FEDERAL FOOD SAFETY RESEARCH: CURRENT PROGRAMS AND FUTURE PRIORITIES

An Inventory of Publicly Supported Food Safety Research by the U.S. Department of Agriculture, Department of Health and Human Services, and Environmental Protection Agency

Compiled by the National Science and Technology Council
Committee on Science
Interagency Working Group on Food Safety Research

July 1999

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President Clinton established the National Science and Technology Council (NSTC) by Executive Order on November 23, 1993. This Cabinet-level council is the principal means for the President to coordinate science, space and technology policies across the Federal Government. NSTC acts as a "virtual" agency for science and technology to coordinate the diverse parts of the Federal research and development enterprise. The NSTC is chaired by the President. Membership consists of the Vice President, Assistant to the President for Science and Technology, Cabinet Secretaries and Agency Heads with significant science and technology responsibilities, and other White House officials.

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THE WHITE HOUSE
WASHINGTON

Dear Colleague:

The President and Vice President consider maintaining and enhancing the safety of our food supply to be a major priority for this Administration, as food safety affects the health and well being of all Americans. A robust program of research has contributed to initiation of a number of reforms that are increasing food safety. Continuation and expansion of federally-sponsored research in food safety will lead to further decreases in the number of illnesses and deaths caused by foodborne pathogens, aiding the Nation in meeting its goals for safer food.

Topping the list of demands for improving food safety is development of effective strategies for reducing microbial hazards on the pathway from farm to table. In accord with this primary thrust of the President's Food Safety Initiative, the National Science and Technology Council focused its assessment of current research programs on research related to foodborne microbial hazards. The inventory of current food safety research programs and of priorities for future research presented in this document provide a valuable baseline for the food safety research plan under development by the newly-established Joint Institute for Food Safety Research.

Sincerely,

Neal Lane
Assistant to the President
for Science and Technology

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Federal Food Safety Research:
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EXECUTIVE SUMMARY

This report provides an inventory of food safety research supported by the U.S. Department of Agriculture (USDA), the Department of Health and Human Services (DHHS), and the Environmental Protection Agency (EPA) and identifies priorities for further investment by the federal government. In accord with the primary thrust of the President's Food Safety Initiative, this first version of the multi-agency inventory is limited to research related to foodborne microbial hazards. The analysis contained in this report will contribute to the planning activities of the Joint Institute for Food Safety Research (JIFSR).

USDA and DHHS spending in Fiscal Year (FY) 1998 for food safety research was $63.6 million and $106.6 million, respectively. EPA spending in FY 1998 for research on microbial pathogens in water that may be used in food production or food processing was $5.2 million. The allocation of current year funds (FY 1999) to specific program objectives and categories has not been completed as of the time of the writing of this report. However, it is noted that the FY 1999 appropriations provided increases for food safety research in USDA ($26.4 million) and DHHS ($10.3 million) as well as a slight increase in EPA's microbial pathogens in water research ($0.7 million). The President's budget for FY 2000 proposes additional food safety research spending for USDA ($22.3 million) and DHHS ($6.2 million).

The inventory includes information regarding scientific and fiscal resources allocated in FY 1998 for projects falling primarily within the eight general categories listed below. The numbers in parentheses indicate the percentage of the portfolio accounted for by each category.

MANAGEMENT OF FOOD-ASSOCIATED RISKS

- Detection of Foodborne Hazards (20.6 %)
- Control of Foodborne Hazards (24.5%)

ASSESSMENT OF FOOD-ASSOCIATED RISKS

- Pathogenicity of Foodborne Microorganisms (25.5%)
- Drug Resistance/Susceptibility of Foodborne Microorganisms (2.6%)
- Epidemiology of Food-Associated Organisms/Disease (4.3%)
- Risk Assessment: methods, data (4.7%)
- Food Handling, Distribution, and Storage (5.5%)
- Economic Factors (1.3%)

The remaining 11 percent of the portfolio includes NIH-funded research that is related to foodborne microbial hazards but not readily accommodated within the eight categories (e.g., projects that relate simultaneously to several categories).

Modifications in the scope and focus of the research portfolio will continue to occur as the research agencies consult with stakeholders, especially the regulatory agencies, about the scope of their research agendas. In the future, this will be driven by the work of the JIFSR, which will be the primary coordination and priority setting mechanism for food safety research in the federal government. Examples of shifts in research priorities can be seen in decreasing support for some detection research and increasing support for research on antibiotic resistance. Consultation between the research and regulatory agencies needs to be improved to ensure that the orientation of grant and contract solicitations and intramural research programs is truly supportive of the needs of the regulatory and public health sectors. Changes in focus and direction will need to be monitored over time.

INTRODUCTION

During the decade of the 1990s, the safety of the food supply for the American people has become an increasingly visible public health issue and a national priority for the Federal government. The Clinton Administration has undertaken numerous important steps to improve food safety. Foremost among these improvements is the progressive introduction, beginning in 1995, of Hazard Analysis and Critical Control Point (HACCP) systems, which feature a science-based approach toward ensuring effective prevention, detection, and control of foodborne pathogens. Additionally, in January 1997, the President announced his National Food Safety Initiative to stimulate further overall improvement in food safety throughout the farm-to-table continuum. The goal of this Initiative is to protect public health through reductions in foodborne illness. This Initiative has provided the basis for coordinated interagency program planning and the formulation of aggressive Federal budgetary proposals for the food safety system. The U.S. Congress has responded with significant increases in appropriations for food safety in FY 1998 and FY 1999. The administration's budget proposal for FY 2000 contains additional increases.

In response to publicly identified needs to strengthen the coordination of food safety activities and responsibilities among Federal agencies, the President issued Executive Order 13100 in August 1998 to establish his Council on Food Safety. This Council is co-chaired by the Secretary of Agriculture, the Secretary of Health and Human Services, and the Assistant to the President for Science and Technology and Director of the Office of Science and Technology Policy (OSTP). Recognizing the essentiality of a strong science base for the U.S. food safety system, the President earlier, on July 3, 1998, had announced the creation of the Joint Institute for Food Safety Research (the "Institute" or JIFSR) to coordinate food safety research among USDA, DHHS, EPA, and other agencies that conduct important food safety research (e.g., the National Science Foundation, the Department of Commerce's National Oceanic and Atmospheric Administration). A report outlining the conceptual structure of the Institute was presented to the Office of the President on July 2, 1999.

This report on the food safety research portfolio of the U.S. Department of Agriculture (USDA), the Department of Health and Human Services (DHHS), and the Environmental Protection Agency (EPA) was developed by the Interagency Working Group (IWG) on Food Safety Research formed earlier in 1998 under the auspices of National Science and Technology Council (NSTC), Committee on Science. The IWG is co-chaired by USDA and DHHS.

The IWG was charged to conduct an in-depth review of federal research related to microbiological aspects of food safety, food-associated toxins, and antibiotic resistance. Since part of EPA's Drinking Water Research Program provides a "collateral benefit" to the food safety research portfolio, in that it addresses microbial pathogens in water that may be used in food production or food processing, relevant research is included in the inventory. Chemical/pesticide and drug residues as potential food safety hazards were not included in this inventory. Specifically, the IWG was asked by the NSTC to (1) provide an inventory of current food safety research programs carried out within or supported by USDA, DHHS, and EPA and (2) identify priorities for further Federal investment. The analysis contained in this report will establish a programmatic foundation for the JIFSR's planning activities. This report presents an analysis of the Federal inventory of food safety

research projects funded and active during FY 1998. This inventory has been assembled from information provided by the primary Federal agencies involved in food safety research listed in the box below.

Department of Health and Human Services (DHHS)
Food and Drug Administration (FDA)
Centers for Disease Control and Prevention (CDC)
National Institutes of Health (NIH)
Department of Agriculture (USDA)
Agricultural Research Service (ARS)
Cooperative State Research, Education, and Extension Service (CSREES)
Economic Research Service (ERS)
Environmental Protection Agency (EPA)

Among these listed agencies, CSREES in USDA and NIH in DHHS represent the major extramural funding agencies for these two departments. The other agencies have a major emphasis on intramural research programs at Federal laboratories (NIH also has a major intramural program). Information reported by EPA represents both its intramural and extramural research programs. The inventory includes information regarding scientific and fiscal resources allocated for projects falling primarily within eight general categories:

- Detection of Foodborne Hazards
- Control of Foodborne Hazards
- Pathogenicity of Foodborne Microbes
- Drug Resistance/Susceptibility of Foodborne Microbes
- Epidemiology of Food-Associated Organisms/Disease
- Risk Assessment: methods, data
- Food Handling, Distribution, and Storage
- Economic Factors

These categories encompass the five broad areas initially identified by the President's National Food Safety Initiative (FSI) as requiring a concerted interagency research effort in order to close significant gaps in scientific knowledge. The five areas of emphasis are the following: (1) improving detection methods; (2) understanding microbial resistance to traditional preservation techniques; (3) understanding antibiotic drug resistance; (4) developing prevention techniques for pathogen avoidance, reduction, and elimination; and (5) understanding the contribution of food handling, distribution, and storage to pathogen contamination of food and developing preventive measures. The categories used in the IWG's analysis also reflect progress made during the first year of the FSI as well as input provided by various stakeholders at the June 30, 1998 and December 1, 1998, public meetings.

As noted in the FSI report to the President in 1997, research is needed to fill critical gaps in scientific knowledge concerning both assessment and management of food safety risks, and also to aid in development of the necessary tools to manage those risks. Risk assessment is a critical precursor to effective science-based risk management. One of the goals of the FSI is to enhance the ability of the Federal agencies to conduct microbial risk assessments, in support of the overall goal of reducing the incidence of foodborne illness. However, even in the face of significant knowledge gaps that impede the development of full risk assessments, the primary Federal agencies involved in food safety are charged with managing these food safety risks. Thus, there are some more immediate needs that relate directly to risk management in the short-term, while results from more long-term research efforts are being collected and evaluated.

Accordingly, the IWG has further organized the eight categories listed above, analyzing those that most directly affect management of food safety risks as one group and those that most directly deal with the subcategory of risk assessment as a separate group. The individual recommendations listed for each of the research categories were developed from two types of information. First was the input provided by stakeholders at several public meetings that have been held during the past 12-14 months, specifically including research needs of the regulatory agencies. Second, the recommendations reflect the changing directions of budget requests from the individual agencies as they adjust their research effort to the changing needs of the stakeholders and society in general. The recommendations recognize that regulatory needs for applying HACCP principles mandate effective technologies and processes that provide scientific, risk-based prevention, control, and intervention strategies to meet the Government Performance and Results Act (GPRA) objective of reducing the incidence and prevalence of foodborne diseases.

The analysis includes some proposed concepts as to how additional funds that have been requested for FY 2000 would be allocated to meet specific needs in the food safety research portfolio. These proposed concepts reflect the research needs as reported in meetings noted above as well as at the first National Food Safety Research Conference, which was sponsored by ARS and CSREES on November 12-13, 1998. An important concept is the need for increased collaboration and enhanced partnerships with private sector organizations so that public and private research outcomes are available to the entire community of people involved in improving food safety.

CURRENT FOOD SAFETY RESEARCH PROGRAMS

The funding data for food safety research programs compiled for this report are based upon FY1998 spending. USDA and DHHS spending in FY 1998 for food safety research was $63.6 million and $106.6 million, respectively. EPA spending in FY 1998 for research on microbial pathogens in water was $5.2 million. This research, while being funded to support development of safety standards for drinking water, has the important collateral benefit of protecting public water supplies used in food production or processing. The allocation of current year funds (FY 1999) to specific program objectives and categories has not been completed as of the time of the writing of this report. However, it is noted that the FY 1999 appropriations provided increases for food safety research in USDA ($26.4 million) and DHHS ($10.3 million) as well as a slight increase in EPA's microbial pathogens in water research ($0.7 million). The President's budget for FY 2000 proposes additional food safety research spending for USDA ($22.3 million) and for DHHS ($6.2 million). An additional relevant

program is the Fruit and Vegetable Agricultural Practices Survey conducted by USDA's National Agricultural Statistics Service (NASS) ($2.5 million requested in FY 2000 budget request). This NASS survey was not included in the USDA funding inventory, but is part of the FSI.

Not all data sets and inventory categories are available for both Departments and all agencies. During the compilation of the research inventory, it became apparent that the agencies currently use different program classification systems and categories to track food safety spending. Research spending can also be categorized by food group or type, harvest stage, pathogen, or by various combinations or crosscuts of these categories. The establishment of a uniform food safety research program classification system and relational databases among agencies should be among the first priority tasks of the JIFSR.

The analysis is based on projects that were funded and active during FY 1998 in the seven agencies listed above. Information relevant to on-going programs for FY 1999 and proposed FY 2000 programs is also incorporated. This inventory and analysis will provide a basis for the establishment of the JIFSR and its research coordination activities. The current inventory and analysis is focused on topics directly related to microbiological safety. Future iterations of such an inventory could be expanded to include other information such as that related to pesticide or other chemical contaminants. The inventory could also include research sponsored by other governmental agencies and private sector organizations.

The inventory data have been evaluated in the context of Food Safety Initiative plans, agency strategic plans, budget development plans, and research needs identified by program customers and stakeholders. These needs, gaps, and future program priorities are discussed in the following section of this report. We have previously listed the eight components that combine to provide an effective research effort that will generate the type of information needed for regulatory programs and voluntary industry safety and quality assurance programs to be effective.

MANAGEMENT OF FOOD-ASSOCIATED RISKS

To provide for timely and efficacious management of the causes of foodborne illnesses, adequate public health surveillance systems must be operational. Further, it is essential that public health officials have adequate understanding of the potential adverse health effects of an organism, the capacity to detect the organism(s), and the knowledge about techniques or practices to prevent or control these pathogens. Detection systems must be sensitive and accurate with relatively rapid process times and should build on reliable sampling schemes. Risk management rests heavily on technologies and systems to prevent contamination of food with human pathogens or other hazards wherever possible or to eliminate or control the levels of such hazards when they are detected in food at various stages along the farm-to-table continuum.

Detection of Food Borne Hazards

Goal: The desired goal is to have detection and quantification methods that are highly reliable, rapid, cost effective, and can be used at the production or processing site with a minimum of expense. Effective use of such detection methods requires an understanding of the sampling of animals, plant

products, and food products, and drinking water distribution systems. These detection systems would support implementation of HACCP programs in processing facilities and the implementation of Good Agricultural Practices/Good Manufacturing Practices in the farm or production setting. Another critical venue is the sampling and testing of imported fresh fruits and vegetables to ensure a safe food product for the American public. Water, whether used for food production, food processing or drinking, also continues to be an area where sampling and detection protocols need to be improved. Finally, it is important to provide user-friendly detection methods that are rapid and can be used in a variety of settings within the food distribution system.

Analysis: A review of the expenditures indicates that approximately 21 percent of the total food safety research funds were focused on detection methods with a major emphasis on *Salmonella* and *E. coli* O157:H7. Fewer funds were directed to detection methods for *Listeria* because prior research had resulted in the development of effective methods. Because allocation of funds to specific pathogens is usually related to the perceived or estimated risk associated with that organism, detection research on *Campylobacter*, viruses, and parasites received less attention. An exception would be research on detection of waterborne parasites, which has received considerable attention. Overall, there has been improvement in the development and implementation of detection methods that are highly sensitive, reliable, and rapid, although methods to detect some pathogens in water need more attention. However, there is a relative lack of information about sampling methodologies, and this continues to be a major deterrent to more effective monitoring of food products. In reviewing the proposed plans for the contributing agencies, funding levels proposed for detection systems show only relatively modest increases. However, as stated below, there will be a shift from research directed specifically at new detection methods, to an increased interest in sampling systems that are more representative of large shipments of food products. There will also be an increased emphasis on the use of recombinant DNA and genetic fingerprinting to identify specific strains of a given organism; this will aid in trace backs and further understanding of the routes of contamination of food.

Recommendations:

- Develop better sampling models for all food products, with emphasis on fresh fruits and vegetables.

- Develop new and improved detection and quantification systems for viruses and parasites that can cause foodborne and waterborne illness.

- Identify indicator organisms, quality attributes, and other product characteristics that could be used as markers of increased contamination by pathogens.

- Conduct research leading to better detection and quantification methods for emerging foodborne or waterborne pathogens or hazards.

- Expand the scope of the research to include development of multi-organism detection systems

- Expand research on nucleic acid fingerprinting and other methods for identification of strains of

organisms and to trace sources of contamination.

- Assess existing data and research outcomes (when there has been substantive work done in prior years) to determine if sufficient knowledge exists to support improved detection and identification tests for re-emerging pathogens.

Control of Food Borne Hazards

Goal: Food is generally not a sterile product and often is contaminated with various pathogenic microorganisms. While it is possible to provide a safe food product at the point of consumption through proper preparation, including cooking procedures, it is still desirable to provide a raw food product with a minimum of pathogens or other hazardous contaminants present. Therefore, production and processing practices should be used that minimize the presence of such hazards and avoid causing foodborne illness in humans. Because pathogens can enter a food product at multiple points in the food production chain, an effective strategy requires that we have control or intervention procedures at several places in that chain. We need to ensure that all foodborne pathogens are receiving an appropriate level of attention in the research programs in proportion to the level of risk that they generate in the food production chain. While this inventory is focused only on the research portfolio, it should be mentioned that an important component of all control programs is the education of producers, processors, food handlers, and consumers about proper food handling techniques and the implementation of HACCP-type programs, where appropriate.

Analysis: Nearly 25 percent of the total research budget was focused on development of prevention, control, or intervention strategies. A major focus of this work has been on the meat, poultry, eggs and dairy sectors, with less attention given to fresh fruits and vegetables. DHHS has a significant involvement in prevention and control research on produce, which has been focused largely on the post harvest area. DHHS also has a program on seafood products with both pre- and post-harvest components. A major effort has been made within USDA in developing intervention strategies, due largely to the strong effort in the meat and poultry industries. During the FY 1998, FDA, ARS, and CSREES increased their research effort on fresh fruits and vegetables. This increased level of activity has continued into the FY 1999 budget with ARS reporting an increase from $30 million (FY 1998) to $38 million (FY 1999). CSREES has proposed about a 43% increase to $5.4 million, while FDA increased its funding by about 10% to $3.2 million. In addition to pathogen-specific research, the inventory also highlighted significant generic research on microorganisms that could be applied to most of the foodborne pathogens that are of major concern at the present time. Newer control measures being studied include anti-microbial rinses that may utilize chemicals or some of the newer options such as bacteriocins. Also, there is an increased emphasis on the production phase of the food chain with applied studies on the implementation of Quality Assurance programs in food animal production, often initiated by the commodity groups themselves.

Recommendations:

- Increase research efforts on microbial ecology or epidemiology projects to support prevention or control strategies during the production phase of the food system for both animals and plants.

- Increase applied research on efficacy of intervention and control measures in production systems.

- Develop commodity specific data to enhance science-based guidance to industry on Good Agricultural Practices and Good Manufacturing Practices that will help assure the safety of fresh and fresh-cut produce.

- Link research outcomes more closely with development of technology transfer or extension education programs to be more effective in causing desired changes in production and processing procedures.

- Identify economic factors that are incentives or disincentives to adoption of specific intervention strategies.

ASSESSMENT OF FOOD-ASSOCIATED RISKS

The risks of food-associated illness must be understood both qualitatively and quantitatively before they can be managed effectively. Risk assessment allows for identification of gaps in the knowledge base as well as identifying the key points where a control measure may be needed. The decisions on research foci or topics should emanate from a risk framework that identifies knowledge gaps or risk factors for which there are no existing data. Risk models for various pathogens and over different segments of the food system can help identify areas for which knowledge is lacking or there is an unacceptable level of uncertainty. These topics can then be incorporated into the research agenda. Issues such as pathogenicity of organisms, ecology or epidemiology of pathogens, sensitivity to antibiotics or anti-microbials, and tools or models for risk assessment are critical to implementation of a risk-based framework for determining research priorities.

Pathogenicity of Foodborne Microorganisms

Goal: While prevention is the ultimate goal, it is also critical to develop an adequate understanding of host-pathogen interactions that enables food industries, water industries, public health officials and medical personnel to intervene as appropriate in foodborne or waterborne disease outbreaks. Many of the foodborne or waterborne human pathogens that are of current interest are not pathogens in the animal systems where they may have a reservoir. Thus, the animal work should focus more on issues related to carrier states and rates of shedding rather than true pathogenesis studies. This is in distinct contrast to the public health concerns for the human population where knowledge of virulence factors, and other information that would assist in planning human disease prevention and treatment protocols for the human population, in general, and sensitive sub-populations, in particular, is of greater value.

Analysis: The total research effort on pathogenicity of foodborne microbes represented about 26

percent of the total inventory. While there were no specific expenditures reported in this category for USDA, this is partly due to differences in classification as there were a number of projects that included work related to pathogenesis, but were classified under another category such as prevention and control. However, DHHS (NIH) has a major focus on human enteric diseases, which includes a major effort on pathogenesis related issues. This substantial investment covers virtually all of the foodborne and waterborne organisms known to cause enteric disease in humans. The genetic basis of virulence factors, new emerging strains of known organisms, host-pathogen interactions, and the impact on at-risk sub-populations are included in this research. Important new efforts for NIH involve the use of genetic sequences of these organisms to better predict their virulence status and develop control or intervention strategies.

Recommendations:

- Increase research on microbial genomes of important foodborne or waterborne pathogens to improve knowledge about organism binding by host cells and other possible virulence factors to develop more sophisticated intervention strategies.

- Enhance existing collaborative efforts between the DHHS (NIH) and USDA programs working on sequencing of microbial genomes. (Priority setting for this activity to ensure attention to the most critical organisms is very important.)

- Continue efforts on use of genetic information in the development of disease prevention strategies, including new, innovative vaccine and immunization strategies.

- Obtain data to support assessment of public health risks posed by toxins in seafood, produce, and grain.

- Develop modeling techniques for human exposure and dose-response models for foodborne and waterborne pathogens.

- Foster closer linkages between research on microorganisms and research on detection/control studies.

Drug Resistance/Susceptibility of Foodborne Microorganisms

Goal: There has been an overall increase in the number of resistant strains of bacteria that are found associated with human disease. Both antibiotic usage in animals and overuse of antibiotics in human medical situations have been cited as contributors to this problem. An improved understanding of the relationship between inappropriate use of antibiotics and the increased numbers of resistant strains will permit more informed regulatory decisions. A particular issue that needs to be resolved is the contribution of the sub-therapeutic usage of antibiotics in animals to resistant strains of foodborne bacterial pathogens. An understanding of how anti-microbial resistance develops and is transferred from one organism to another is crucial to finding solutions to this problem. The current efforts of an interagency task force between DHHS and USDA to assess anti-microbial resistance and develop a 5-year action plan will facilitate resolution of this issue.

Analysis: This topic has received limited attention in the research program when compared to other topics in the portfolio. In FY 1998, only 2.6 percent of the food safety research funds were dedicated to this category of research. However, the increased interest and the public health implications have provided an impetus for both Departments to increase their collective efforts on this topic during the past year. This includes giving specific emphasis to antibiotic resistance in Requests for Proposals. There are active projects on antibiotic resistance in FDA and additional efforts are planned for FY 1999. For CSREES, the funding for this area is projected to double in FY 1999 and double again in FY 2000 to a total of $2.5 million. The ARS budget is projected to have significant increases for this topic with a nearly 10-fold increase from FY 1998 to FY 2000. These increases are reflective of the greatly enhanced public health concern and the need to understand the process of resistance development and its possible transfer from animal pathogens to human pathogens.

Recommendations:

- Increase the level of research activity on how resistance develops and, specifically, on the relative contribution to the total resistance picture from sub-therapeutic antibiotic use in animals vs. inappropriate use in the human population.

- Increase research on the mechanisms by which drug resistance can be transferred among bacteria. (Is it possible for resistance developed in a common animal microbe such as a bovine strain of *E. coli* to be transferred to the human pathogen organism, *E. coli* O157:H7? Can resistance be transferred from spoilage organisms to pathogens?)

- Conduct research that will lead to the development of alternative approaches to the use of antibiotics in animals. (This may include studies on use of molecular biology approaches for accelerated development of vaccines, discovery of other options for immune system enhancement, and more use of bio-control concepts to prevent or control disease pathogens in animals.)

- Increase emphasis on surveillance for anti-microbial resistance at all steps along the farm-to-table continuum.

Epidemiology of Food-Associated Organisms/Disease

Goal: Credible microbial risk assessments require substantive data on the epidemiology and ecology of these organisms. Population-based studies of foodborne or waterborne illnesses in humans provide vital information about routes of exposure, hazardous food consumption patterns (behavioral factors and handling practices) and other aspects that reduce the uncertainties about these problems. Epidemiologic and ecologic studies about these human pathogens in the production and processing environments are also very important in determining the potential sources of contamination and possible control points.

Analysis: DHHS has several projects on epidemiology of food-associated illness in humans. Many projects that generate data on the epidemiologic aspects of the organisms in the production setting were classified in either Prevention/Control or Risk Assessment. In FY 1998, approximately 4.3

percent of the food safety research funds were targeted toward epidemiological research. It is clear that the level of effort in FY 1998 was not adequate to provide the needed information on epidemiology and risk factors to permit accurate risk assessments for all organisms. In the CSREES projections, there is a major increase with a supplemental program of $5 million in FY 1999 devoted entirely to the epidemiology of foodborne pathogens throughout the food production chain with a special emphasis on the production setting. This effort is projected to increase further to $7 million in FY 2000. EPA is conducting related epidemiology research on the occurrence of waterborne disease in collaboration with the CDC and other partners. EPA's extramural resources for this work totaled $2.4 million in FY 1998, $1.5 million in the FY 1999 budget, and $2.0 million is proposed for the FY 2000 budget.

Recommendations:

- Conduct more studies on the incidence/prevalence of food-borne illness in selected human population groups.

- Conduct case control studies to help define proposed causes of food-associated illnesses and evaluate exposure pathways for foodborne hazards.

- Increase research emphasis on epidemiologic and ecologic studies of the major foodborne pathogens in the production and processing sectors, with a special emphasis on food animal production sites and fresh fruit and vegetable production.

- Use current food safety surveillance programs, such as FoodNET and PulseNET, as a foundation on which to build an expanded program in epidemiology.

Risk Assessment: Methods/Data

Goal: Quantitative risk assessment requires both solid data and specialized tools, e.g., biological and mathematical models. To facilitate the ability of regulatory agencies to determine critical points for regulatory effectiveness, "sensitivity analyses" must be performed. This analysis helps identify points where the greatest impact on reducing the risk of an adverse human health outcome are, rather than determining the points of greatest risk. A high quality risk assessment model will also inform the researchers about the gaps in the information base where research could be effective in filling those gaps and improving decision making about food safety issues.

Analysis: While the research investment in risk assessment has been smaller than some other categories, there is still a substantive effort in progress. In FY 1998, approximately 5 percent of the food safety research funds were focused on risk assessment. Risk assessment models have been completed for *Salmonella enteritidis* (SE) in eggs and for *E. coli* O157:H7 in ground beef. Work on risk assessment for *Listeria* and *Vibrio parahemolyticus* is well underway. However, there is very limited risk assessment information for other important foodborne pathogens or toxins. There is a need for a much stronger effort in this area to identify knowledge or data gaps and, thus, assist in focusing both research and regulatory efforts. The ARS research agenda projects little change in the FY 1999 budget, but a major increase from $4.9 million (FY 1999) to $7.3 million (FY 2000).

CSREES also has projected a significant increase to about $2.1 million in FY 1999 and a further increase to $2.7 million in FY 2000. From FY 1998 to FY 1999, FDA received a $.2 million increase, and the FY 2000 President's Budget provides an additional $.3 million. EPA's extramural resources devoted to relevant risk assessment methods/data development will remain relatively stable through the period of FY 1998 to FY 2000 with resources totaling $0.5, $0.6, and $0.6 million for FYs 1998, 1999, and 2000, respectively.

Recommendations:

- Develop and validate risk assessment models focused on those foodborne hazards of greatest concern to public health and regulatory officials.

- Evaluate animal models for human exposure to help assess the risks of various foodborne hazards as related to selected exposure scenarios, including healthy vs. at-risk populations.

- Develop more detailed data on human dietary exposure patterns, particularly for at-risk sub-populations.

- Perform overall risk-based analyses on all foods to determine relative risks for different food consumption patterns. (What is the relative risk of eating sprouts, beets, eggs, or chicken, using different exposure/consumption scenarios?)

- Establish a wider array of risk assessment projects. (If the food safety system is to be science and risk based, reliable quantitative risk assessment models are needed, including models for potential or emerging agents.)

Food Handling, Distribution, And Storage

Goal: Food products can be contaminated due to unsafe practices by workers and low levels of contamination can be exacerbated by improper storage, handling, or transport practices. Thus, research on these specific components to identify special conditions, issues, or solutions, are critical to ensuring the maintenance of the safety of the food product after leaving the original producer or processor. The HACCP concept needs to be applied throughout the food system, including the food preparer. Improved methods for risk communication are needed and effective approaches to educating persons in this segment of the food system are important. Applied research on best practices must be linked with educational/certification programs to ensure the continued safety of the food product.

Analysis: Reflecting some of the differences in mission, this received significant attention within the USDA research portfolio, with about 15 percent of the USDA budget (approximately 6 percent of the overall food safety research budget) being spent on this topic in FY 1998. This has been focused broadly across the spectrum of foods, including significant attention to fresh fruits and vegetables. There are modest increases projected for this area over the next two years. However, this is an area where the educational programs that provide guidance and knowledge on how to prevent contamination and maintain a safe food supply are perhaps more helpful than major increases in

research funding.

Recommendations:

- Integrate applied research with educational programs to provide a stronger basis for recommending changes in current practices, and to support the establishment of certification programs for food handlers through educational programs.

- Develop improved methods for monitoring time/temperature parameters along with improved indicators of poor handling, transport, or storage.

- Conduct studies that will provide robust evaluations of the impact of research and education programs on the actual incidence of foodborne illnesses.

- Identify and evaluate food safety characteristics of packing and handling procedures, especially for products that do not include a terminal inactivation step.

Economic Analysis

Goal: Economic analyses are an important component of the food safety effort because they can provide: (1) information on the benefits and costs of regulatory intervention and alternatives; (2) information about the effect of economic incentives that might induce industry to undertake certain new practices; and (3) an understanding of the societal cost of foodborne illness in humans and the societal cost of eliminating it. Therefore, economic studies need to be done in parallel with other research, so that the economic benefit or cost is clearly understood from the beginning, and can be weighed against the probability of food-borne illness occurring.

Analysis: The economic studies are nearly all within the USDA (ERS). The total funding for this area represented about 1.5 percent of the total budget. Much of the research has focused on the economic cost to society of foodborne illness, while other studies have examined the cost/benefit of implementing a HACCP-based inspection system or other food safety efforts.

Recommendations:

- Incorporate economic studies more fully into a wider range of on-going research projects, in accordance with policy and regulatory priorities, across the entire food chain.

- Develop economic models that examine how economic incentives can be used to facilitate implementation of food safety procedures.

- Collect data on the economic impact of possible regulatory decisions.

CONCLUSION

USDA, DHHS, and EPA support a diverse portfolio of research projects that will improve the safety of our nation's food supply. Within USDA, ARS has had a close consultative linkage with Food Safety Inspection Service (FSIS) and other regulatory agencies, with much of their research focused on food safety issues in animal-derived products. USDA's CSREES combines both extramural research programs and educational outreach programs, thus providing basic and applied types of research and, through the Cooperative Extension Service, an unparalleled system for rapid dissemination of food safety information to the grass roots level and to all individuals involved in the food system. Within DHHS, NIH has a focus on fundamental biomedical research on enteric pathogens of humans; its portfolio has a major emphasis on pathogenesis, virulence factors, and other similar issues. FDA, which is also part of DHHS, serves both a regulatory and research function with its research goals highly relevant to its regulatory needs. EPA's relevant research focuses on the quality of water for drinking that may subsequently be used for food production and processing.

Differences in the manner of classifying projects among the agencies have resulted in some disparities in the IWG's efforts to categorize the total research portfolio. Better synchrony among agencies in classification of research projects will improve the quality of the data and the subsequent analysis in future years. An important task for the JIFSR will be to develop a system for classifying research projects that is acceptable to all agencies and creates a uniform platform for collecting such data. This should not, however, be construed as preventing individual agencies from also using their own historical classification systems, which often are related to their specific mission and have served them well.

One of the important outcomes of this analysis is the documentation of how the research portfolio is subject to change based on changing food safety needs. In several instances, support for research on a specific pathogen or problem area has been described as decreasing, which is a result of changes in the public health concerns about that specific pathogen. As an example, in the early 1990s, considerable research effort was focused on *Listeria* because of the concern for its presence in products where growth occurred during refrigeration. As information became available and the problem lessened, and foodborne illness outbreaks were increasingly linked to *E. coli* or *Salmonella*, the focus of research programs shifted to these latter pathogens. With more information on the actual incidence of various pathogens becoming available from programs such as FoodNET, the research portfolio will continue to shift to address the problems of highest priority. Improved molecular fingerprinting will complement information technology databases for pathogen identification and characterizing sources of contamination of public health significance.
The emerging issue of resistance to antibiotics and the relative contribution to this problem from agricultural uses of antibiotics in food animals and inappropriate use in human medical situations has resulted in significantly more funds being directed toward this problem over the period covered by this inventory. In planning for the FY 2001 budget submission, CSREES is considering a program specifically targeted on research to develop alternatives to antibiotic usage in animals, especially the sub-therapeutic usage. The current joint effort between DHHS and USDA to plan a coordinated effort on anti-microbial resistance will have impact on future directions and priorities for this topic. All of these examples demonstrate that the research establishment does respond to changing societal concerns and public health needs.

In order to accomplish the recommendations for future work that are contained in this report, agencies have either made decisions to shift the focus of existing funding as was cited above for the *Listeria* vs.

E. coli, or are requesting additional funding in the FY 2000 or FY 2001 budget to meet these needs. The recent decision to proceed with the program on food safety in fruits and vegetables by FDA and the issuance of the Guide to Minimize Microbial Contamination of Fresh Fruits and Vegetables required additional funding for both research and educational efforts to support this plan. In CSREES, a new Food Safety Special Research Grants program in FY 1998 was entirely devoted to food safety questions about fruits and vegetables, and ARS has made a major shift in emphasis to more research on food safety problems of fresh fruits and vegetables during the past two years. In 1999, added funding for the Food Safety and Quality Education Initiative in CSREES is being used, in part, to support a national conference on development of needed educational materials and funding of projects focused specifically on this issue in support of the FDA effort. This provides evidence of shifting the emphasis to meet new needs and also demonstrates the interactions and collaborations that exist among the contributing agencies as they work together to solve the very large problem of food safety.

Shifts in the focus of the research portfolio will continue to occur as the research agencies consult with stakeholders, especially the regulatory agencies, about the scope of their research agendas. To a large degree, in the future this will be driven by the work of the JIFSR, which will be the primary coordination and priority setting mechanism for food safety research in the federal government. Consultation between the research and regulatory agencies needs to be improved to ensure that the scope of Requests for Proposals and intramural research programs are truly supportive of the needs of the regulatory and public health sectors. Changes in focus and direction will be a constant occurrence and need to be monitored over time.

APPENDIX A

INTERAGENCY WORKING GROUP ON FOOD SAFETY RESEARCH

Department of Health and Human Services

William Raub (Co-Chair)	Office of Science Policy
Joseph Levitt Robert Buchanan Patricia Henson	Food and Drug Administration
Claire Broome Morris Potter	Centers for Disease Control and Prevention
Wendy Baldwin Van Hubbard	National Institutes of Health

U.S. Department of Agriculture

Eileen Kennedy (Co-Chair)	Office of the Under Secretary for Research, Education, and Economics
Catherine Woteki	Office of the Under Secretary for Food Safety
Kaye Wachsmuth	Food Safety and Inspection Service
William Wagner Edward Wilson	Cooperative State Research, Education, and Extension Service
Betsy Kuhn	Economic Research Service
K. Darwin Murrell Jane Robens Cairid Rexroad	Agricultural Research Service
Dorothy Caldwell	Food, Nutrition, and Consumer Services

Environmental Protection Agency

Elaine Francis	Office of Research and Development

Executive Office of the President

Clifford Gabriel	Office of Science and Technology Policy
Wendy Taylor	Office of Management and Budget
Amandeep Matharu	
Noah Engelberg	
Dana Flower-Lake	
Margaret Malanoski	

APPENDIX B

DATA TABLES

The tables reflect expenditure data for fiscal year 1998 with future projections based on actual budget figures for 1999 and requested dollars for 2000. Please note that, in general, numbers of projects are not given for 1999 or 2000. This is particularly true for the Cooperative State Research, Education, and Extension Service (CSREES) and the National Institutes of Health (NIH), where the use of extramural awards as the primary vehicle precludes information about numbers of projects or topic being available until after the award process has occurred for a given fiscal year.

For CSREES, the budget totals given reflect USDA's Office of Budget and Program Analysis totals for the Food Safety Initiative and include only a portion of the projects or funding from the base programs such as Hatch, Animal Health and Disease (Sect.1433), and Evans-Allen in the 1998 values.

Part of EPA's Research Program for Microbial Pathogens and Disinfection By-Products in Drinking Water, specifically that part of the program that addresses microbial pathogens in water that may be used in food production or food processing, provides a "collateral benefit" to the food safety research portfolio. The associated resources are reflected in the tables.

The reader should review all table footnotes carefully. Because of the lack of categorization of research effort in 1999 and 2000 by NIH, the totals for DHHS in each category represent only the data from CDC and FDA. Also, this has resulted in a lack of totals for each category of research effort for the DHHS and USDA combined reports in Tables 4 and 7. The list of tables is given below. Please note that detailed tables for research category by agency across the three years are provided in Tables 10-15.

Index of Tables

TABLE 1

SUMMARY OF INVENTORY OF FEDERAL FOOD SAFETY RESEARCH
Fiscal Year 1998, $$ in 1000's

RESEARCH FOCUS	DHHS		USDA		EPA		Total	
	Projects	Dollars	Projects	Dollars	Projects	Dollars	Projects	Dollars
Detection of food borne hazards	65	21,550	82	12,385		2,200	147	36,135
Control of food borne hazards	36	9,302	167	33,610		0	203	42,912
Pathogenicity of food-borne microbes	247	44,619	28	0		100	275	44,719
Antimicrobial/antibiotic resistance/ susceptibility of food borne microbes	11	3,374	8	1,100		0	19	4,474
Epidemiology of food-associated organisms/illness	34	5,097	0	0		2,400	34	7,497
Risk assessment: methods/data	8	3,179	22	4,648		500	30	8,327
Food handling, distribution, and storage	2	4	24	9,606		0	26	9,610
Economic analysis	1	49	15	2,254		0	16	2,303
Other	94	19,458	0	0		0	94	19,458
Total	498	106,632	346	63,603	*	5,200	844	175,435

*Number of projects for EPA not available.

TABLE 2

SUMMARY OF INVENTORY OF USDA-REE FOOD SAFETY RESEARCH
Fiscal Year 1998, $$ in 1000's

RESEARCH FOCUS	ARS		CSREES		ERS		USDA Total	
	Projects	Dollars	Projects	Dollars	Projects	Dollars	Projects	Dollars
Detection of food borne hazards	28	11,125	54	1,260	0	0	82	12,385
Control of food borne hazards	49	29,800	118	3,810	0	0	167	33,610
Pathogenicity of food-borne microbes	0	0	0	0	0	0		0
Antimicrobial/antibiotic resistance/ susceptibility of food borne microbes	4	600	4	500	0	0	8	1,100
Epidemiology of food-associated organisms/illness	0	0	0	0	0	0	0	0
Risk assessment: methods/data	8	4,498	12	150	0	0	22	4,648
Food handling, distribution, and storage	15	8,926	9	680	0	0	24	9,606
Economic analysis	0	0	0	0		2,254		2,254
Total	104	54,949	197	6,400		2,254	301	63,603

TABLE 3

SUMMARY OF INVENTORY OF DHHS FOOD SAFETY RESEARCH
Fiscal Year 1998, $$ in 1000's

RESEARCH FOCUS	FDA		CDC		NIH		DHHS Total	
	Projects	Dollars	Projects	Dollars	Projects	Dollars	Projects	Dollars
Detection of food borne hazards	43	18,400	11	1,019	11	2,131	65	21,550
Control of food borne hazards	7	3,000	1	10	28	6,292	36	9,302
Pathogenicity of food-borne microbes	14	6,000	2	505	231	38,114	247	44,619
Antimicrobial/antibiotic resistance/ susceptibility of food borne microbes	7	3,000	1	200	3	174	11	3,374
Epidemiology of food-associated organisms/ illness	0	0	5	465	29	4,632	34	5,097
Risk assessment: methods/data	6	2,600	1	60	1	519	8	3,179
Food handling, distribution, And storage	0	0	0	0	2	4	2	4
Economic analysis	0	0	0	0	1	49	1	49
Other	0	0	0	0	94	19,458	94	19,458
Total	77	33,000	*21	*2,259	400	71,373	498	106,632

*These figures represent estimates of CDC resources supporting the areas identified for research focus but do not represent discrete research projects.

TABLE 4

SUMMARY OF INVENTORY OF FEDERAL FOOD SAFETY RESEARCH
Fiscal Year 1999, $$ in 1000's

RESEARCH FOCUS	DHHS		USDA		EPA		TOTAL	
	Projects	Dollars	Projects	Dollars	Projects	Dollars	Projects	Dollars
Detection of food borne hazards	54	20,648		16,325		600		
Control of food borne hazards	8	3,200		43,383				
Pathogenicity of food-borne microbes	16	7,180		0		100		
Antibiotic/antimicrobial resistance/susceptibility of food borne microbes	8	3,400		3,462				
Epidemiology of food-associated organisms/illness	5	200		5,000		1,500		
Risk assessment: methods/data	7	2,875		7,021		600		
Food handling, distribution, And storage	0	0		12,077				
Economic analysis	0	0		2,707				
Total		*116,884		89,975		**2,800		209,659

*This number includes $79,381 million for NIH. NIH research dollars are not allocated until after grant awards are actually made; splits reflect only CDC and FDA dollars. Therefore, no totals by category can be calculated.

**In addition to the resources declared above, EPA has a current grant solicitation for FY 1999 with approximately $3 million focused on drinking water pathogens. It is not possible to attribute these resources to specific categories until grant awards are made.

TABLE 5

SUMMARY OF INVENTORY OF USDA-REE FOOD SAFETY RESEARCH
Fiscal Year 1999, $$ in 1000's

RESEARCH FOCUS	ARS		CSREES		ERS		USDA Total	
	Projects	Dollars	Projects	Dollars	Projects	Dollars	Projects	Dollars
Detection of food borne hazards	40	14,217		2,108	0	0		16,325
Control of food borne hazards	70	37,943		5,440	0	0		43,383
Pathogenicity of food-borne microbes	0	0		0	0	0		0
Antimicrobial/antibiotic resistance/ susceptibility of food borne microbes	7	2,222		1,240	0	0		3,462
Epidemiology of food-associated organisms/illness	0	0		*5,000	0	0		5,000
Risk assessment: methods/data	9	4,909		2,112	0	0		7,021
Food handling, distribution, and storage	18	10,577		1,500	0	0		12,077
Economic analysis	0	0		0	0	2,707		2,707
Total	144	69,868		17,400	0	2,707		89,975

* = Shifted funds from detection (1,000), control (4,500), and risk assessment (500) as compared to OBPA budget listing

TABLE 6

SUMMARY OF INVENTORY OF DHHS FOOD SAFETY RESEARCH
Fiscal Year 1999 $$ in 1000's

RESEARCH FOCUS	FDA		CDC		NIH		DHHS Total	
	Projects	Dollars	Projects	Dollars	Projects	Dollars	Projects	Dollars
Detection of food borne hazards	43	19,800	11	848				
Control of food borne hazards	7	3,200	1	0				
Pathogenicity of food-borne microbes	14	6,400	2	780				
Antimicrobial/antibiotic resistance/ susceptibility of food borne microbes	7	3,200	1	200				
Epidemiology of food-associated organisms/illness	0	0	5	200				
Risk assessment: methods/data	6	2,800	1	75				
Food handling, distribution, and storage	0	0	0	0				
Economic analysis	0	0	0	0				
Total	77	35,400	**21	**2,103		*79,381		116,884

*NIH research dollars are not able to be allocated until after grant awards are actually made.

**These figures represent estimates of CDC resources supporting the areas identified for research focus but do not represent discrete research projects.

TABLE 7

SUMMARY OF INVENTORY OF FEDERAL FOOD SAFETY RESEARCH
Fiscal Year 2000, $ in 1000's (estimated)

RESEARCH FOCUS	DHHS		USDA		EPA		Total*	
	Projects	Dollars	Projects	Dollars	Projects	Dollars	Projects	Dollars
Detection of food borne hazards	54	23,365		19,846		900		
Control of food borne hazards	8	3,700		51,325		0		
Pathogenicity of food-borne microbes	16	7,400		0		0		
Antimicrobial/antibiotic resistance/ susceptibility of food borne microbes	8	3,900		8,115		0		
Epidemiology of food-associated organisms/illness	5	200		7,000		2,000		
Risk assessment: methods/data	7	3,177		10,011		600		
Food handling, distribution, and storage	0	0		12,791		0		
Economic analysis	0	0		3,230		0		
Total		*123,099		112,318		**3,500		238,917

*This number includes $81,357 million for NIH. NIH research dollars are not allocated until after grant awards are actually made; splits reflect only CDC and FDA dollars and no totals are given by category.

**Funding levels for the EPA competitive grants program in FY 2000 specifically targeted to drinking water pathogen research have not been determined at this time.

TABLE 8

SUMMARY OF INVENTORY OF USDA-REE FOOD SAFETY RESEARCH
Fiscal Year 2000, $$ in 1000's (estimated)

RESEARCH FOCUS	ARS		CSREES		ERS		USDA Total	
	Projects	Dollars	Projects	Dollars	Projects	Dollars	Projects	Dollars
Detection of food borne hazards		14,917		4,929	0	0		19,846
Control of food borne hazards		42,693		8,632	0	0		51,325
Pathogenicity of food-borne microbes	0	0	0	0	0	0		0
Antimicrobial/antibiotic resistance/ susceptibility of food borne microbes		5,641		2,474	0	0		8,115
Epidemiology of food-associated organisms/illness	0	0		*7,000	0	0		7,000
Risk assessment: methods/data		7,309		2,702		0		10,011
Food handling, distribution, and storage		11,027		1,764		0		12,791
Economic analysis	0	0	0	0		3,230		3,230
Total		81,587		27,501		3,230		112,318

* = Shifted funds from control (6,000) and risk assessment (1,000) as compared to OBPA estimates

TABLE 9

SUMMARY OF INVENTORY OF DHHS FOOD SAFETY RESEARCH
Fiscal Year 2000, $$ in 1000's (estimated)

RESEARCH FOCUS	FDA		CDC		NIH		DHHS Total	
	Projects	Dollars	Projects	Dollars	Projects	Dollars	Projects	Dollars
Detection of food borne hazards	43	22,700	11	665				
Control of food borne hazards	7	3,700	1	0				
Pathogenicity of food-borne microbes	14	7,400	2	0				
Antimicrobial/antibiotic resistance/ susceptibility of food borne microbes	7	3,700	1	200				
Epidemiology of food-associated organisms/illness	0	0	5	200				
Risk assessment: methods/data	6	3,100	1	77				
Food handling, distribution, and storage	0	0	0	0				
Economic analysis	0	0	0	0				
Total	77	40,600	**21	**1,142		*81,357		123,099

*NIH research dollars are not able to be allocated until after grant awards are actually made.

**These figures represent estimates of CDC resources supporting the areas identified for research focus but do not represent discrete research projects.

TABLE 10

SUMMARY OF INVENTORY OF ARS FOOD SAFETY RESEARCH
Fiscal Years 1998-2000, $$ in 1000's

RESEARCH FOCUS	1998		1999		2000	
	Projects	Dollars	Projects	Dollars	Projects#	Dollars
Detection of food borne hazards	28	11,125	40	14,217	# 40	14,917
Control of food borne hazards	49	29,800	70	37,943	# 70	42,693
Pathogenicity of food-borne microbes	0	0	0	0	0	0
Antimicrobial/antibiotic resistance/ susceptibility of food borne microbes	4	600	7	2,222	# 7	5,641
Epidemiology of food-associated organisms/illness	0	0	0	0	0	0
Risk assessment: methods/data	8	4,498	9	4,909	# 9	7,309
Food handling, distribution, and storage	15	8,926	18	10,577	# 18	11,027
Economic analysis	0	0	0	0	0	0
Total	104	54,949	144	69,868	# 144	81,587

 # = FY99 + new projects

TABLE 11

SUMMARY OF INVENTORY OF CSREES FOOD SAFETY RESEARCH
Fiscal Years 1998-2000, $$ in 1000's

RESEARCH FOCUS	1998		1999		2000	
	Projects	Dollars	Projects	Dollars	Projects	Dollars
Detection of food borne hazards		1,260		2,108		4,929
Control of food borne hazards		3,810		5,440		8,632
Pathogenicity of food-borne microbes		0		0		0
Antimicrobial/antibiotic resistance/ susceptibility of food borne microbes		500		1,240		2,474
Epidemiology of food-associated organisms/illness		0		*5,000		**7,000
Risk assessment: methods/data		150		2,112		2,702
Food handling, distribution, and storage		680		1,500		1,764
Economic analysis		0		0		0
Total		6,400		17,400		27,501

* = Shifted funds from detection (1,000), control (3,500), and risk assessment (500)

** = Shifted funds from control (6,000), and risk assessment (1,000)

TABLE 12

SUMMARY OF INVENTORY OF ERS FOOD SAFETY RESEARCH
Fiscal Years 1998-2000, $$ in 1000's

RESEARCH FOCUS	1998		1999		2000	
	Projects	Dollars	Projects	Dollars	Projects	Dollars
Detection of food borne hazards	0	0	0	0	0	0
Control of food borne hazards	0	0	0	0	0	0
Pathogenicity of food-borne microbes	0	0	0	0	0	0
Antimicrobial/antibiotic resistance/ susceptibility of food borne microbes	0	0	0	0	0	0
Epidemiology of food-associated organisms/illness	0	0	0	0	0	0
Risk assessment: methods/data	0	0	0	0	0	0
Food handling, distribution, and storage	0	0	0	0	0	0
Economic analysis	0	2,254	0	2,707	0	3,230
Total		2,254		2,707		3,230

TABLE 13

SUMMARY OF INVENTORY OF FDA FOOD SAFETY RESEARCH
Fiscal Years 1998-2000, $$ in 1000's

RESEARCH FOCUS	1998		1999		2000	
	Projects	Dollars	Projects	Dollars	Projects	Dollars
Detection of food borne hazards	43	18,400	43	19,800	43	22,700
Control of food borne hazards	7	3,000	7	3,200	7	3,700
Pathogenicity of food-borne microbes	14	6,000	14	6,400	14	7,400
Antimicrobial/antibiotic resistance/ susceptibility of food borne microbes	7	3,000	7	3,200	7	3,700
Epidemiology of food-associated organisms/illness	0	0	0	0	0	0
Risk assessment: methods/data	6	2,600	6	2,800	6	3,100
Food handling, distribution, and storage	0	0	0	0	0	0
Economic analysis	0	0	0	0	0	0
Total	77	33,000	77	35,400	77	40,600

TABLE 14

SUMMARY OF INVENTORY OF CDC FOOD SAFETY RESEARCH
Fiscal Years 1998-2000, $$ in 1000's

RESEARCH FOCUS	1998		1999		2000	
	Projects	Dollars	Projects	Dollars	Projects	Dollars
Detection of food borne hazards	11	1,019	11	848	11	665
Control of food borne hazards	1	10	1	0	1	0
Pathogenicity of food-borne microbes	2	505	2	780	1	0
Antimicrobial/antibiotic resistance/ susceptibility of food borne microbes	1	200	1	200	1	200
Epidemiology of food-associated organisms/illness	5	465	5	200	1	200
Risk assessment: methods/data	1	60	1	75	1	77
Food handling, distribution, and storage	0	0	0	0	0	0
Economic analysis	0	0	0	0	0	0
Total	*21	*2,259	*21	*2,103	*21	*1,142

*These figures represent estimates of CDC resources supporting the areas identified for research focus but do not represent discrete research projects.

TABLE 15

SUMMARY OF INVENTORY OF NIH FOOD SAFETY RESEARCH
Fiscal Years 1998-2000, $$ in 1000's

RESEARCH FOCUS	1998		1999*		2000*	
	Projects	Dollars	Projects	Dollars	Projects	Dollars
Detection of food borne hazards	11	2,131				
Control of food borne hazards	28	6,292				
Pathogenicity of food-borne microbes	231	38,114				
Antimicrobial/antibiotic resistance/ susceptibility of food borne microbes	3	174				
Epidemiology of food-associated organisms/illness	29	4,632				
Risk assessment: methods/data	1	519				
Food handling, distribution, and storage	2	4				
Economic analysis		490				
Other	94	19,458				
Total	249	71,373		79,381		81,357

*NIH research dollars are not able to be allocated until after grant awards are actually made.

TABLE 16

SUMMARY OF INVENTORY OF EPA FOOD SAFETY RESEARCH***
Fiscal Years 1998-2000, $$ in 1000's

RESEARCH FOCUS	1998		1999*		2000**	
	Projects	Dollars	Projects	Dollars	Projects	Dollars
Detection of food-borne hazards		2,200		600		900
Control of food-borne hazards						
Pathogenicity of food-borne microbes		100		100		0
Antimicrobial/antibiotic resistance/ susceptibility of food-borne microbes						
Epidemiology of food-associated organisms/illness		2,400		1,500		2,000
Risk assessment: methods/data		500		600		600
Food handling, distribution, and storage						
Economic analysis						
Other						
Total		5,200		2,800		3,500

*In addition to the resources declared above, EPA has a current grant solicitation for FY 1999 with approximately $3 million focused on drinking water pathogens. It is not possible to attribute these resources to specific categories until grant awards are made.

**Funding levels for the competitive grants program in FY 2000 specifically targeted to drinking water pathogen research have not been determined at this time.

***Resources reflect part of EPA's research program for microbial pathogens and disinfection by-products in drinking water, that addresses microbial pathogens in water that may be used in food production or food processing.

ABSTRACT

This report provides an inventory of food safety research supported by USDA, DHHS, and EPA and identifies priorities for further investment by the federal government. In accord with the primary thrust of the President's Food Safety Initiative, the first version of the multi-agency inventory is limited to research related to foodborne microbial hazards. The analysis contained in this report will contribute to the planning activities of the Joint Institute for Food Safety Research (JIFSR). USDA and DHHS spending in FY 1998 for food safety research was $63.6 million and $106.6 million, respectively. EPA spending in FY 1998 for research on microbial pathogens in water that may be used in food production or food processing was $5.2 million. The allocation of current year funds (FY 1999) to specific program objectives and categories has not been completed as of the time of the writing of this report. However, it is noted that the FY 1999 appropriations provided increases for food safety research in USDA ($26.4 million) and DHHS ($10.3 million) as well as a slight increase in EPA's microbial pathogens in water research ($0.7 million). The President's budget for FY 2000 proposes additional food safety research spending for USDA ($22.3 million) and DHHS ($6.2 million).

The report identifies ongoing and projected research activities in eight general categories: detection of foodborne hazards; control of foodborne hazards; pathogenicity of foodborne hazards; drug resistance of foodborne microbes; epidemiology of food-associated organisms; risk assessment methods and data; food handling, distribution, and storage; and economic analysis. For each category, the report also identifies needs and opportunities for further research related to enhancing the safety of the food supply.

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