaking its work on the establishment of various aspects of standards for foods and limits for ingredients, food additives, pesticide and veterinary drug residues, and various contaminants in food, the Commission relies on the use of independent scientific advice provided by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) and the Joint FAO/WHO Meetings on Pesticide Residues (JMPR). These committees provide the scientific advice that forms the basis for the development of food safety recommendations used in international trade. These FAO/WHO committees invite independent experts to

assess, in their own personal capacity, the state of scientific knowledge of food additives, pesticide and veterinary drug residues in food, mycotoxins and other chemical contaminants in food, and food irradiation treatments, and make recommendations to member governments and to CAC on such matters.

The principal role of the CAC is to develop harmonized international food standards and codes of practice for use in international trade. CAC standards, guidelines, and recommendations are similar to regulations promulgated under national food law in that the principal consideration behind their development is to protect consumers from poor-quality or unsafe foods. Differing interpretations of the scientific data available with respect to consumer protection can lead to differences in national regulations, even assuming that these differences are not being exploited in order to establish nontariff trade barriers.

The CAC process narrows these differences of interpretation and provides the basis for removing unjustified or arbitrary trade barriers based on claims of consumer protection. These approaches are more consistent with trends in modern food regulatory systems and should facilitate the harmonization process as a result.

The CAC's role in the harmonization of national food safety standards has been further strengthened by the support of the SPS Agreement, which refers to them as the base for all national standards in food safety. The SPS Agreement states that national measures that conform to Codex Standards and other recommendations are deemed to be necessary to protect health; this obliges governments that choose to apply stricter standards to justify doing so.

Codex Committee on Food Import and Export Certification Systems

This Codex Committee is of particular relevance and active in the work of international harmonization and equivalency. With increasing international trade in foodstuffs and the specific requirements of the WTO Agreement on Sanitary and Phytosanitary Measures, there is a need for uniform guidelines for inspection and certification procedures in all countries. The work of the Codex Committee on Food Import/Export Inspection and Certification Systems is therefore important to these matters in relation to the trade of food.

The committee is looking at measures that are necessary to improve the certification process for food, including aspects of inspection and laboratory techniques. Their efforts are based on ensuring that inspection and certification procedures meet the requirements of the SPS Agreement of transparency,

equivalency, and risk assessment. WTO members must be clear about what standards they apply to imported foods; these should not be more stringent than those applied to domestically produced foods.

More attention is now being paid internationally to risk-based inspection systems. The concept of "equivalency" basically means that the exporting country need not apply procedures for regulating the processing and production that are identical to those required in the importing country, provided that the outcome of the regulatory process is the same in terms of assuring the quality and safety of the food product. This also applies to the inspection systems used by the two countries, with risk-based inspection and the recognition of equivalence in inspection systems leading to more accurate certification procedures and the mutual acceptability of certificates issued by national export authorities.

The last session of this committee proposed draft guidelines for the development of equivalence agreements between food import and export inspection and certification systems. Work also is progressing on providing guidelines and criteria for official certificate formats. Codex therefore has a major influence on food regulation and trade. Governments, industry, and consumers, by participating in the Codex process, give clear recognition to the importance and the relevance of Codex standards, guidelines, and other recommendations.

Twenty-Second Session of the Codex Alimentarius Commission

During the Twenty-Second Session of the Codex Alimentarius Commission held in Geneva on June 23–28, 1997, guidelines were adopted and issues proposed for future discussion relating to the international environment of food trade. Codex Alimentarius recognizes its role and obligation in advising member governments on how to proceed in updating their food control systems to ensure compliance with the WTO requirements. We have seen that governments need to ensure that food control requirements are science based and are developed and implemented using methods and principles of risk analysis. To facilitate trade further and ensure consumer protection, countries need guidance on harmonization of standards and the parameters to be considered when determining that different food control systems are in fact equivalent and provide the same level of assurance that a product is safe.

Guidelines of specific relevance to this area that

were adopted at this Codex Alimentarius Commission include the following:

- Recommended International Code of Practice—General Principles of Food Hygiene;
- Guidelines for the Application of the Hazard Analysis and Critical Control Point (HACCP) System;
- Principles for the Establishment and Application of Microbiological Criteria for Foods;
- Guidelines for the Exchange of Information between Countries on Rejections of Imported Food;
- Guidelines for the Design, Operation, Assessment and Accreditation of Food Import and Export Inspection and Certification Systems; and
- Guidelines for the Assessment of the Competence of Testing Laboratories involved in the Import and Export Control of Foods.

With reference to the way in which Codex develops standards, guidelines, and other recommendations, it was decided to include the four statements of principle on the “role of science and the extent to which other factors are taken into account” in the Codex Procedural Manual.

1. The food standards, guidelines, and other recommendations of Codex Alimentarius shall be based on the principle of sound scientific analysis and evidence, involving a thorough review of all relevant information, in order that the standards assure the quality and safety of the food supply.
2. When elaborating and deciding upon food standards, Codex Alimentarius will have regard, where appropriate, to other legitimate factors relevant for the health protection of consumers and for the promotion of fair practices in food trade.
3. In this regard, it is noted that food labeling plays an important role in furthering both of these objectives.
4. When the situation arises that members of Codex agree on the necessary level of protection of public health but hold differing views about other considerations, members may abstain from acceptance of the relevant standard without necessarily preventing the decision by Codex.

The need for an Action Plan on Codex-wide Development and Application of Risk Analysis Principles and Guidelines was confirmed, and a work strategy was set out on how this plan should be implemented

by Codex Committees. The recommendations and outcome of Joint FAO/WHO Expert Consultations on Risk Assessment and Risk Management have been included in this plan.

In recognition of the difficulty in setting standards for microbiological safety of foods, member countries recommended setting up an international expert advisory body similar to JECFA and JMPR on the microbiological aspects of food safety to address, particularly microbiological risk assessments.

Conclusions

International food trade is continuing to grow as countries rely on each other to secure an adequate and varied food supply through the import and export of food products. Opportunities for growth are encouraged through the international free market governed by the rules of the WTO. Countries will have improved access to export markets, but this improved access will be accompanied by greater competition and the need to ensure international confidence in the safety of their food supply.

This is particularly challenging to developing countries when quality assurance systems in the food industry and food control systems should be strengthened. In addition to an unsafe, poor-quality food supply, barriers to international trade can occur where countries impose different requirements at the point of importation. The approach of the trade agreements of adopting international standards and codes of practice can be expected to decrease the variation in requirements imposed in the past by different countries. The role of the CAC in the development and adoption of such standards and codes of practice for food, and the emphasis of the CAC on the application of principles of science, the risk analysis approach, and application of quality assurance to the entire food chain, will lead to greater harmonization between countries. FAO will continue to provide and strengthen its technical assistance to member countries so that they will comply with the requirements of the SPS and TBT Agreements.

Much therefore needs to be done so that all countries can take full advantage of new possibilities for free international trade on the basis of the Uruguay Round Agreements and can exploit comparative advantages in each country to produce various food products in cost-effective ways, with regard to improved food quality and safety.

6 Food Safety: International Dimensions

Summary of Respondents' Presentations

Introduction

The food trade has had a long and successful history, but in recent years we have seen the rate of globalization of agriculture and food processing systems increase exponentially. The system components are in a state of constant change, complicated by food safety concerns and political agendas. The parameters differ from region to region and country to country.

How do we guarantee the rights of all citizens of the world to a safe, nutritious, and sufficient food sup-

ply? The Uruguay Round opened the door to allow entry of many developing countries into world food trade, but food safety and quality problems have often hindered that access. John Lupien's remarks describe how international standards, guidelines, and codes of practice help countries move their food products successfully into world commerce.

By and large, we all understand what constitutes safe food. Implementing what we already know is one of our greatest challenges.

Issues Equal Needs

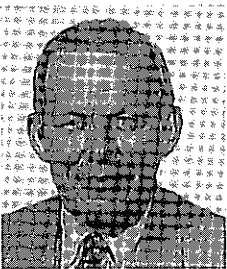
Food Quality, Not Just Food Safety

Food safety alone does not satisfy all the standards set for international trade. The top reasons for import detentions cited by the U.S. Food and Drug Administration for the second half of 1996 include filth (31%), microbiological contamination (14.2%), low acid canned food (12.8%), labeling errors (9.7%), pesticide residues (8.5%), and decomposition (8.1%). Not all of these endanger food safety. We must ensure the larger framework of food quality; it should be the vital underpinning of all marketing and production decisions.

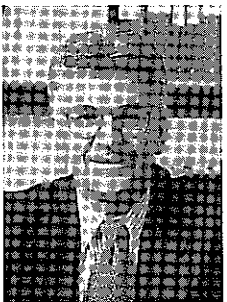
Sufficient National and Corporate Infrastructures

Government, abetted by strong interministerial or interagency coordination, must provide adequate support for its national agricultural system. There should be a positive regulatory atmosphere that facilitates a well-managed industry in the production of high quality foods within the confines of everyday business. Simple processes such as quality control and Good Manufacturing Practices can play a significant role in

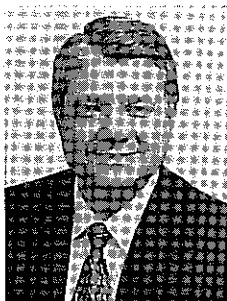
Respondents



Dr. James L. Emerson is Assistant Vice President and Director of Scientific and Regulatory Affairs, The Coca-Cola Company, Atlanta, Georgia. His responsibilities include managerial as well as corporate safety assessment of ingredients, designing and directing toxicology studies, and interfacing with trade/scientific associations and regulatory agencies on a global basis.



Mr. Charles P. Schroeder is Chief Executive Officer of the National Cattlemen's Beef Association. He was previously Executive Vice President of the University of Nebraska Foundation and earlier was Director of the Nebraska Department of Agriculture.



Dr. Stephen A. Ziller, Jr., is Vice President, Scientific and Regulatory Affairs for the Grocery Manufacturers of America, Inc. (GMA). He directs GMA's science and regulatory efforts.

Rapporteurs

Dr. Robin W. Yeaton Woo, Georgetown University, Washington, D.C.

Dr. Dale M. Maronek, Oklahoma State University, Norman, Oklahoma

ensuring food safety. Industry leaders have strong incentives to protect their brand names. In fact, the HACCP system embraced today by U.S. food safety regulatory authorities was originally developed by industry.

Relevant International Standards

The Codex Alimentarius and the FAO standards, guidelines, and codes of practice help nations enter the global marketplace with tradable foods. Other useful examples come from the simplified regulatory regimes of some developed countries such as Canada.

Both FAO and the World Health Organization provide technical expert consultations to assist developing countries in building their capacity. Many of the reasons for detention or rejection of food commodities in international trade are avoidable and preventable and are not related to “high tech” requirements. We need more highly focused, targeted education in emerging trade blocks. International standards and trade agreements mean nothing if those who work within the regulatory arena and industry do not understand the requirements.

These standards also serve as reference points in trade dispute resolution and international harmonization.

Cooperation and Harmonization

A partnership must be achieved among industry, government, academia, and consumer groups to develop appropriate national regulations and risk communication to guarantee a safe food supply. Key to this effort are participation, consensus, and transparency.

National standards should be harmonized wherever possible at the international level, along with the development of uniform guidelines. However, we should keep in mind that there is usually more than one way to solve a food quality problem. That fact pertains to establishing standards of equivalency of food processing and inspection systems, as well as end products.

Coherent and Rational Regulatory Monitoring

End product testing is not the solution to effective regulation. Instead, we need regulatory monitoring systems of inspection, testing, and certification that encourage and embrace new technologies (such as ir-

radiation) that reduce the risks to consumers. These systems should make sense, rewarding compliance and not punishing “bad luck.”

Sound Science and Elimination of Nontariff Trade Barriers

Harmonious decision making in the international food arena cannot happen unless national policies are based on sound science. We need wider scientific support of the food system, ranging from basic agricultural research and technology development to economic analysis, risk assessment, and communication systems.

Trade cannot be truly free unless we eliminate nontariff barriers that have been framed as problems in food safety but have no basis in science.

Communication of Information

Nations must improve their record keeping strategies and better communicate their requirements and reasons for import detentions. On the national level, the flow of science information needs to be enhanced from farm to table and between industry and regulators.

Risks need to be communicated better to consumers, without sensationalistic misinformation from the media. The broad message to be conveyed is that food is good for you (refer to the FAO publication *Getting the Best from Your Food*). While specific safety issues and preferences differ around the world, food safety should never be compromised in the name of food sufficiency.

Solutions

There are strong incentives to being a part of the growing world trade market. The basic resources in developing countries are agriculture and people. Developing world trade encourages the growth of subsidiary industries particularly needed in the rural setting, creating jobs, and enlarging the national tax base.

Enhanced agricultural development leads to surplus and thus to trade, but the products must meet the rules of the buyer. This requires better food quality and safety systems, and governments must develop good monitoring regimes as back up.

Codex Alimentarius can satisfy our need for standards, and FAO can provide specific project guidance. But for these systems to work in the global food trade, we must all participate, inform, and implement.

7 Agriculture Research in the Twenty-First Century

Dr. Perry L. Adkisson

Introduction

As the world's population approaches 6 billion in the year 2000, the productivity and imagination of agriculture will be challenged as never before. Although there is more food being produced than ever before, 70 to 80% of the world's people exist on substandard diets, and 10% are near starvation. The greatest challenge to us in the twenty-first century will be the need to produce adequate food to meet the needs of an expanding and increasingly affluent human population.

Although the United States has the most advanced and productive agricultural system in the world, we cannot become complacent and neglect the research that will create the agricultural technology of the future. We know we must be able to sustain and increase crop yields. We also must do a better job of preserving soil fertility, make more prudent use of natural resources including petroleum and its products, minimize the adverse environmental impacts of farming, develop more healthful food products, and compete economically in world markets.

Sustained and stable production is as important as the quantity of output. The most sought after goal of agriculture in the twenty-first century will be increased, more stable yields of major food and feed crops. Secondary goals will be concerned with food-animal production, food quality and safety, environmental quality, and economic issues (Wittmer, 1983).



Dr. Perry L. Adkisson is Chancellor Emeritus and Distinguished Professor Emeritus of Texas A&M University, College Station, Texas. He helped shape the principles underlying integrated pest management, which utilizes a variety of techniques—biological, cultural and chemical—to reduce the use of synthetic pesticides in crop protection. With Dr. Ray Smith, he was co-recipient of the 1997 World Food Prize.

Features of Research Planning for Agriculture

On the earth today, 20 crops stand between people and starvation. These are wheat, rice, maize, potatoes, barley, sweet potatoes, cassava, soybeans, oats, sorghum, millet, sugarcane, sugar beets, rye, peanuts, field beans, chick peas, pigeon peas, bananas, and coconuts. Of these, four crops—wheat, rice, corn, and potatoes—provide 60% of all human food. Cotton will remain a major crop as the world's most used natural fiber for clothing.

In the United States, new technologies, resource inputs, economic incentives, and government decisions affecting future agriculture or food policy will focus on crops that are of the most economic importance to the country, including certain tree, forest, and vegetable crops. In addition, research emphasis on food animal production, animal diseases, foods and nutrition, environmental quality, and economic and policy issues will be maintained.

Technologies will be sought that add to rather than deplete the earth's resources, that are nonpolluting and environmentally friendly, that may be applied to farms of all sizes, and that are sparing of capital, management, and nonrenewable resources. Technologies must be developed that will produce stable production with high yields (Wittmer, 1983).

Because of resource constraints, a shift will occur in the United States to a more scientifically and biologically based agriculture. It will be a less traditional, more high technology industry.

Conventional Research in Support of Food Production

Support for agricultural research in the United States must be increased in areas such as these (National Research Council, 1977):

- plant and animal breeding,
- improved efficiency of production of crops and livestock,

- plant and animal resistance to environmental stress,
- pest management,
- animal and plant health,
- weather and climate,
- irrigation and water management,
- soil management,
- fertilizer management,
- environmental quality,
- aquatic food sources,
- postharvest losses and storage,
- basic biological research in support of the above,
- integrated production systems,
- market expansion,
- food policy issues, and
- information systems.

This broad spectrum of research and development activities will be necessary to maintain and improve the performance of food production systems. Two newer areas of research that I believe deserve special emphasis are (1) biotechnology and (2) development of new food plants to provide better prevention of diet-related diseases.

Agricultural Biotechnology and the Future

The impact of biotechnology on agriculture is no longer a promise. Basic research knowledge has been transformed into practical applications, and the first products are being introduced in production agriculture. These include safer vaccines for livestock; insect resistant cotton, corn, and other crop cultivars; and Roundup-ready soybeans.

The Genetic Engineering of Plants

The most direct way to use biotechnology to improve crop productivity is to genetically engineer plants so they have new characteristics to improve the efficiency of production. The tools of biotechnology can accelerate the progress of conventional science.

Examples of how genetically engineered plants might benefit agriculture (National Research Council, 1987) include

- developing herbicide and pest-resistant crop cultivars;
- changing the composition of the oil seeds by

changing the length of fatty acid chains and the degree of saturation to reduce the risk of circulatory diseases and cancer;

- adding essential amino acids to plants such as corn and soybeans in which one or more of these compounds is lacking, and improving the nutritional qualities of plant parts used for food or feed;
- controlling plant growth and development processes such as flowering, dormancy, ripening, leaf and fruit drop, leaf composition, plant shape, root development and efficiency, and postharvest characteristics;
- enhancing the nitrogen-fixing capabilities of legumes, extending this ability to nonlegumes, particularly grasses and cereal grains;
- increasing photosynthetic efficiency of crop cultivars;
- enhancing resistance to environmental stress, e.g., drought, salt, soil acidity, aluminum toxicity, heat, cold and frost; and
- improving the efficiency of nutrient utilization.

Diet-Health Issues

Diets, food sources, food safety, convenience, and relationships between diets and incidence of major diseases will become increasingly more important research areas, and they will be consumer driven. In the United States, consumers are becoming more knowledgeable about the role of diet in the induction or prevention of several major diseases.

No less an authority than the U.S. Surgeon General suggests that the food we eat is killing us. In the 1988 Surgeon General's Report on Nutrition and Health, the ten leading causes of death in the United States are listed. Of these, five—coronary heart disease, certain types of cancer, stroke, diabetes mellitus, and atherosclerosis—are diet-related. These five diseases cause two-thirds of the more than two million deaths that occur in the United States each year (U.S. Department of Health and Human Services, 1988). In addition, obesity is a major health concern.

Because these diseases are diet-related, it should be possible to prevent them, delay their onset, or lessen their severity by changing our diet or changing the composition of the foods we eat.

Nearly every week there is a media report that some medical researcher has identified a phytochemical in some vegetable, fruit, or other food plant that can inhibit tumor formation or reduce the risk of heart attack, stroke, or atherosclerosis. However, there is very little being done by our agricultural experiment stations to enhance these properties in food plants. We

need to link our great medical research centers with our agricultural experiment stations to identify the phytochemicals that aid in the prevention of disease, determine their threshold of action, and design and develop new varieties of food plants having optimal levels of the compounds needed to provide maximum prevention of these diseases. Alternately, we should eliminate compounds that are hazardous to health such as natural carcinogens, and change the composition of oil seeds to reduce risks of coronary heart disease, stroke, and atherosclerosis.

Conclusions

As we project the research needs for agriculture in the twenty-first century, we should expect no dramatic changes in the food habits of people. Some 20 crops will continue to meet primary needs. With the appropriate technologies, resource inputs, and economic incentives, there will be no worldwide shortage of food. A wide variety of new crop production techniques will result in significant increases in food productivity in the twenty-first century, provided we are able to expand agricultural research at a level necessary to cope with the problems created by an increasing human population, degradation of the environment, and depletion of natural resources.

Sustaining and increasing food supplies in the twenty-first century will hinge on the expansion of the agricultural research base. At a time when more research is needed, funding for agricultural research is declining as it has been for years. On a global basis, research spending doubled between 1971 and 1991 from \$7.3 billion to \$15 billion, but the annual rate of increase declined from 4.4% in 1971–1981 to 2.8% in 1981–1991 (Mann, 1997). A continuation of this trend will pose a major threat to meeting the rising world demand for food.

In the United States, federal and state funding for agricultural research, as measured in constant dollars, has declined by one-third since 1970. Current budget proposals (Congress and the Administration) do not reverse this trend. In the fiscal year 1988 budgets for federal research and development (R&D) agencies, the House and/or Senate endorsed increases in the budgets of the following agencies: National Science Foundation by 8.6%, National Institutes of Health by 7.5%, National Aeronautics and Space Administration by 4.7%, Environmental Protection Agency by 12.7%, Department of Energy by 8.7%, Department of Defense by 8.7%, Department of Commerce by 9.8%, Department of Interior by 4.2%, Department of Transportation by 10%, and Department

of Veterans Affairs by 11.4%. The only agency to have its research budget reduced was the Department of Agriculture, where the House and Senate trimmed 2.7% and 1.9%, respectively (National Research Council, 1997). The proposed reduction in the R&D budget of the USDA is not only a national disgrace, it is an international disgrace. Somehow proponents of agricultural R&D must plan and execute a better budget strategy than they currently are doing.

I want to make a particular point with respect to present federal support of agricultural research. Although there has been a substantial increase in funding in recent years for the National Research Initiative (NRI) of the USDA, there has been an overall decline in funding for production-oriented research. As a result, emphasis has been increased on basic biotechnology-oriented research while there has been a decline in conventional research, for example, plant and animal breeding, crop protection, and soil and water conservation. As a result, many talented production-oriented agricultural scientists (plant and animal breeders, production specialists, agronomists, entomologists, agricultural engineers) are underfunded and under-employed. A scientist cannot maintain a breeding program or deal with a pest emergency with a three-year competitive grant that might not be renewed.

Also, funds are practically nonexistent for new large regional or national problems that might best be solved by a multiuniversity, multidisciplinary approach requiring several millions of dollars per year.

We need to have a better balance between funds available for basic and production-oriented research in agriculture. We need more funding for both areas of research, and we certainly must reverse the decline in funding for agricultural research. Congress should double the \$1.4 billion currently appropriated annually for agricultural research and establish higher yields as one of the nation's top research priorities. Significant increases in R&D funding must be made, and soon, if we are to meet the most important needs of the human population in the twenty-first century: a full stomach, safe drinking water, and a clean environment. All of us, as individuals and as members of groups such as CAST, should inform our state and federal legislators of the importance and the great need for increasing funding for agricultural R&D.

Let me conclude with this quote from Sylvan Wittmer: "When we consider changes in the resource base, new technologies, and the impacts of science, we are mindful of the creativity, innovation and vision of people—the human resource—which is the greatest of all resources. No limitations can be ascribed to the

creativity of the human mind, and it will be the unpredictable spark of creativity that will be the important contributor to the new agriculture of this 21st Century" (Wittmer, 1983). But to sustain creativity, our researchers must be adequately funded and provided a good environment in which to work.

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8 Food Security: International Dimensions

Ms. Catherine Bertini

Introduction

There is a food crisis today. But it is not a crisis of food supply. The problem is hunger, a harsh reality for more than 800 million poor people.

We have made progress in the fight against hunger. In 1970, an estimated 35% of the world's people were hungry; today, the figure is down to 20%. This is a substantial accomplishment. And our farmers, our researchers, our fishing crews can take pride in their achievements; from 1970 to 1995 the global food supply increased by 55%. Even on a per capita basis, food production increased by 11% during this time period. But, with all this, more than 800 million people remain hungry.

And what does the future hold? Several expert institutions—the International Food Policy Research Institute, the Food and Agriculture Organization of the United Nations, the World Bank, and the United States Department of Agriculture—have made their projections. They differ in accordance with the assumptions made, especially with respect to population growth and overall economic expansion. But on the essentials, they are in agreement. We can expect the following.

- The supply of food will have to keep growing, and growing rapidly. Production will have to increase by 30 to 50% to meet anticipated demand in the year 2020.

- Two factors will determine the demand for food: population growth and economic growth. In developing countries, population growth will account for roughly three-fourths of the increase in the demand for food. At the same time, as more people in the developing world become more prosperous, they will spend some of their new income on greater amounts of food and then on different foods. Like people in well-off industrialized countries, they will want—and be able to afford—a greater variety of foods and more meat and poultry.
- Most experts predict that the world's farmers will be able to respond to the challenge and expand production to meet this growing demand.
- Food production is expected to increase not only in absolute terms but on a per capita basis.
- Production will not grow equally throughout the world, however. Much of the capacity to expand the supply of food will be in North America and other regions that are already major grain producers.
- As a result, trade in food will become more and more important in balancing out regional differences between supply and demand.

And *all* the experts agree on one central point: we cannot be complacent. We dare not take production increases for granted. Agricultural investment, especially in research, will be essential to stimulate and maintain a rapidly growing supply of food.

With this expanded supply of food, will everyone have enough to eat? For millions of people, the answer will be no. Projections are that in 2010 the chronically hungry will number well over 600 million. Better than the past, admittedly. It will represent a further decrease—to 12%—in the proportion of the world's people who are hungry. But hundreds of millions of hungry people, in a world that can produce enough to feed them all, is not success.

The experts tell us that this is what we can expect.

- The problem of hunger will be worst in subSaharan Africa and parts of South Asia, especially Bang-



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ladesh. These regions will continue to face widespread, chronic undernutrition.

- In Africa and the Near East, the absolute number of hungry people will increase, though the proportion of the population that is undernourished will decline.
- There will be only a little progress in reducing the number of malnourished children under age five who are malnourished. In subSaharan Africa, the proportion of malnourished children will decline by only 3% between 1990 and 2020—during the same time period that the global production of food will have increased by 30 to 50%.

How can this be? Essentially, the supply of food will increase in response to market demand—to buying power. But there will still be millions of people too poor to transform their nutritional needs into a commercial demand for food. These are the people who are left out of the global picture of supply and demand. Their needs are commercially silent. That is why increased production is not enough to help them.

To tackle this crisis of hunger, we will have to *think beyond food supply to food security*. In doing so, four principles deserve to be at the center of our thinking.

Food Security Is About People, Not About Commodities

The first principle is that food security is about people, not about commodities. Consider who is hungry, and why.

- The chronically hungry are the very poor. Most of them are landless or near-landless. They must sell their labor to earn their living and use their earnings to buy food for the family.
- Millions of poor families, who manage to obtain enough food part of the time, live so close to the margin that short-term problems—a poor harvest, drought, the demands of the local money lender, the loss of employment, or even the lean period before the harvest—undermine the possibility of food security.
- Women and girls suffer disproportionately, in spite of their predominant role in producing, processing, and preparing food. When food for the family is short, women eat last.
- The hungry are the children of the hungry. Malnourished women give birth to underweight babies whose future health, productivity, and ability to learn are compromised from the day they are

born.

- Hunger is widely found in regions that are semi-arid and economically marginal. These are not the areas that offer significant potential for production increases, so they are the least able to attract, or benefit from, increased investment in agriculture.
- In these regions, infrastructure is typically weak and marketing costs high. Their inhabitants are not well placed to benefit from production increases elsewhere in the country, from market incentives, or from stability of supply.
- The hungry are victims of war and civil disruption. An estimated 50 million people are refugees or displaced persons today.

The vast majority of these people are hungry because they cannot gain *access* to enough food, even when it is or could be available. More production *in itself* will not help them, though it will certainly be part of the solution.

No Long-Term Solutions Without Short-Term Solutions

The second principle is that there will be no long-term solutions without short-term solutions. Robert Solow, the Nobel laureate in economics, has made the point that “those who are so urgent about not inflicting poverty on the future have to explain why they do not attach even higher priority to reducing poverty today.” He does not say—nor do I—that we can afford to lessen our commitment to build a better future. My point is simply that addressing today’s poverty, today’s hunger, is part and parcel of preparing a better future.

For the fact is, *today’s hunger leads to tomorrow’s hunger*.

Hunger has a long arm. It reaches from childhood far into adult life, and indeed into the next generation. While we are waiting for the long-term benefits of overall economic growth, of research, of investments in productivity, a vicious cycle of intergenerational hunger continues.

- Hunger passes from hungry mother to malnourished child. Maternal malnutrition virtually guarantees that children will suffer stunted growth, susceptibility to disease, low birth weight, and intellectual impairment.
- Hungry infants—if they survive—become unhealthy children. Approximately 31% of preschool

children in developing countries are exposed to sickness and possibly death because they are undernourished. An estimated 50 percent of disease-related mortality among infants could be avoided if infant malnutrition were eradicated.

- Irreversible damage will be done. People cannot eat retroactively. The harm caused by early malnutrition or under nutrition cannot be offset by adequate nutrition later. So the children who do survive a hungry childhood will begin adult life preprogrammed for chronic illness and unable to fully realize the potential of what is often their only asset—their labor.

This is a vicious cycle. It ruins lives, and it is a great burden on a society.

A few months ago, several eminent scientists visited the World Food Programme in Rome to conduct a seminar on how nutrition can affect productivity. Professor Robert Fogel, a Nobel Prize winner in economics from the University of Chicago, made the case that when we consider the economic history of a number of today's prosperous countries, it becomes clear that economic progress can be directly tied to improvements in diet. Improved diets have led to better health, greater physical capacity, and increased work productivity in the population as a whole, and in this way directly affected the development of national economies.

In other words, good nutrition for pregnant women and young children is an excellent investment. The results are not as immediately visible and measurable as they are in the case of projects to plant trees or build a road. But the long-term pay-off is substantial, not just for individuals but for all of society. Good nutrition at these critical times of life reduces tomorrow's illness and tomorrow's low productivity, as well as today's malnutrition.

In other ways, too, hunger inhibits people from realizing their potential, their productivity, and their contribution to society. We all know that poverty causes hunger. What we often overlook is that the reverse is also true—*hunger is a cause of poverty*.

There is a tendency for people in richer countries to ask, "Well, why can't these people help themselves the way we do and our parents did before us?" A reasonable question. My answer is this: It is next to impossible for chronically hungry people to take the first important steps on the path out of poverty.

Imagine you are a man sleeping on the streets of Calcutta—no job, no land to farm, no education. The occasional odd job keeps you and your family alive, but not much more. You and your family are malnour-

ished, prone to illness, lacking in mental and physical vitality. Could you really help yourself break out of poverty? Just exactly how would you do it?

Or, imagine for a moment the life of a mother in rural Mali. The country is mostly desert—few trees and very little water. That woman awakens every morning knowing that her day must be devoted to finding wood for a fire to cook, fetching water so her family may drink, and finding food. She is very likely to spend four or five hours—often more—looking for wood and hauling water. Does she have time to attend a prenatal clinic? Is she likely to attend the demonstration of an improved agricultural technology? Or take up an opportunity to learn new skills? No. The needs of today are so pressing that she has little time and less energy for the special effort that might help her build her income.

Many poor people have only one asset—their labor. But they cannot get the full benefit of their labor if they are undernourished. Study after study—in India, Sierra Leone, Brazil, and Sri Lanka—have shown a connection between the productivity and wages of adult workers and their nutritional status.

Hunger marginalizes people. There may be opportunities—training, clinics, education, new technology—but they cannot take advantage of them. Chronic hunger is part of a vicious cycle of low productivity, ill-health, and indebtedness. For the hungry, the struggle for the next meal and the problems of today are so overwhelming that it is practically impossible to make the smallest investment in a better life tomorrow. So—once again—today's hunger leads to tomorrow's hunger.

We need to reexamine the easy assumption that long-term solutions are always better than short-term responses. Can we really build long-term food security without breaking the cycle of intergenerational hunger without acknowledging that hunger is a poverty trap? My answer is no. Tomorrow's hunger is linked to today's hunger, and we have to deal with them together.

Invest in People As Well As in Increased Production

The third important principle is that we need to invest in people as well as in increased production. A steady income is the greatest contributor to family food security, so employment creation is a key element of the attack on hunger. For millions, the employment will be in agriculture and fisheries. For others, food security will arrive with a job in a factory, or from a

sidewalk business repairing bicycles.

Investment in people will often mean investment in “marginal” areas as well as in more agriculturally productive areas where returns, as conventionally defined, are better. Chronic hunger is concentrated where economic returns to agriculture are low, and where there are high transaction costs due to deficient infrastructure and inefficient markets. This is particularly the case in semiarid and highland areas. Conventional economic wisdom would tell us that investments should be made in more promising areas, where the rate of return is highest. Investment decisions made in this way will certainly increase food production, but will not enable the poorest to improve their access to food.

Investing in people means helping them to create assets, assets that truly benefit poor people and poor communities. Sometimes this means a rural road to link the village to a market, or an embankment to protect the community from periodic flooding, or assets embodied in people themselves—good health, basic education, new skills. One of the best investments is education.

Investments in education are highly justified by their returns, to society at large as well as to individuals. A World Bank survey of 13 countries showed that ensuring a minimum of four years of primary education can increase the country’s productivity by 8 to 10%.

The education of girls is of special importance. Study after study has shown that education of girls has a vital connection to family planning decisions, for example. In developing countries with a female literacy rate of less than 20%, each girl grows up to have, on average, six children; where female literacy has reached 80% or more, this figure drops to 2.7. There is also a relationship between a girl’s education and the health, education, and prospects of her future children.

Invest in Women, for Today and for Tomorrow

The fourth principle is that we particularly need to invest in women, for today and for tomorrow. When we invest in women, we empower them to improve the well-being of entire families and communities. You don’t have to take my word for it. This is what an International Food Policy Research Institute paper had to say: “Increasing women’s physical and human capital promotes agricultural growth, greater income for women, and better food and nutrition security for all.

Poor women play important roles in all aspects of food security, food production, economic access to food, and nutritional security.”

First, we must support women as agents of social change by seeking their views as to what is needed, by directing more resources to them, and by ensuring that they have more control over the management of these resources. More than 80% of the food in Africa is raised by women, and 60% in Asia. Yet women still have a hard time gaining adequate access to the basics that every farmer needs—credit, fertilizer, technology, and control over land.

Food is more easily targeted to women than almost any other resource. We can trace a can of vegetable oil or a bag of wheat flour to ensure that it really reaches a poor and anemic woman in rural Rajasthan, or a malnourished child in Liberia. We can count and weigh the food as it is delivered for school lunches in Chad to keep children coming to school. It is far more difficult to make that kind of direct connection between other types of development assistance and the poorest segments of rural society.

For these women, as for their children and their communities, food aid is far more than short-term help. It is an investment in the future. You do not see this food aid on your television screen. It lacks the drama of North Korea or Rwanda. But quietly and effectively, WFP uses food to help people work their way out of the poverty trap.

Actions

Last year, WFP, the United Nations’ (U.N.) food aid agency and the largest such agency in the world, was able to get food to 45 million poor people. We take pride in that accomplishment. But 45 million still represents a small portion of the more than 800 million people who are hungry. Of course, WFP does not account for all food aid; our share is about 29%. But let us assume for a moment that all food aid from all the donor countries were targeted to the poor. Then, as a rough estimate, all the food aid available today might be enough to help about 150 million people—still a lot less than 25% of the 800 million plus who are hungry.

In fiscal year 1996, the United States spent \$1.2 billion on food aid for developing countries. That is a lot of money. But just to keep it in perspective, consider this: the same year, we spent \$38 billion on domestic food assistance. This provided for the national School Lunch Program, the School Breakfast Program, the Special Milk Program, and the Child and Adult Care Program, among others. And \$1.6 billion

was spent on domestic food assistance right here in the state of Illinois. In other words, the United States spent more for food assistance for people in Illinois than it spent on food aid for the 800 million chronically hungry in the developing world.

In 1995, the USDA projected the need for food aid in the year 2005—less than 10 years from now. According to its most optimistic scenario, almost four times the current level of food aid will be needed *merely to maintain current consumption levels*. Far more would be needed, according to USDA, to meet the minimum nutritional needs of the world's people.

But the availability of food aid is declining at an alarming rate. Five years ago, donor countries provided 15.2 million tons of food to developing countries. In 1996, global food aid amounted to exactly half of that. Half—at a time when we count the hungry in the hundred of millions.

Emergencies

Food aid is not a luxury or a frill. Very often, it is literally a matter of life and death. In addition to the silent emergencies, there are millions of refugees and other people caught up in the violence and disruption of civil war, or in natural disasters. The WFP is involved in North Korea, Bosnia, Afghanistan, Rwanda, Congo, and many other countries where people suffer a lack of food.

The year 1992 was the year of the famine that did *not* happen. There is no doubt that there *could* have

been starvation in frightening proportions especially in southern Africa. But there was no famine. The WFP spearheaded the largest U.N. relief operation ever up to that time. Donor countries—especially the United States—responded generously. With their support, the WFP programmed food aid targeted to the most vulnerable. We also provided logistical expertise to enable the countries of southern Africa to bring in a total of 11.6 million tons of food—six times the normal volume of imports—at an estimated cost of \$4 billion.

Now we are participating actively in contingency planning in the poor countries affected by El Niño, analyzing where food aid will be needed and by whom, and we are planning a response in Southern Africa, Central and South America, and some parts of Asia.

Conclusion

There is a food crisis today. To address it, we need to do a lot more than grow additional food. We will have to focus our attention on people, not crops, and on hungry households rather than national production targets. We will have to invest food aid in helping hungry families build a more secure future. And from time to time, we will have to make provision for major life-threatening emergencies—wherever vulnerable people find their fragile food security threatened by events beyond their control. And most importantly, we have to remember that food security is about people. If we direct our resources to people, we will enable them to make the difference.

9 Food Security: International Dimensions

Summary of Respondents' Presentations

Introduction

There is an international food crisis today. It is not a crisis of production or supply; it is a crisis of hunger and poverty. Since 1970, the decline in hunger has been slower than the increase in the global food supply. Even with a 55% increase in worldwide food pro-

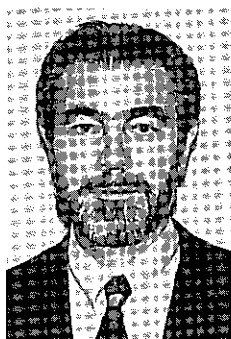
duction between 1970 and 1995, the decline in the number of malnourished people around the globe dropped by only 15%. While both the increase in food production and the decrease in hungry people are substantial accomplishments, an estimated 20% of the world's people remain hungry today.

The supply of food will have to continue growing rapidly to meet anticipated demand in the next millennium. Most experts predict that the world's farmers will be able to respond to this challenge and increase production. Production, however, will not increase equally throughout the world, and trade in food will become more important in balancing regional differences in supply and demand. Today, 90% of the food is consumed in the country that produced it. This figure is likely to change significantly.

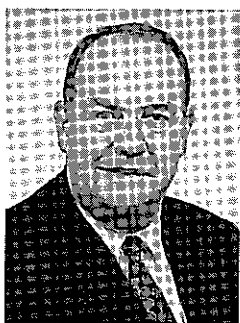
Even with an expanded supply of food, it is estimated that the chronically hungry will still number well over 600 million people, or 12% of the world's people in 2010. These people are left out of the global picture of supply and demand because their needs are commercially silent. Global food security does not guarantee national food security, and national food security does not guarantee family food security. We need to do more than just grow more food to solve the crisis of hunger. We need to think beyond food supply to food security, to who is hungry and why.

Investment in women is particularly important. Women are central to rural food security and must be empowered to improve their family's and children's welfare, to act as agents of social change for the entire community.

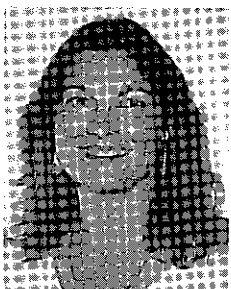
Respondents



Dr. Hans R. Herren is Director General of the International Centre of Insect Physiology and Ecology (ICIPE). Dr. Herren was recipient of the 1995 World Food Prize. He introduced biological control of cassava mealybugs in sub-Saharan Africa, saving Africa's staple crop, cassava.



Dr. Alex R. McCalla is Director of the Agriculture and Natural Resources Department of the World Bank, and Professor Emeritus of Agricultural Economics at the University of California, Davis. He has served as Dean of the College of Agricultural and Environmental Sciences and Founding Dean of the Graduate School of Management at the University of California, Davis.



Ms. Gretchen H. Stanton is a Senior Counselor in the Agriculture and Commodities Division of the Secretariat of the World Trade Organization. She served as the chair of the Working Group on Sanitary and Phytosanitary Measures during the negotiations of the Uruguay Round Agreement on the Application of Sanitary and Phytosanitary Measures. She previously worked for the USDA Foreign Agricultural Service in Washington, D.C. and Mexico City.

Rapporteurs

Mr. George Vrtis, Georgetown University, Washington, D.C.

Dr. Deon D. Stuthman, University of Minnesota, St. Paul, Minnesota

Dr. William C. Stringer, University of Missouri, Columbia, Missouri

Issues

Food Security Is About People, Not Commodities

The world's chronically hungry are also the world's poor. Millions of poor families live so close to the margin that short-term problems undermine the possibility of food security. Most of these people live in rural regions that are economically marginal, offer little potential for agricultural production increases, and are not well-situated to benefit from regional production increases, market incentives, or supply stability. These are people left out of the calculus of the modern market economy; they cannot gain access to food even when it is available. Their hunger is caused by poverty, and their poverty is caused by hunger. More production in itself will not break this tightly linked circle of events. This is not a supply-side problem. We need to focus on these people and their access to food rather than on availability, on individuals rather than on aggregate production and population numbers.

No Long-Term Solutions Without Short-Term Responses

While we are working on and waiting for the long-term benefits of economic growth, research, and investments in productivity and education, a vicious cycle of intergenerational hunger continues. Hunger passes from hungry mother to malnourished child. And, if they survive, hungry infants become unhealthy children, subject to stunted growth, disease susceptibility, and intellectual impairment. Irreversible damage is done; people cannot eat retroactively. Those who survive to adulthood are often unable to realize the potential of their only asset, their labor. These people's labor becomes undervalued because of their undeveloped capabilities coupled with the lack of energy and the weakness that accompany malnutrition. Chronic hunger is part of a cycle of low productivity, ill health, and indebtedness. We need to focus on this generation and the causes of hunger to help solve the problems of the future. Good nutrition for pregnant women and young children is an excellent investment. Improved diet leads to better health, greater physical capacity, and increased work productivity in the population as a whole, and it directly affects the development of a nation's economy.

Investment in People As Well As Production

The greatest contributor to food security is a steady

income. Investment in people means helping them create assets and economic linkages. This can mean investment in infrastructure to build roads that link a rural village to a market, or in basic education and new skills, or in development of marginal areas where agricultural productivity is low. Chronic hunger is concentrated in rural areas where economic returns to agriculture are low and where there are high transaction costs because of deficient infrastructure and inefficient markets. Investment decisions must break with conventional economic wisdom. If we continue to invest in promising areas where the rate of return is high, we will certainly increase food production, but we will not enable the poorest to improve their access to food.

One of the best investments is education, especially at the local, rural level. Studies show that ensuring a minimum educational attainment increases productivity, decreases birth rates, and provides better health and education prospects for future children. It is also vital that investment be made in increasing the productivity and profitability of the rural sector. This means more fully integrating and strengthening national support for agricultural programs, including education, marketing, transport, and storage.

Women and Social Change

In the fight against hunger, women are of special importance. Poor women play central roles in all aspects of food production and food security. More than 80% of the food in Africa and 60% of the food in Asia is grown by women. Yet, women still find it difficult to gain access to the basic requirements of credit, fertilizer, technology, and land. We must support women as agents of social change and empower them to improve their family welfare. We need to seek their views on obstacles to food security, direct more resources to them, and ensure that they have more control over the management of these resources.

Food aid helps people work their way out of the poverty and hunger trap. Even though we have made accomplishments, the vast majority of need goes unaddressed. The total food aid available today is estimated to be enough to help 150 million people, far less than the 800 million who are hungry. Food aid donations have declined alarmingly since the Uruguay Round. In 1996, global food aid amounted to exactly half the 1995 total. In fiscal year 1996, the United States spent \$1.2 billion on food aid in developing countries. The same year, the United States spent \$1.6 billion on food assistance in the State of Illinois alone. Food aid is not a luxury; it is a matter of life and death,

and it helps hungry families build a more secure future.

Solutions

- Responses to the international food security crisis must be integrated.
- Focus must be shifted from production to the causes of hunger—poverty and lack of economic integration.
- Poor people need carefully constructed assistance programs that focus on their particular needs.
- Food aid must be decentralized and economically integrated to address the rural poor's situation.
- Short-term responses are necessary for producing long-term solutions.
- Women and education are core areas requiring investment.
- The productivity and profitability of the rural sector must be increased. To do this, we must integrate education, marketing, transport, and storage responses to these needs.
- Private investment must be incorporated into public initiatives.
- The distortions food aid creates in the market must be lessened and eventually eliminated.
- Aggregate numbers produce averages; the international food security crisis cannot be solved without looking at statistical outliers.

10 Food Security: Domestic Dimensions

Dr. Robert L. Thompson

Introduction

I am deeply honored to be asked to address this important conference organized by CAST. In this presentation I will first address the determinants of food security, emphasizing the important role of income in determining individual food insecurity and the role of agricultural production in determining aggregate food security. I then turn to a highly stylized region-by-region review of the agricultural demand and supply potential, and conclude with inferences for investments in agricultural research, public policy, and the global agricultural trading environment.

Food Security

Of the world's 5.8 billion people, an estimated 800 million suffer from hunger. At the individual level, food insecurity is mainly caused by poverty. The rich in no country go hungry except in times of war, natural disaster, or politically imposed famine.

There are 1.3 billion people who subsist on an income of less than one U.S. dollar per day. The World Bank calculates that 80% of the world's poor live in rural areas, where the bulk of the people earn their living from farming. Half of these poor people live in less favored areas. To understand the roots of the problems of poverty and hunger in rural areas, it is important to recognize that no country in the world has solved the problem of rural poverty by focusing exclusively on agriculture. Certainly by raising pro-

ductivity in agriculture, you can improve the lot of rural people, increase the availability of food, and reduce the real price of food. But availability is not enough. It takes purchasing power to gain access to food needs above a family's own production. And there is not enough land per person in most rural areas for everyone who is trying to make a living from agriculture to grow enough to feed his or her family adequately and have enough left to sell to raise the family income above the poverty line.

The only countries that have substantially reduced rural poverty have created off-farm employment opportunities—either within the rural communities or in distant cities. In the highest income countries today, the majority of farm families earn more than half of their family income from nonfarm sources. One or more members of the family work full-time or part-time off the farm. Some of these jobs are in agricultural input supply or in adding value to the raw products of the land. Many, however, are in cottage industries and other businesses completely unrelated to agriculture.

In many developing countries today, the only option for rural people to escape poverty is to move to distant cities. In 1990, there were four cities of more than 10 million people in the world, and it is projected that by 2010 there will be 21 cities of this size, 13 of which will be in Asia. The diseconomies of supplying safe drinking water and social services, and of removing garbage and sewage from cities of this size, are overwhelming. While urbanization is a trend that will not likely be reversed, it could be slowed down if there were more attractive opportunities in rural areas. To do this will require much larger investments in roads, communications, education and health care and putting the necessary preconditions in place for employment and enterprise growth. These investments in infrastructure and human capital are also important for successful agricultural development.

The world's population continues to grow rapidly; however, the growth rate is falling faster than many analysts expected. Each year the United Nations' median projection of the world population at zero population growth is revised downward. Much that is



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for Economics at the U.S. Department of Agriculture from 1985 to 1987.

written about the ability of the world's farmers to feed this population adequately and to do it without environmental damage focuses on the number of mouths to be fed. Certainly the growth in the world's population creates additional need for food, but whether that need is translated into effective demand depends on purchasing power.

While global population growth gets most of the media attention, what has been much less noted is the broad-based economic growth that has been empowering millions of poor people with the purchasing power to upgrade the quality of their diets. As poor people gain more income, the first thing they do is modify their family diets, usually by including more fruits, vegetables, animal protein, edible oils, and sweets. This income effect accounts for more of the recent growth in global demand for food than population growth. While there are hundreds of millions of people in the world who have been left behind by this economic growth, many millions more are participating—particularly those living in urban areas. Much of this economic growth is in East and Southeast Asia and much is associated with privatization and moves to a market economy.

The combined effects of population and income growth are expected to double global food consumption in the next 30 years. This brings us to the question of aggregate global food security. At the national level, food security is a problem of availability. We ask whether a country's farmers can satisfy its food demand at competitive prices. Each country should use its arable land and agricultural production potential to the fullest extent that it can efficiently, or without wasting resources. It is important to recognize that investments in agricultural research can create a comparative advantage in agriculture where one did not exist previously. If a country cannot efficiently produce its own food supply, then can it export other products to earn the foreign exchange to import food, or is a dependable supply of food aid available?

Food security at the global level depends on whether the world's farmers and food system can provide two or even three times as much food as today—at no higher real cost—and do it in a manner that does not destroy the environment. There are only three ways to increase global food availability: increase the land area planted, increase yield per hectare, and reduce post-harvest losses. If we doubled food production by doubling the number of hectares of land under cultivation, it would create massive environmental damage. This could be done only with large-scale destruction of forests, and with them, wildlife habitat and biodiversity. This would also reduce the carbon sink

and destroy the homes of indigenous peoples.

This paper examines how much more fertile, well-watered, unforested, nonerodible land is available and where, and then draws inferences for research, public policy, and international trade in ensuring food security without environmental damage. In the next section of the paper, we will take a highly stylized tour of the continents to address these questions.

Asia

Asia has a much larger fraction of the world's population than of its arable land. Many parts of Asia have made significant investments in agricultural research and in education. A number of countries of East Asia and Southeast Asia have been experiencing very rapid economic growth with rapid creation of nonagricultural employment, often widely dispersed through the countryside. As these countries raised per capita incomes from a low to a middle level, diets changed rapidly to include more fruits and vegetables, animal protein, edible oils, and sweets. Despite significant growth in agricultural productivity, these countries' food consumption quickly outgrew internal food production capacity, and agricultural imports grew rapidly, particularly for feed grains and protein meals to feed livestock and poultry. As incomes have risen, rice consumption has fallen and wheat consumption has risen.

The land-labor ratio in most of these countries is very low. Some of the highest income countries of East Asia introduced quite high price supports and protectionist import policies for their most important traditional products. However, even with these policies, they could not provide parity of income to their farmers from their small land holdings. As a result, large off-farm migration has occurred, and part-time farming has become a common means of supplementing farm income.

With 1.2 billion people, China has 22% of the world's population but it has only 9% of the arable land. While its population is growing slowly, with economic growth rates of around 10% per year, diets are changing rapidly in China, with large increases in poultry and pork consumption, in particular. China experienced very rapid growth in agricultural output during the 1980s following its economic reforms; however, its future ability to feed itself has become an issue of great media attention and numerous academic conferences. Until recently there was significant doubt about how much productivity growth potential existed in China. However, the recent announcement by the State Statistical Bureau that the statistics on

land area under cultivation had been significantly underestimated means that crop yields per hectare are lower than thought previously. With larger investments in agricultural research and in technology transfer, it should be possible to increase yields considerably.

Over the last 20 years China's public policy has varied in how supportive it has been of agriculture. The recent Grain Bag policy, which encourages provincial self sufficiency, has been a step backward. In addition, the inadequate rural transportation infrastructure reduces the ability of the internal market to function efficiently. Some attention is being given to the need to increase the production of high-value-per-hectare plant and animal products in place of cereals, with the objective not only of supplying domestic demand, but also generating export revenue that could pay for imports of even more grain than could be grown on the same land. Consistent with this, the government of China has reduced its cereals self-sufficiency goal from 100 to 92%. China is likely to become the world's largest importer of maize and soybeans.

While China has received most of the recent media attention, we should also pay attention to India. Some demographers now project that by the middle of the next century India will have 1.5 billion people, and China, 1.4 billion. India has made large investments in agricultural research. The Green Revolution that started in the late 1960s satisfied the growth in food demand for at least one generation. It is important to remember that India has 250 million middle-class consumers, but also half a billion very low-income people. While India has been slow to abandon the socialist model and let market forces work, economic growth is starting to accelerate in India. If this growth becomes broad-based, diets are likely to change, and India too is likely to place greater demands on the world food system. India already consumes large quantities of dairy products. With higher incomes, Indian consumers are likely to eat a lot more poultry, sheep, and goat meat.

Asia, having so much more of the world's population than arable land, is likely to become an even larger net food importing region as per capita incomes rise, requiring much larger agricultural exports from other regions of the world.

Africa

Africa has experienced rapid population growth and slow economic growth. It is the one continent with declining per capita food production, and this has oc-

curred for three decades. Africa has the oldest exposed land surface in the world. The heavy weathering of its soils has left them with weak structure and very low nutrient content. Many regions of Africa receive low annual rainfall with quite high variance. Some regions are prone to desertification. Africa is the continent with the greatest natural limitations to high-productivity agriculture. While there is a modest amount of additional land that could be brought into agricultural production, especially in the southern cone, much of this land is subject to these same climatic and soil-quality constraints.

There is a smaller cumulative stock of agricultural research results available in Africa than on other continents. This reflects an under-investment by African national governments and by the international system. Because the food staples in many African countries are crops not widely grown in other parts of the world—for example, millet, sorghum, yams, and sweet potatoes—there exists a smaller stock of international research results upon which to draw than in wheat, rice, or maize. Nevertheless, the available research demonstrates that high yields are attainable in many regions of Africa with improved varieties, better soil management, and applications of chemical fertilizers.

Many countries in Africa have had a pronounced antirural or antiagricultural bias in their public infrastructure investments and agricultural price policies. Many countries have enforced price ceilings and accepted dumped food aid to keep food cheap in the cities. This in turn depresses farm prices. As a result of the terrible condition of most rural roads, the cost of transport is extremely high. This further depresses the farm level prices of commodities and increases the price of fertilizer and other purchased inputs. These price-distorting effects have often been further accentuated by inefficient parastatal marketing monopolies. As a result, it is simply not profitable for farmers to adopt the improved technologies that are available in many parts of Africa.

Diffusion of improved technologies is impeded by several other factors. The agricultural extension service is often weak, and it fails to recognize that working with the 70% of African farmers who are women may require a different approach than working with male farmers. The private sector serving agriculture is often not well developed because of inadequacies in the legal code or because of unfair competition from inefficient but subsidized public companies. Moreover, credit is often unavailable.

Agricultural productivity could be much higher than it is now in Africa, and somewhat more land

could be brought into production without causing environmental damage. Africa could produce much more of its food supply. There are a few signs of progress in various parts of the continent, particularly in the southern cone.

The antirural bias of many African governments is also reflected in the low priority they project for agricultural and rural development projects to foreign aid donors and to the international development banks. There are often more resources available to Africa for agricultural and rural development than are used.

If and when faster economic growth occurs in Africa, this will cause food consumption to grow even faster. Therefore, even with some agricultural successes, I expect Africa to continue to be a net food importer from the rest of the world—both commercially and for food aid—well into the twenty-first century.

Western Europe

Western Europe is a mature, highly protected, high-income market, with limited expected growth in food consumption. Western Europe's high-income consumers are very quality conscious, and they are placing increasing demands upon their food system for organic foods and for labeling food products as to the processes used to produce the raw agricultural products from which they were made.

Large investments in agricultural research and relatively high price supports have led to very high agricultural productivity levels by international standards. The European Union's price policy substantially stabilized the internal prices of most products, insulating European farmers from international price shocks. Agricultural production has grown much faster than internal consumption over the past two decades, with substantial quantities exported with the assistance of subsidies to offset the high internal support prices.

Government stocks have accumulated at various times as a result of price support operations. At times, these inventories have been donated as food aid to poor countries. Land set-aside and marketing quotas have been used to constrain overproduction stimulated by the high price supports. In response to both financial and political pressures, the European Union's (EU) price support levels have been reduced significantly in recent years. Furthermore, in the Uruguay Round GATT agreement the EU agreed to reduce its subsidies to agricultural exports.

Western Europe has had some of the most intensive crop and livestock production in the world in terms of livestock feeding rates and heavy fertilizer

and agricultural chemical application rates. This has led to adverse environmental consequences, especially in surface and ground water where nitrates and pesticide residues have accumulated. As a result, environmental activists in Western Europe have sought and achieved government regulations to reduce the adverse environmental consequences of intensive agricultural production.

In addition to environmental regulations, a number of Western European countries also impose animal welfare regulations and other production process regulations that prevent their farmers from adopting lower unit-cost-of-production technologies available to farmers in other countries. Other regulations restrict the ability of European agricultural scientists to use certain powerful basic research tools to develop productivity-enhancing and cost-reducing technologies, or prevent European farmers from adopting such technologies developed in other countries. Biotechnology is a prime case in point. Such regulations tend to increase the unit cost of agricultural production and reduce the competitive position of European farmers. Their competitiveness has been further reduced as the value of price supports and marketing quotas has been capitalized into farm asset values, thereby raising the capital cost of farming in Europe relative to other countries.

An unanticipated consequence of the EU's price supports was a loss in the domestic market for cereals in livestock rations. Imports of several cereal substitutes, in particular, manioc, have been admitted to the European Union free of tariffs. As a result, the relatively higher priced cereals grown in Europe dropped out of least-cost ration formulations to be replaced by manioc imported from Southeast Asia and other cereal substitutes. This further increased the fraction of the EU's cereal production to be exported. As cereals price supports have fallen in the last few years, more EU-grown cereals are going back into least-cost rations, reducing the quantity available for export.

As price supports have fallen and environmental regulations have been imposed, the intensity of agricultural input use has been reduced in Western Europe, and the volume of agricultural products available for export has fallen. As EU-grown cereals once again replace cereal substitutes in rations and as export subsidies are further reduced, this will limit agricultural export prospects. Therefore, despite the likely growth in world agricultural import demand in the next century, I expect that Western Europe's agricultural exports will be no larger, and likely will be smaller, than they were recently.

Central and Eastern Europe

Agriculture in Central and Eastern Europe underperformed relative to its potential under central planning during the socialist period. To appreciate the productive potential of this region, one has only to recall that the Ukraine, which has some of the world's most fertile soil, was the world's largest wheat-exporting country as recently as 1930. The former Soviet Union was a major cereals importer during the 1970s and 1980s.

During the socialist period, food consumption levels were quite high relative to other countries because of food price controls and large consumer subsidies for food. Food processing was generally done by large-scale state monopolies, which paid little attention to consumer service or quality control.

Agricultural productivity levels have been low by international standards. This reflects inadequate economic incentives, weak applied research and technology transfer, and unreliable agricultural input supply systems. Production units were often extremely large, but information processing capacity and incentives available to effectively manage such large scale units were inadequate. Post-harvest losses were very large, estimated as high as 40% lost between the farm field and the consumer.

The agricultural sector of the former Soviet Union consistently underperformed relative to its potential. While some observers point to the climatic constraints imposed by its northern climate, Canada, with a similar climate, has consistently been a major agricultural exporter. Basic agricultural science in the former Soviet Union was well respected internationally; however, the applied research and technology transfer system was weak in contrast. For example, conversion rates of feed into meat were very low because rations were not balanced with enough protein. There needs to be a much stronger two-way flow of information between production agriculture and agricultural researchers with stronger incentives to study real-world problems of importance to the agricultural sector. Since the economic reforms, public investment in agricultural research has decreased, and many formerly prestigious research institutes have fallen on hard times.

Since the beginning of economic reforms in the former Soviet Union, per capita income has fallen and the previously large food subsidies have been eliminated, with a resulting decrease in food consumption. With a reduction in agricultural production subsidies, agricultural production decreased even more, especially in animal agriculture. The previously large pe-

riodic bulk commodity imports, particularly of feed, vanished. With the liberalization of imports, a number of high-value food products, including meats and processed foods, are being imported. These products could be produced in the region, but the consumers with purchasing power to buy such goods are unsatisfied with the domestically produced products because of lack of attention to customer service and quality control.

As the economies of Central and Eastern Europe have moved toward a market system, privatization of agriculture has begun, moving at different speeds in different countries. In many cases, property rights are still ill-defined, and not easily registered, protected, transferred, or pledged as collateral against loans. Private input markets and sources of production credit have been slow to evolve. Rural roads and other marketing infrastructure, including bulk and refrigerated storage, have not been improved fast enough. Public monopolies have often replaced state monopolies, with no improvement in customer service or quality control. The old state-supported basic research system has collapsed for lack of resources, and it has not been replaced with an effective applied research and technology transfer system. Public policy continues to reflect an antiagricultural bias, with farm product prices depressed well below world market levels, and farm input prices held well above world market levels.

Once the transition to a market economy is completed and these problems are addressed, there is no reason that Central and Eastern Europe cannot supply more of their internal consumption and be large exporters of a number of crop and animal products. The northern countries of Central Europe are well poised to do this soon. Most countries of the former Soviet Union and the southern countries of Central Europe seem to be a number of years away from achieving their potential. Nevertheless, as we contemplate the capacity of the world's farmers to produce two or three times as much food as today at no higher prices and without environmental damage, this region will have an important role to play.

South America

South America is the region of the world with the largest area of arable land available to be brought into agricultural production without causing deforestation or other environmental damage. While the destruction of the Amazon rain forests receives a great deal of media coverage, there is abundant, nonerodible, unforested land than can be brought into agricultur-

al production in regions south of the Amazon. South America is a region of abundant land area relative to its population, and it has some of the world's most fertile soil in its southern cone. While it is a historically important agricultural exporting region, its performance has fallen far short of its potential.

The agricultural sector of South America has underperformed relative to its potential for over 60 years. Many countries have had a strong antiagricultural bias in their public policies, often under investing in rural services and infrastructure and imposing heavy taxes on agricultural exports. Public policy so depressed returns in agriculture that it remained a very extensive industry with very low productivity per hectare relative to its potential. It was not profitable to adopt higher yielding varieties or to apply much fertilizer.

Recently this situation has been changing rapidly in many Latin American countries. Economic reforms have liberalized the economies of many countries, and agricultural export taxes have been cut. Several outstanding agricultural export success stories have occurred in the last 20 years, including soybeans and frozen concentrated orange juice in Brazil, fruits and wines in Chile, and cut flowers in Colombia.

Brazil, in particular, has made a major commitment to public investments in agricultural research. As a result, the huge Campo Cerrado region in the Central West part of Brazil has been converted from an unproductive region of scrub vegetation to a highly productive producer of soybeans. This is but one example of how investments in agricultural research in the region are breaking natural bottlenecks to expansion of agricultural production to meet the growing world market demand.

It is important to recognize that the distribution of income and wealth is more skewed in South America than in other regions of the world. If an economic development strategy is adopted that successfully increases the incomes of the millions of poor people, there will be a large increase in demand for agricultural products within South America, and a larger proportion of their production will be consumed internally rather than exported. Nevertheless, this region is expected to supply a much larger volume of agricultural exports to satisfy the growing import demand in Asia and other regions in the twenty-first century.

Oceania

This region, which is dominated by Australia and New Zealand, has historically been a strong agricultural exporter, and it is expected to continue to be in

the future. In these mature, high-income markets, internal demand for agricultural products is growing slowly.

These countries have traditionally afforded their agriculture low levels of government assistance. Several years ago New Zealand completely eliminated agricultural assistance. These countries have historically invested strongly in agricultural research, often paid for by taxes that farmers impose upon themselves. With high productivity levels, these countries' agricultural export potential is limited mainly by their size and climatic constraints, in particular low rainfall in much of Australia.

Both countries have significantly repositioned their agricultural sectors in recent years to take advantage of the rich and growing markets to the north in Asia. Australia has experienced a large increase in dairy and cattle production, and New Zealand in dairy and fruits. Both have shifted the balance of their exports from bulk commodities to higher-valued agricultural exports whose demand is growing in the more affluent Asian markets. They will continue to be major agricultural exporters, but with limited expansion potential.

North America

North America has a mature, high-income, slowly growing market for agricultural output. As a result, this region, which has invested large sums in agricultural research and is blessed with large expanses of fertile, well-watered soils and a relatively low cost transportation system, has become the largest agricultural exporting region of the world. However, like the other regions described, agriculture in this region also is undergoing significant changes.

Canada has a large land area and sparse population. While Canadian agriculture might be expected to be constrained by its northerly climate, large investments in agricultural research and rural infrastructure made it possible for Canada to become a major agricultural exporter. Canadian agriculture has also benefited from substantial government assistance. Prairie grain producers benefited from large subsidies to rail transportation to ocean ports for almost a century until two years ago when the subsidy was eliminated. As a result, prairie agriculture is rapidly repositioning itself and has substantially increased the production of oilseeds, particularly canola, and fed livestock, particularly cattle and hogs, relative to wheat. The balance of Canada's agricultural exports has shifted toward higher value products, particularly meats. We can expect Canada to be an even larger

exporter of both bulk commodities and higher-valued agricultural products in the future.

About half of United States agriculture received significant levels of government support for more than 60 years, in particular field crops and dairy, while the rest of American agriculture, including horticultural crops and the rest of animal agriculture, was basically on the free market. In 1996, the U.S. Congress made the largest changes in agricultural policy since support began in 1933. Most subsidies linked to the volume of agricultural production were eliminated. This effectively got the U.S. government out of the business of stock holding. Set-asides associated with price supports were eliminated. (However, a long-term set-aside of erodible or environmentally fragile land in the Conservation Reserve Program was retained.) Target prices and deficiency payments were eliminated. The net effect of all of these changes was to move most of the previously protected parts of American agriculture to a free market. These changes have significantly increased U.S. farmers' planting flexibility and responsiveness to world market demand.

While many parts of the United States are blessed with fertile soils and favorable climatic conditions, public and private investments in agricultural research and transportation infrastructure account for significant parts of the international competitiveness of American agriculture. In the last 20 years, real public investments in agricultural research have declined, but there has been a large increase in private-sector investments in research. This reflects, in part, improvements in intellectual property protection that ensure that the private sector can reap the returns on its investments in research. These developments are focused particularly in biotechnology and in electronic sensors, information processing, and geopositioning systems.

Another major recent innovation has been low-till agriculture or conservation tillage, which reduces labor and energy costs, conserves moisture, and improves soil conservation. Applications of the electronic technologies in so-called precision farming are starting to expand, and we are poised at the beginning of the biotechnology revolution in production agriculture. These technological changes are expected to increase productivity significantly and reduce unit costs of production while having positive environmental effects as well. They should make it possible for the United States to further expand agricultural production and exports.

In 1981, 90% of U.S. agricultural exports were raw, bulk commodities. Today, over half are high-value agricultural products like meats, fruits, vegetables,

nuts, and wine. I anticipate that in the future the United States will export a larger fraction of its maize and soybeans in the forms of meats and other animal products, including dairy products. It will also export large quantities of high-value products from the horticultural sector, but it will also continue to be a large exporter of food and feed grains and oilseeds.

Conclusions

1. There exists a limited amount of additional fertile, well-watered, nonerodible, unforested land available in the world that can be brought into agricultural production at low cost. This tends to be in North and South America and southern Africa. There is somewhat more land that can be brought into production with significant investment in reclamation or irrigation.
2. There exists a great deal of much higher productivity technology available in the world than is presently in use. For example, there is widespread application of fertilizer with the wrong nitrogen-phosphorus-potash balance and widespread use of rations with the wrong energy-protein balance for poultry and livestock. As a result, in each case the productivity from using these inputs is much lower than their potential. In some cases the technology transfer system is deficient, and farmers do not know better; in other cases the marketing system, especially when it is in the public sector, does not make the proper inputs available. In many countries public policy depresses output prices and increases input prices, so that it is not profitable to adopt higher yielding technologies. Investments in transportation infrastructure are essential to reduce the costs of input supply and product marketing. These observations are particularly germane to Africa and Eastern Europe.
3. We are living in the golden age of the biological sciences and of information processing. There are numerous powerful research tools available to agricultural scientists to develop environmentally benign agricultural production technologies. However, just as these powerful research tools were becoming available, the public sector reduced its investments in agricultural research at both the national and international levels. The private sector has increased its investments at the same time, but not by as much as the public sector cuts. In several countries, government regulations have restricted the ability of the private sector to apply some of the powerful new research tools such as biotechnology. Many governments provide in-

adequate intellectual property protection or so increase the cost of getting approval to sell the products of their research that the cost becomes prohibitive. Moreover, the private sector will not invest in minor products or regional staples of poor countries where there is a limited commercial market for the products of the research. Overall there is substantial under investment in agricultural research relative to what is needed to raise productivity on the fertile, nonerodible soils. Otherwise, it will be necessary to expand production onto fragile lands or presently forested lands, with great environmental damage. Larger investments in agricultural research should increase agricultural production potential on all continents and protect the environment.

4. It is important that governments that discriminate against their agricultural sectors reduce the antiagricultural bias in their public policies. I am not advocating a policy of subsidizing agriculture. The experience of a number of high income countries demonstrated that such policies have rarely helped the intended beneficiaries and have often resulted in unanticipated adverse environmental consequences. Rather, governments should give their farmers a level playing field in which they are not asked to pay more than the world price for their inputs and receive the world price for their outputs. There is an important role for public investments in rural infrastructure, human capital, and agricultural research, and for government in registering and protecting property rights and providing a legal code and fair judicial system to support the efficient functioning of a market economy.
5. It is important to remember that no country in the world has solved the problem of rural poverty and food insecurity in agriculture. Increasing agricul-

tural productivity can help, but it is not sufficient. It is necessary to augment farm income from non-farm sources either through part-time or full-time employment outside of agriculture. Part of this can be in industries that supply inputs to farmers or add value to the raw products of the land. However, part of it needs to be in sectors completely unrelated to agriculture.

6. A larger fraction of the world's food production is likely to move through international trade in the twenty-first century. Research and technology transfer have the potential to raise agricultural productivity in all regions of the world. However, because the world's population and arable land are distributed among the continents in very different proportions, we expect that particularly Asia and to some extent Africa will be larger importers of food and agricultural products in the twenty-first century. North and South America and Central and Eastern Europe have the productive potential, if appropriately developed, to supply this import demand at no higher real prices and without environmental damage. It would be economically and environmentally expensive for every country to try to achieve national food security via self sufficiency. As long as the international trading system is permitted to move agricultural products freely from surplus to deficit countries, there is no reason that the trading system cannot ensure food security to all. To ensure national food security, the trading system must permit food-deficit, low-income countries to export goods in which they can be competitive to earn the foreign exchange necessary to pay for their food import needs. Otherwise, to assure national food security, such countries will require reliable food aid—an unattractive long-term prospect.

11 Food Security: Domestic Dimensions

Summary of Respondents' Presentations

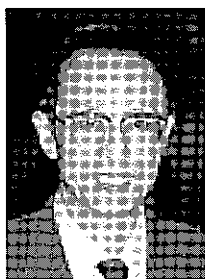
Introduction

When discussing food security, it is virtually impossible to separate domestic issues from international ones. International trade and food aid are essential to increase food security in developing nations. Poverty is the root cause of hunger: the ability to access food is determined primarily by purchasing power. Today, 1.3 billion people in the world earn less than

\$1 per capita per day in income and therefore are not food secure.

To alleviate the problem of food insecurity domestically, developing countries should institute at least two of the following steps: (1) increase agricultural productivity, (2) increase economic development activities in rural areas, (3) invest more in agricultural research, and (4) refrain from exploiting farmers by adherence to a "cheap food policy." On an international level, opening up markets will enable developing nations to export products for which they have a comparative advantage. To assist those countries that cannot afford to import foods, agricultural aid should be provided.

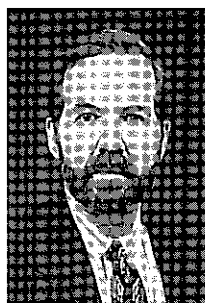
Respondents



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Issues

Domestic Strategies for Reducing Food Insecurity

Food insecurity is highest among inhabitants of rural areas. Since a lack of purchasing power is the leading cause of the problem, countries should focus on increasing the incomes of these residents. Increasing agricultural productivity can lower the unit cost of production, which will result in lower food costs and increased purchasing power. Although this strategy avoids exploiting farmers, unlike cheap food policies that artificially depress food prices, it alone is not the panacea.

Developing countries should invest more public resources in rural economic development. The bias of public resource allocation toward urban areas makes cities more appealing to the poor. To slow migration, broad-based development strategies should be utilized in rural areas. These should include ensuring a safe water supply, building new roads, investing in public

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schools, and creating attractive employment and entrepreneurial opportunities.

Good domestic policy is a critical starting point to attain the goal of hunger eradication. It should include a transparent legal framework, gender equality, environmental protection, accountability, and attention to susceptible populations.

International Strategies for Reducing Food Insecurity

In 30 years, the global demand for food is expected to double, putting pressure on the international food supply system. Since only 10% more arable land is available throughout the world, the solution lies in increasing productivity and decreasing postharvest losses.

Although Asia and Africa are expected to contribute heavily to the increased pressure on the food supply, South America, North America, and Eastern Europe should be able to meet this demand if they make effective use of the available arable land and increase their investments in agricultural research and biotechnology. Although China expects to reach its peak population in 2030, it is confident that it can remain largely self-sufficient. Higher yield levels have been attained in some provinces, and future production increases will be achieved through the use of biotechnology and through increased irrigation in the north.

To ensure that the global demand for food is met, international trade is essential. Open markets without the specter of embargoes should be encouraged, and more funds should be made available for use as agricultural aid.

Dissemination of Information

Information is viewed as a public good that is valued by society but cannot be provided only by the private market. A focus on information and its value in vertically organized food systems is required for efficiency, the achievement of societal goals, increased understanding of complex technologies, and a working knowledge of how decisions are reached.

The effective use and interpretation of information is as important as its dissemination. Institutional design and grassroots organization must be stressed to ensure that all those involved in food production have access to information.

Response of the World Food Summit and the United States

The World Food Summit was held in Rome in November 1996 to discuss solutions to reduce food insecurity throughout the world. It will be successful in its mission if there is a decline in the number of hungry people in the world over the next 20 years. The United States' response to lead this effort has been gratifying. Secretary of State Madeleine Albright has listed international food security as one of the primary American foreign policy priorities.

In the World Food Summit's plan of action, seven focus areas were identified: (1) policy environment, (2) poverty eradication and access to adequate food, (3) sustainable increase in agricultural production, (4) contribution of trade to food security, (5) preparation for food emergencies, (6) optimal investment in human resources, and (7) monitoring of the implementation plan. However, priorities will differ by region.

Needs

Although increased agricultural research is necessary to discover new ways to expand production, Congress has reduced the USDA budget this year. More funding is needed to finance innovative research projects that can help to reduce production costs in the long run. Food aid has also been decreasing because of a reduction in government stock surpluses. Higher levels must be restored to support poor countries that cannot afford to participate in the international trade market.

Recently, bad science has become politically correct. We all need to work harder by communicating effectively with the media to ensure that the correct messages are presented. Doing this will enable the public to gain a better understanding of scientific and international issues.

Solutions

To increase funding for agricultural research, everyone involved, e.g., farmers, producers, industry, consumer groups, and health organizations, must commit themselves to explaining the benefits of agricultural research to Congress. Interest groups should adopt investment in research as an issue on which they could focus their lobbying efforts.

If the public sector is unable to provide the necessary funds, private investment should be sought to improve infrastructure and to increase foreign aid. Some incentives that could encourage investment in-

clude intellectual property protection, a favorable tax code, a fair judicial system, and no corruption.

Ultimately, to improve food safety and security,

everyone must consider themselves part of the food system. Through increased knowledge and communication, much can be accomplished.

12 Food Security for Developing Countries

Dr. Pierre Spitz

History

"Here's a farmer who hanged himself on the expectation of plenty." These are the words used by the drunken porter of Macbeth to point out the paradoxical nature of agricultural pursuits, that is, the possibility for farmers to be ruined by good harvests bringing prices down. What Shakespeare wrote at the beginning of the seventeenth century was echoed one and one-half centuries later by the French economist Quesnay, the leader of the physiocratic school, who referred to the "destitution of plenty." Quesnay added, in the article "Grains" published in the French Encyclopaedia in 1757, the symmetrical argument: during famines large farmers become rich in an ocean of misery. Today in the industrialized countries, food is treated like any other commodity and we all tend to think that the market forces will make the necessary adjustments. We forget the very long history of our own agrarian societies before industrialization. We are forgetting societies in which food security is still a central concern; that is a few billion people today. I cannot resist leaving the European history without quoting the Italian economist Galiani who wrote the following in 1770: "Have you ever examined what is the fundamental difference between the product of the soil and the product of the industrial worker? There is no good or bad harvest in manufacturing.

Geneva watches do not fear frosts, hail, or drought. But if a watchmaker sets the price of a watch at six francs because it was made in 1760, a year of abundance, but sells an identical watch at eight francs because it was made in 1761, a year of expensive wheat, what would you say?"

The variability of harvests and the attendant issues of food security for a family, a village, or a nation were indeed at the roots of the development of economic thinking. This is forgotten by our western-centric history of economic thought.

To my knowledge, a counselor of the Chinese Duke of Wei in the fifth century before Christ was the first to build a quantitative model for food price stabilization, one that was much more sophisticated than the biblical granary of Joseph. His name was Li K'uei. He wrote: "If grain is very expensive, consumers suffer and their families are scattered and emigrate; if grain is very cheap, the producers suffer and that is impoverished. Whether the price is very high or very low, the prosperity of the state suffers."

This conflict between producers and consumers could not, according to Li K'uei, be resolved except by the establishment of public granaries, which would maintain a stable price satisfactory to both parties and thus prevent speculation by traders.

Officials of public granaries should, according to him, classify harvests by reference to a seven-year scale: one average, three good, and three bad. In considering the range from the worst to the best of these seven years, the scale of harvest varied from one to 20. For every good year, Li K'uei indicated what should be stored, consumed, and sold. In a bad year, the government should release stocks to the extent necessary to bring consumer levels back to their average figures.

This was the principle behind the stable-price granary. Li K'uei's writings were translated into English in a thesis written at the University of Columbia in 1911 and dedicated to the economic principles of Confucius and his school. Henry A. Wallace, who became Secretary of Agriculture of the United States in 1933, was very much struck by it. During 1926-1927, he wrote several articles in the periodical *Wallace's*



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Farmer about the Chinese granary, calling it the Ever Normal Granary (ENG). I quote his words: "There is more government science in this principle than in the vast majority of plans suggested to put American agriculture on the right track. . . . This plan would involve a certain dose of government interference, which our citizens are perhaps not yet ready to accept. However, it should be remembered that the government intervenes continuously in agriculture and that its interventions are largely responsible for the present surplus of agricultural products, because of the experiments it has conducted, of which the results have been made widely known by its extension services."

The first Agriculture Adjustment Act of 1933 tried to reduce the surplus without foreseeing downward fluctuations. After the severe drought of 1934, Wallace again took up his favorite theme of ENG, coupled with the classical biblical example and a reference to the storage practices of the Mormons of Utah. In 1938 and for several years afterward, the ENG idea appeared in official documents of the Department of Agriculture. In January 1942, Wallace again had recourse to ENG, but on a world-wide basis this time. The proposal by Lord Boyd Orr, first Director-General of FAO, to establish a World Food Board was described to the American public—notably in a series of articles in *The New York Times* in August 1946—as an international extension of the ENG preached by Wallace.

Twenty-five years later, food scarcities and famines struck Africa, Asia, and Latin America, while the Soviet bulk purchases of grains pushed up grain prices. The human tragedies and the economic and political tensions that built around food issues in the years 1972–1973 triggered the organization of the World Food Conference in Rome in 1974. It became clear through the debates that, for developing countries, increasing food production at the national level was no guarantee of food security at the local level.

Establishment of the International Fund for Agricultural Development

Historical examples amply support this observation. During 1876–1878, British India exported four million tons of grain, and famine killed 6 million people. In Ireland in 1846, one million people perished and hundreds of thousands were forced to emigrate while ships continued to export grain produced by tenant farmers to their landlords in England. During the Ethiopian famine of 1973–1974 at the time of the

World Food Conference, grain exports continued. It was estimated that in 1973, while 100,000 of its people starved to death, Ethiopia exported 9,000 metric tons of grains; that is, food for 100,000 people for three months, almost double its 1972 exports. To put it in other words, to aim only at increasing food production by concentrating on the best endowed farmers—who produce the bulk of the marketed food—does not necessarily ensure that the smaller farmers would increase their production to such an extent that their food self-provisioning needs would be covered or that they would generate sufficient cash purchasing power to bridge their food deficits. During the 1974 World Food Conference, consensus was quickly reached that in developing countries agricultural growth will not eliminate rural poverty by a trickle-down effect. It was agreed that less endowed areas and farmers needed special assistance to alleviate rural hunger and increase food security in the countryside. It was therefore felt that a new institution was needed in order to attack directly rural poverty alleviation projects. Lending for investment projects meant that the projects should be cost-effective and sustainable. This is how, as a result of the food scarcities and famines of the early seventies, the World Food Conference gave birth to the International Fund for Agricultural Development (IFAD).

In a few months, we are going to celebrate the twentieth anniversary of IFAD. What have we learned in the struggle for food security in the poorest areas of the world? We have learned that there is no general rule to improve food security in varied national and local circumstances except that the intended beneficiaries should be fully involved.

Examples of Food Security Improvement

Let us take an example of food security improvement at the local level through international aid. I will not choose examples in Asia or Latin America but in subSaharan Africa, the region that has a less favorable record as far as food security improvement is concerned. In subSaharan Africa I will not select success stories in Ghana or Uganda, two countries known for the progress made, but a poor Sahelian country, Niger. In the Diffa district of Niger, seasonal hunger triggers migrations to coastal areas. When famine threatens, these migrations become permanent and people become refugees. Listening to the people of Diffa, the IFAD staff identified an opportunity for improving food security. Green pepper was in demand

in neighboring Nigeria, and a few innovative farmers were starting to take advantage of growing it to get the needed cash to buy food. The water needed for growing green pepper was available from a river flowing from July to December. Listening to people again, the IFAD staff chose small gasoline-motor pumps instead of large diesel-motor pumps generously provided by donors but difficult to maintain. Small pumps were provided for small groups of farmers from village to village. Credit was given for three years to these groups of two to five farmers; 300 pumps were bought, and credit reimbursed at 100%. Average cash income increased by 100% after loan repayment. With this cash, food is purchased so that farmers do not have to exploit and further degrade very poor soils. Desertification is arrested and the environment protected. The people do not need to migrate. Social tensions, famine risk, and migrations are reduced, and food security improves. Of course there is still a risk that this market opportunity might disappear. But observations throughout the world show that once a farmer enters the market, he, or I should rather say in Africa, she, is quick to seize other opportunities.

In other regions of Niger, the difficulty of identifying a similar cash crop with a good market potential and the absence of water resources makes the improvement of food security an even greater challenge. In the department of Illela, for instance, the only option is to grow more food or to migrate out, particularly because the average rainfall has been declining over the last three decades. What IFAD did in that area was to work on improving traditional techniques known as *tassa* and *half-moons*. *Tassas* are planting pits, one to two feet wide; *half-moons* are six- to eight-foot-wide semicircular loops. They capture water as it flows on the hardened soil surface.

These two structures concentrate water and nutrients. Without my going into details here, over a few years, nearly 700 farmers corresponding to a population of about 40,000 people improved dramatically their food security. The average food yields increased by 60 to 70% without fertilizers and more than doubled with fertilizers. What is even more important is that yields, in the two drought years of 1992 and 1993, were more than three times the yields on control plots without soil and water conservation measures, and this level of production was ensuring a reasonable amount of food self-provisioning. The risk of food scarcities and famines has therefore decreased considerably through these simple techniques, and as in the previous example, out-migration flows are being reduced. Needless to say, soil erosion and environmental degradation are stopped in the process, particu-

larly if fertilizers are used to build up soil fertility. But because the labor necessary for such soil and water conservation measures is quite intense, IFAD is considering using tractor-driven, specially designed implements to increase the area cultivated with such techniques. It is an interesting case of modernization of traditional techniques because, too often, agricultural techniques are imported and imposed in a manner that totally disrupts the local societies. Even in this case of improvement (of a tractor designed to dig *half-moons*) emerging from the local ecological, social, and economic context, discussion would have to be held in order to agree beforehand on how the mechanization costs will be shared, how land rights will have to be interpreted, and the like.

Methods of Solutions to Food Insecurity

These examples show that local solutions to food insecurity can be identified, provided that (1) the concerned people are consulted with respect and humility, (2) the value of their knowledge systems is recognized, and (3) external knowledge interacts with local people's knowledge in a nondisruptive, mutually enriching manner.

This of course requires more detailed attention to the social and cultural fabric of the society than is usually the case in designing big dams for irrigation projects. But the risk of failure is much lower. So many big irrigation structures have to be rehabilitated for lack of maintenance because people were not consulted and did not feel any sense of ownership. That is why IFAD has moved away from grandiose irrigation projects to small and medium scale projects involving beneficiaries of the design, with rights and responsibilities clarified from the start. Water user associations in particular have been successful in maintaining the irrigation structures developed with and by the people concerned.

Additional Investments Needed

Even if all IFAD-financed projects were successful in ensuring food security at the local level in rural areas of developing countries, rural food insecurity would not be eradicated through IFAD investments alone. IFAD has indeed only a commitment lending level of \$450 million dollars a year. But by sharing the knowledge acquired in rural poverty alleviation with our development partners, successes may be replicated on a large scale. That is why IFAD moves toward

becoming an organization with knowledge of rural poverty alleviation, giving a great importance to the evaluation of its projects and the dissemination of lessons learned. It is my conviction that through the concerted effort of all development partners, a considerable improvement of rural food security may occur in the coming decades, provided that the necessary resources are mobilized. However, development aid is declining, particularly in this country, the richest in the world. Even in the case of IFAD, a small organization with 100 professionals, an institution known for its cost-effectiveness and catalytic role, the U.S. contribution is decreasing. There is a great danger that if this short-sightedness continues, rural food insecurity, far from being reduced, will grow with its attendant social tensions, conflicts, strife, increased migrations, and refugee flows.

Food Insecurity Causes Conflict and Suffering

Conflicts that seem to be ethnic or religious more often than not have economic roots in deprivation and food insecurity. Foreign trade and investment in destabilized countries become risky propositions. Feeding cities that grow out of rural migrations without a proportionate increase in employment opportunities is already a crucial issue in many countries. It might worsen if rural food security does not improve. Cities are the seats of power and in cases of food shortages people can take to the streets. In the last two decades, numerous food riots following price increases are testimony to this. Country dwellers are a threat to the authorities only when they head toward the cities.

Physically dispersed, they are also socially divided between those who benefit from rising prices and those who suffer because they are short of food. But in times of food scarcity, all urban social categories become united in their struggle against rising prices, even if they are affected to varying degrees. The poorest know that their very lives are threatened, whereas the others, at worst, run the risk of having to change their food habits and may in fact merely be deprived of some luxuries. However, entrepreneurs, even if they personally do not suffer greatly, have to cope with the wage claims that follow in the wake of soaring food prices. If the government is to stay in power, it must take effective action to check the rise in food prices through a combination of measures that will be determined by the prevailing circumstances. In such a situation of food insecurity in growing cities of developing countries today, the triumph of lib-

eralization and *laissez-faire* policies finds a lesson in humility. Even if the country has sufficient means of payment to import the required basic food at the prevailing world prices, how does it distribute it to the masses or unemployed people deprived of purchasing power? In 58 B.C., wheat was distributed free in the city of Rome. But now that subsidies, food rations, and the like have become anathema for the great thinkers and policy makers of our times, how do we ensure the right to food of the poor and the deprived?

The poorest developing countries have the potential to ensure food security if the required assistance aid comes forward. They also have the potential to reduce migrations to towns and cities if the proper technological choices are made in the agricultural sector. They have the potential to ensure the food needs of the cities and to provide employment in urban areas. For whatever food imports may be necessary from time to time, food exporting countries have the potential to meet the demand and the information systems to forecast it in time. I could have treated food security at the international level only, dealing with figures and projections of supply and demand, under several assumptions of agricultural policies of industrialized countries as well as developing countries. This is the subject of countless analyses that, sophisticated as they might be, do not incorporate the human sufferings of those whose right to food is denied.

Development Aid Provides Right to Food

So, I made the choice to concentrate on the men and women who work the land, who produce the world's supply of food, and, who hold the lives of all human beings in their hands, including those of the generations to come through their husbandry of natural resources. In theory, they have the power of life and death. How is it that, during the last three decades, hundreds of thousands of men and women who worked the soil of Asia, Africa, and Latin American, who sowed the seeds, harvested the crops, and minded the herds, have perished for lack of food? How is it that they die of hunger in those parts of the world, whereas most of the people who do not produce food-stuffs are spared?

For, during the same period and in the same countries, no one in ministries, banks, or barracks starved to death. Might it not be precisely because agricultural production is of such vital importance that those who work on the land in the poor countries are robbed of the power that is theoretically theirs? People who

have thus become so powerless that they can no longer be sure of having enough food for themselves from one year to the next, or even from one season to the next, and who die for that reason, bear witness to the fact that, as the most downtrodden social group, they have lost the most elementary of rights—the right to food, the right to life itself.

It is the role of development aid to restore this right not only for humanitarian reasons or ideals of solidarity. As said by Mr. Fawzi Al-Sultan, president of IFAD, in a meeting on Africa held in 1994 with U.S. Congressmen: “We must take seriously the future of Africa, for it is our future as well. We can invest now in sustainable development, or pay later for the emergency relief of starving populations, for the resolution of civil conflicts, and for the relocation of millions of refugees—fundamental challenges to the internation-

al community arising from the dangerous convergence of poverty and dwindling natural resources.”

I would like to conclude with a reference to a development project in a Sahelian country, designed with the full participation of the people and for which an anthropologist, knowing the area and its people extremely well, designed tools of participatory evaluation. He sat with people and patiently designed graphic symbols easily understandable by everybody. For instance, on a sheet of paper, a granary symbolic of food security was drawn and the participants in the project were requested to indicate periodically by the stroke of a pen how full it was. At the end of the process, villagers told this anthropologist, “We enjoyed a lot doing all that with you. We had a lot of fun and we like you. But for us our success can be identified much more easily. We will be successful if our children do not have to leave our village.”

13 Food Security—Broadly Defined

Dr. Clayton Yeutter

Introduction

This presentation will be a summary—hopefully—of at least some of what you have heard over the past two days. Let us start with the domestic side of this complex issue of food security, food safety, and environmental protection.

Domestic Security

Food availability is not a concern for most Americans. As a nation we are comfortable with our food supply; complacent might even be a more descriptive term. We take it for granted, and that is neither surprising nor irrational. With a high-performing farm sector, we have the capacity to feed our own population and export substantial quantities of food to the rest of the world.

In the past, we have not always been quite so comfortable about our food supplies. A few people here may still remember the dust storms that swept the Great Plains in the 1930s, preceded a few years earlier by misguided trade policies that led to the Great Depression. One does not produce much during a drought, and one does not sell much at a profit during a depression. Fortunately, the demand stimulus policies of President Roosevelt, improved weather, and the motivations of World War II pulled us through that period. And the establishment of GATT in 1947 began the never-ending process of improving global trade rules.

Malthusian views essentially disappeared for three decades, only to emerge once again in the 1970s. The

Soviet Union then became a major food importer, at about the same time that a number of third-world economies began to generate a level of economic growth sufficient to permit their diets to improve. The demand for food worldwide increased, U.S. food exports began to soar, and so did prices on the home front. Consumers began to demonstrate, many conferences like this were held, and the government responded with price controls and even an abortive soybean embargo. The price controls did more harm than good; price rationed the soybeans, as any first-year economics student could have predicted; and the conferences may actually have helped by getting people to think rather than react with raw emotion in the policy making process. Before long the American public began to recognize that we were not about to run out of food and that we, in fact, could readily feed our own populace while dramatically expanding our agricultural exports.

Since then, food has become an ever more attractive price bargain for American families, and we have provided massive food stamp, school lunch, and other such programs for those in need. At the same time we have expanded our food exports from \$10 billion or so annually—when those fierce debates of the 1970s were held—to \$60 billion or thereabouts annually today. We have had a few blips along the way, mostly attributable to the vagaries of weather and a foolish grain embargo, but the big picture is an incredible three-decade success story. So, it is no wonder that Americans now feel comfortable that they will always be fed. The worry is that so few of them know that their food comes from the land.

When it comes to the “quality” of their food (defining that term broadly), Americans are not nearly so satisfied. They do seem to recognize that they may have the most wholesome food supply in the world; they are just not sure that is good enough. This concern is classically illustrated by the *E. coli*-related illnesses that recently led to the destruction of millions of pounds of ground beef. It is also reflected in a number of fruit and vegetable “food safety” incidents, most of which have been attributed (fairly or not) to imports.



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Food safety advocacy groups have contributed to the fear syndrome that exists today. Well-meaning or not, such groups have often exaggerated the risks of foodborne illness, to the point even of forcing removal of the food in question from supermarket shelves. The short-run impact on producers of such actions is, of course, devastating.

An irresponsible media can feed such concerns as well, as evidenced by the scare a few years ago emanating from the use of alar on apples. When “the dust settled,” it was evident that this was a nonproblem in food safety terms; the crisis was a media creation, with no scientific basis. But for apple producers the huge losses were real!

American consumers worry too about the nutritional content of their foods, particularly in these days of high-profile attention to fat content, cholesterol levels, vitamin deficiencies, and the like. Now that we know we will have plenty to eat, we want to know just what it is we are consuming.

We are also concerned about our water supplies—particularly where pollution may be a concern—and that includes concerns over nitrate levels from fertilizer runoff. As population rises, in any country, water will become an ever more valued good. That means people will be increasingly sensitive to the price of that good, and to its quality and general availability. It would not be surprising if Americans were to engage during the next half century in far more political and economic warfare over water than over food. In this regard, it is interesting to note that water markets are finally becoming of significance in the United States.

As I alluded to earlier, Americans are fortunate in that they devote a smaller portion of their disposable income to food than anyone in the world. So, they are not terribly concerned about the price of food, but they do get excited when the price increases swiftly and dramatically. If the price increase is readily explainable—a citrus freeze, for example—they will accept and tolerate it. But if it seems inexplicable, they will quickly conclude that they are being ripped off by someone in the food chain. That someone is likely to be the elusive “middleman.” Consumers may not know where to place the blame, but they will still be angry, and perhaps sufficiently angry to switch to reasonably substitutable alternative foods.

All Americans are environmentalists too. They want to purchase for their families wholesome, good-quality foods at an attractive price, but they do not wish to damage the environment in the process. Because we are now an urban society, most U.S. consumers do not understand agricultural production practices. They will not know the difference between a

nitrogen fertilizer and the application of lime or phosphate. And they certainly will not understand Round-up-ready soybeans, or the differences between and among pesticides and herbicides. Nor will they understand the use of growth hormones in livestock production. They just worry about all that. They see the results in lower-priced foods, and they may even read about higher crop yields and expanded exports. Instinctively, though, they wonder whether it is all worth it, and whether we are doing something (deliberately or inadvertently) that will cause problems in the future.

Americans want to eat well, but they want their children and grandchildren to eat well too. They do not want to change the landscape in a major way, for they want to continue to enjoy the trees they see as they travel, and rivers where they can still see the riverbed. They are not persuaded that the market will handle their “spillover” concerns, and they are correct; it will not always do so. As a consequence, Americans want a certain amount of regulation in the food production/food safety arena: of agricultural chemicals, fertilizers, food processing, pollution control, nutritional labeling, and the like—but not too much regulation, for they are also frightened by too much government, and they do want to be internationally competitive.

Finally, one must add that the future is always a worry. We humans are naturally resistant to change, and today we are being exposed to more change more quickly than ever! This concern is particularly well illustrated by biotechnology research, an endeavor that offers enormous potential for the benefit of humankind. Human medicine will be a huge beneficiary of these research efforts, as will food production. Biotechnology gives promise of ameliorating many of the food safety concerns we have discussed in this conference—if we permit the benefits to evolve. But if, out of irrational emotion and fear, we discourage such research, the opportunity cost will indeed be astronomical. Future generations, in all countries, will pay a gigantic price for our lack of perspicacity.

So where does that leave us on the domestic side? With omnipresent worries about certain aspects of our food supply and food security, all of which are manageable within our market-oriented and capitalistic economy, tempered by sensible regulation. One needs only to visit an American supermarket today, and compare it with one of 50 years ago, or with most food markets anywhere in the world, to know how truly fortunate we are.

International Security

On a global basis, the challenges of food security are far different from those in the United States. Whereas we give almost no thought to the adequacy of our food supplies, much of the rest of the world must do that every day of the year. We constitute 4% or thereabouts of the world's population, which means that well over 5 billion people live outside our borders, most of whom are much less fortunate than we. In much of the third world, birth rates continue to increase, while improved health care leads to greater longevity. As a consequence, population rises, and if agricultural production does not increase accordingly, a policy dilemma arises. The affected nation must either find a way to boost food production or, alternatively, import greater quantities of food.

In most cases, neither option is politically attractive. Boosting domestic production may require production subsidies or other financial incentives. That entails a cost, either to consumers in higher food prices or to the government in the use of taxpayer funds. And it frequently leads governments to adopt diametrically opposite policies: price ceilings at the retail level, to keep consumers happy even though they discourage food production, and yield-based production subsidies, to encourage food production and keep producers happy. The mix often has only a nominal impact on either production or consumption, which means the country loses through increased taxpayer costs and the concomitant commitment of human resources to nonproductive jobs.

Fortunately, this situation has improved in recent years in many parts of the world. Developing nations have thrown off the shackles of their socialist economies and adopted market-oriented economic systems. Thousands of government institutions have been privatized, and the private sector has again begun to flourish in these economies. Much of Latin America is representative of this trend, a huge turnaround from two or three decades ago. But there are countless examples elsewhere in the world too, particularly in Asia, Eastern Europe, and the former Soviet Union. Policy distortions in the production, processing, distribution and sale of food have by no means been eliminated. But the distortions have been minimized in an impressive way, far beyond anything most of us would have predicted when this reform process began.

Where we do still have distortions is in international trade. Ironically and regrettably, the world's most important industry, agriculture, was essentially excluded from the global trade negotiations of the past

50 years. The GATT was signed in 1947, and several "rounds" of trade negotiations have been conducted since then. Trade in manufacturing goods has been freed up tremendously, to the great benefit of the world as a whole. But for all practical purposes, trade in agricultural products did not even make the agenda until the Uruguay Round, which began in 1986. Agricultural trade distortions were extensively debated in the Tokyo Round a decade earlier, but the negotiations went nowhere.

Notwithstanding an enormous effort by the United States and other agricultural exporting nations, the Uruguay Round was only a modest success in market-opening terms. But it did stop many distortions in their tracks, and it has caused myriad nations to begin finally to reform their policies in both production and export subsidies. The Uruguay Round also led to the "tariffication" of all agricultural nontariff barriers, which will make it much easier to negotiate further market openings in the future. Hence, we are gradually getting a more level playing field for agricultural trade, and efficiencies throughout the food chain will emanate from that. Those efficiencies will make it possible for the world to feed more people than ever before, at less cost.

The new WTO is scheduled to begin another tranche of agricultural negotiations in 1999. If that effort is successful, as it should be, we will experience a further leveling of the playing field during the early years of the next century, and another boost in efficiency that will permit us to feed still more people in the world at less cost.

Until agriculture finally penetrated the global negotiating agenda in the Uruguay Round, there was no reason to grant trade negotiations a role in any debate over food security. Trade negotiations were a non-issue, for they had always been a nonstarter! But that has now changed, and we can legitimately and properly expect a positive contribution to emerge from this source for many years to come. Nevertheless, a word of caution is in order. Trade negotiations do not automatically succeed. They require commitment on the part of those who will benefit from more open markets, and a lot of hard work. Protectionist demagoguery always comes to the fore during such negotiations, as people and institutions seek to preserve the status quo—even when the status quo is indefensible. So it takes diligence and effort on the part of governments, farm groups, consumers, and all other potential beneficiaries of expanded trade to make sure those benefits are realized.

Finally, it is necessary, but not sufficient, to do all the good things I have talked about thus far. Third-

world nations can and should eliminate the economic distortions in their own economic systems, and particularly in the food chain. And all nations should participate enthusiastically in the global removal of distortions to agricultural trade. We should all be willing to compete, thereby surfacing and fostering efficiencies in food production, processing, and distribution.

But having an adequate supply of wholesome foods available at an attractive price is not enough if purchasing power is severely limited or absent. That, unfortunately, is still the situation in many parts of the world. Even with the policy reforms that have been undertaken in numerous countries, developed and developing, there are still billions of people with inadequate financial resources to procure the food their families need.

The short-run answer is, of course, humanitarian aid, and the world has been generally responsive to that need. The WFP has been immensely helpful, and many developed countries have country-to-country aid programs of their own, supplemented by the laudatory assistance of numerous nonprofit, private-sector organizations. People are compassionate the world over, and one can cite innumerable examples of that every day of the week.

But one must have a long-run response too, and much of that must come through the macroeconomic policies of the nations where hunger is still a major challenge. Few people, in any country, wish to be dependent on others for their food supplies or their financial well-being. Few countries, if any, wish to have an economy built on external financial support. Few governments want massive numbers of their citizens to be on the dole, whether that dole be domestic or international. Most nations, most governments, most families, most individuals wish to be self-sufficient.

The mark of self-sufficiency is purchasing power, and purchasing power depends on economic growth. Hence, the long-run solution to the food security challenges of the world is a level of economic growth, in all countries, that will ameliorate or eliminate the problem. Most if not all developed countries have reached that point in the aggregate, although income

distribution may leave them with pockets of hunger. That is a purchasing power issue that should be manageable.

Developing countries are still short on purchasing power in the aggregate and on a per capita basis. They often have income distribution inequities too, but there is not much reward for more equitably distributing a pie that is too small. These countries will never deal effectively with their food security challenges until such time as sound macroeconomic policies have given them a much larger pie to cut. It is then that their constituents can share meaningfully in the benefits of economic growth and the purchasing power that has evolved therefrom. In the past their concentration has far too often been on dividing the pie rather than growing it.

Conclusion

We have made a lot of progress in food security generally, and food safety specifically, over the past 30 years. Many of the fears of the 1970s are now behind us forever, though they have been replaced by a new set of preoccupations as we near the turn of the century. We can, without question, provide an adequate diet of wholesome foods for all the people who reside on this planet. We do not yet do so, but that is not a supply question; it is a function of trade impediments and inadequate government policies, particularly relating to purchasing power creation and distribution. It also reflects educational and infrastructure shortcomings.

The answer is to get the policies right, and thereby unleash the creativity, innovativeness, and inherent entrepreneurship of the private sector in all nations. If we do that on a global basis, or even come close, we will readily have the capacity to provide the world with adequate diets far beyond our lifetimes. My compliments go to the sponsors of this conference for focusing attention on this crucial long run policy challenge. We can feed the world, we can minimize the disease risk in food consumption, and we can protect the environment. But only knowledge and commitment will take us there.

Appendix A: Acronyms

BSE	Bovine spongiform encephalopathy	IFAD	International Fund for Agricultural Development
CAST	Council for Agricultural Science and Technology	ICIPE	International Centre of Insect Physiology and Ecology
CAC	Codex Alimentarius Commission	JECFA	Joint Expert Committee on Food Additives
CDC	Centers for Disease Control and Prevention	JMPR	Joint FAO and WHO Meetings on Pesticide Residues
DHHS	Department of Health and Human Services	NRI	National Research Initiative
ENG	Ever Normal Granary	R&D	Research and development
EPA	United States Environmental Protection Agency	SPS	(Agreement) on the Application of Sanitary and Phytosanitary Measures
EU	European Union	TBT	Technical Barriers to Trade Agreement
FDA	United States Food and Drug Administration	UNRISD	United Nations Research Institute for Social Development
FAO	Food and Agricultural Organization of the United Nations	USDA	United States Department of Agriculture
FSIS	Food Safety Inspection Service of the USDA	WFP	United Nations World Food Programme
GATT	General Agreement on Tariffs and Trade	WHO	United Nations World Health Organization
GMP	Good Manufacturing Practices	WTO	World Trade Organization
HACCP	Hazardous Analysis Critical Control Point		

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