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# *ERS Staff Paper*

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Economic  
Research  
Service

Food and  
Consumer  
Economics  
Division

Number 9506

## **Economic Issues Associated with Food Safety**

United States  
Department of  
Agriculture



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**Economic Issues Associated with Food Safety.** Food and Consumer Economics Division, Economic Research Service, U.S. Department of Agriculture. Staff Paper No. AGES 9506.

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### Abstract

This document outlines, in graphs and figures, ERS research findings about the incidence and costs of foodborne illness in meat and poultry, and exposure to pesticide residues on fresh fruit and vegetables. It was prepared as a briefing for staffs of the House and Senate Agriculture Committees.

**Keywords:** foodborne illness, microbial pathogens, cost of illness, pesticide residues

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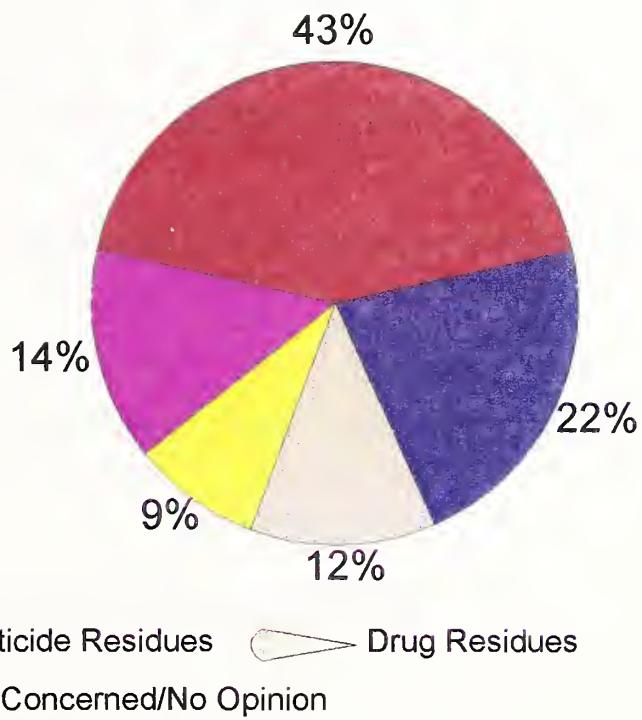
# Outline of Briefing

- ▶ Introduction
- ▶ Foodborne Pathogens in Meat and Poultry
  - Incidence of Illness
  - Medical and Productivity Costs
- ▶ Pesticide Residues in Fruits and Vegetables
  - Health Risk and Consumer Behavior
  - Sources of Residues
- ▶ Conclusions



# "Which Food Safety Issue Concerns You the Most?"

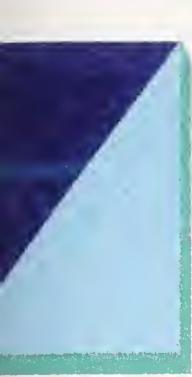
Survey Results from USDA/ARS Diet and Health Knowledge Survey of primary meal planners or preparers in 1,925 households in 1991.



Source: USDA/ARS Diet and Health Knowledge Survey, 1991

- ▶ The 1991 USDA/ARS Diet and Health Knowledge Survey is a nationally representative survey of primary meal planners or preparers in 1,925 households.
- ▶ Respondents were asked "Some people are more concerned about food safety than others. Which one of the following issues, if any, concerns you the most?"
- ▶ Bacteria and parasites in food and pesticide residues on fruits and vegetables were the two most frequently cited concerns.



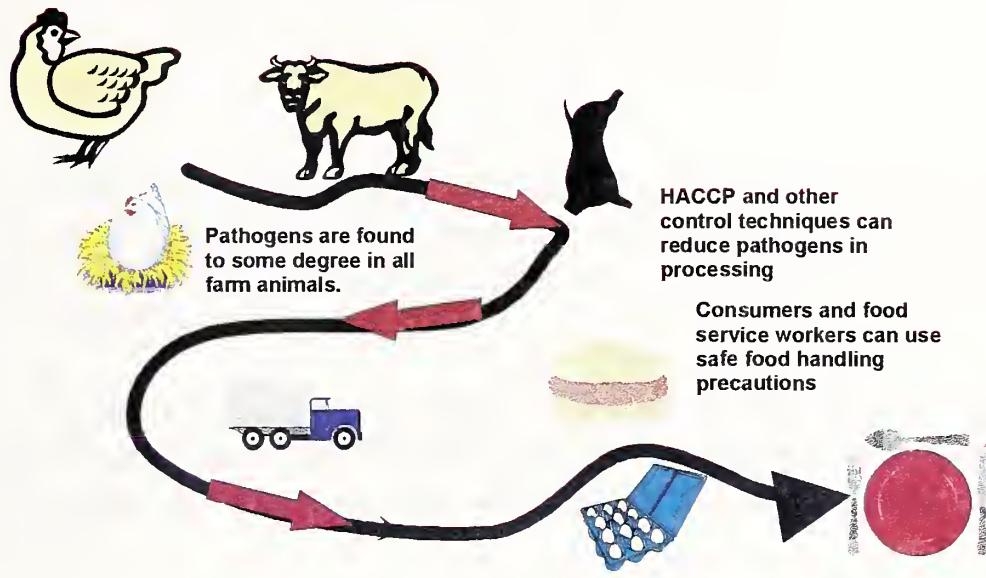


## Food Safety Concerns Flow from Market Imperfection

- ▶ Consumers lack adequate information about food safety
- ▶ Market forces may lead to less-than-optimal levels of food safety
- ▶ Regulation to improve food safety may raise producer costs and food prices
- ▶ The benefits of safer food can be significant
- ▶ Economic research measures costs and benefits



# Pathogens Can Be Controlled at Many Points in the Food Chain



- ▶ Pathogens are found to some degree in all farm animals, but most animal pathogens do not cause human illness.
- ▶ Pathogens may also be introduced to meat and poultry products in slaughter plants, in processing plants, in grocery stores or food service establishments, and at homes. Examples of where pathogens can enter the food chain are through feeds, manure management, processing procedures, or equipment and facility sanitation.





## Pathogens Can Be Controlled ... (cont'd)

- ▶ Improper operating procedures and food handling practices cause pathogens to survive and grow which in turn increases the risk of foodborne illness. Among the most frequent problems are inadequate cooking, inadequate cooling, and improper personal hygiene.
- ▶ Examples of control measures include the Hazard Analysis and Critical Control Point (HACCP) approach during animal and food production, and better food handling practices by meal preparers at homes and in food service establishments.
- ▶ USDA is pursuing a broad, long term science-based strategy to improve the safety of meat and poultry products and better protect public health in its recent HACCP proposal. This proposal focuses on setting clearly defined public health-oriented standards that all federally inspected meat and poultry plants must meet. Plants would be responsible for microbial testing of their products to ensure proper process control and verify achievement of microbial limits. This strategy should foster technological innovation by allowing each plant to select the most cost-effective way for it to comply with the public health standard.
- ▶ Economic analysis of the costs and benefits of alternative ways to improve food safety is useful to firms in the industry and policy makers.



# Cases of Foodborne Illness for Selected Pathogens, 1993

	Cases	Deaths
<b>Bacteria</b>		
<i>Salmonella</i>	732,000 - 3,660,000	732 - 3,360
<i>Campylobacter jejuni or coli</i>	1,375,000 - 1,750,000	110 - 511
<i>Staphylococcus aureus</i>	1,513,000	1,210
<i>E. coli O157:H7</i>	8,000 - 16,000	160 - 400
<i>Clostridium perfringens</i>	10,000	100
<i>Listeria monocytogenes</i>	1616 - 1674	401 - 459
<b>Parasite</b>		
<i>Toxoplasma gondii</i>	2,056	41
<b>Total</b>	<b>3,641,672 - 6,952,730</b>	<b>2,754 - 6,381</b>

Source: Roberts, Buzby, Et. Al, 1994

- ▶ The Centers for Disease Control and Prevention (CDC) and FDA estimate that, each year, between 6 and 33 million people become ill from pathogens in their food; of these, 6,000 to 9,000 die. These estimates may differ from actual numbers because many illnesses are never reported or are not linked to specific foods or pathogens.
- ▶ *Salmonella* and *Campylobacter Jejuni or coli* are the two major pathogens that cause foodborne illness.
- ▶ Illness caused by *Salmonella* is frequently associated with chicken and egg consumption. Symptoms generally occur 6 - 48 hours after eating contaminated food and can last from days to weeks. Acute symptoms include abdominal pain, diarrhea, nausea, stomach ache, vomiting, cold chills, fever, exhaustion, and bloody stools. Endocarditis (infection of the heart), meningitis (infection of the brain tissues), and pneumonia may follow the acute stage. The pathogen can also cause chronic consequences such as rheumatoid syndromes, reactive arthritis, and Reiters' syndrome. Death may result from the illness.
- ▶ Illness caused by *Campylobacter* has been linked to chicken consumption. Symptoms usually begin in 1-7 days after exposure to contaminated food and can last for days. These symptoms include malaise, diarrhea, abdominal pain, bleeding, and fever. Other complications may follow, such as meningitis, arthritis, cholecystitis, urinary tract infection, appendicitis, septicemia, Reiters' syndrome, and Guillain-Barre Syndrome (GBS) - a major cause of non-trauma related paralysis in the U.S. A small proportion of patients die.



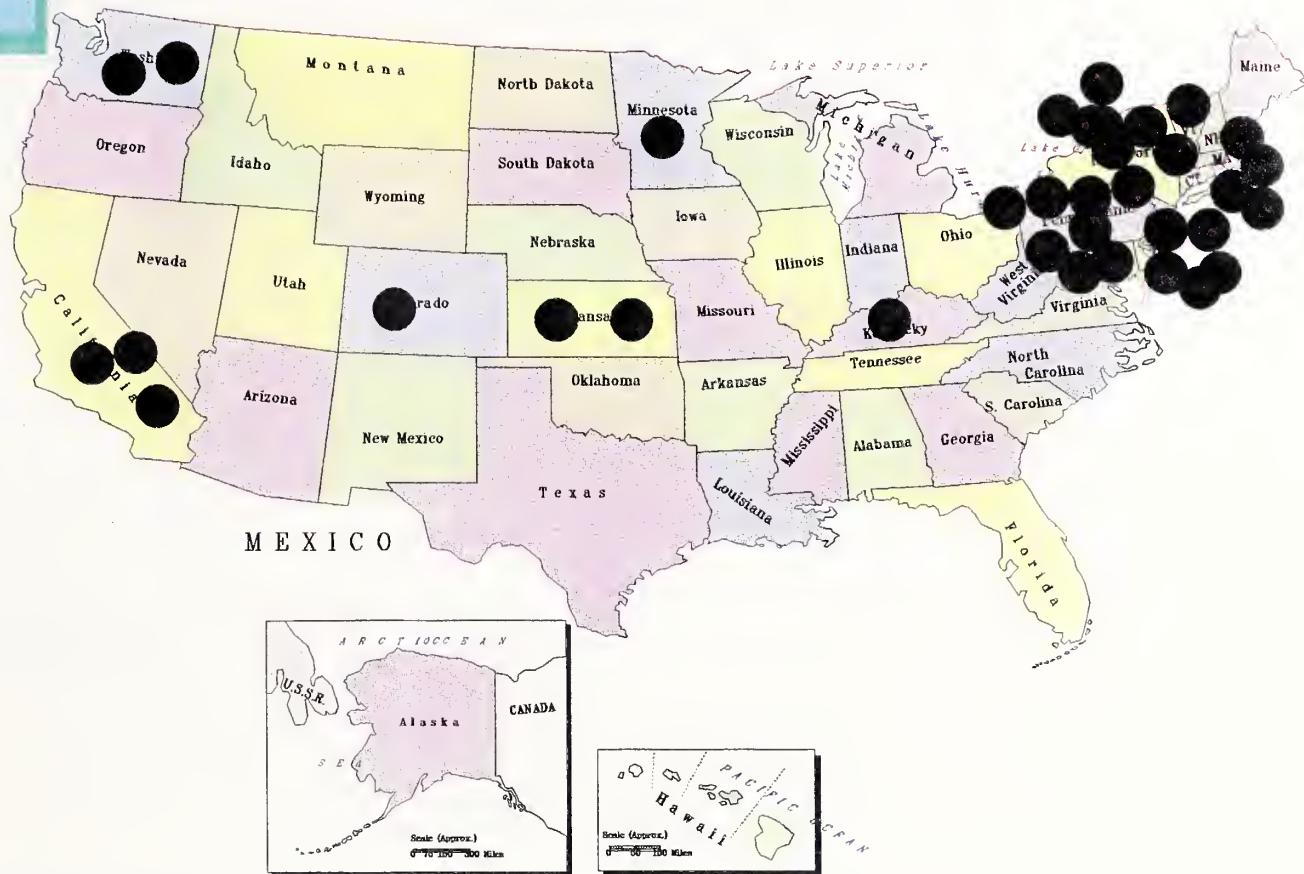


## Cases of Foodborne Illness ... (cont'd)

- ▶ To obtain a more accurate and complete picture of foodborne illness, collaboration is needed to gather representative and comprehensive data, including sporadic illness, chronic consequences, and identification of food sources and pathogens.
- ▶ A proposal by USDA/FSIS and CDC to estimate the number of diarrheal illness due to bacterial foodborne pathogens and to estimate the proportion of specific illnesses attributable to meat and poultry exemplifies the efforts needed to collect better data.



# Salmonella enteritidis Outbreaks, 1994

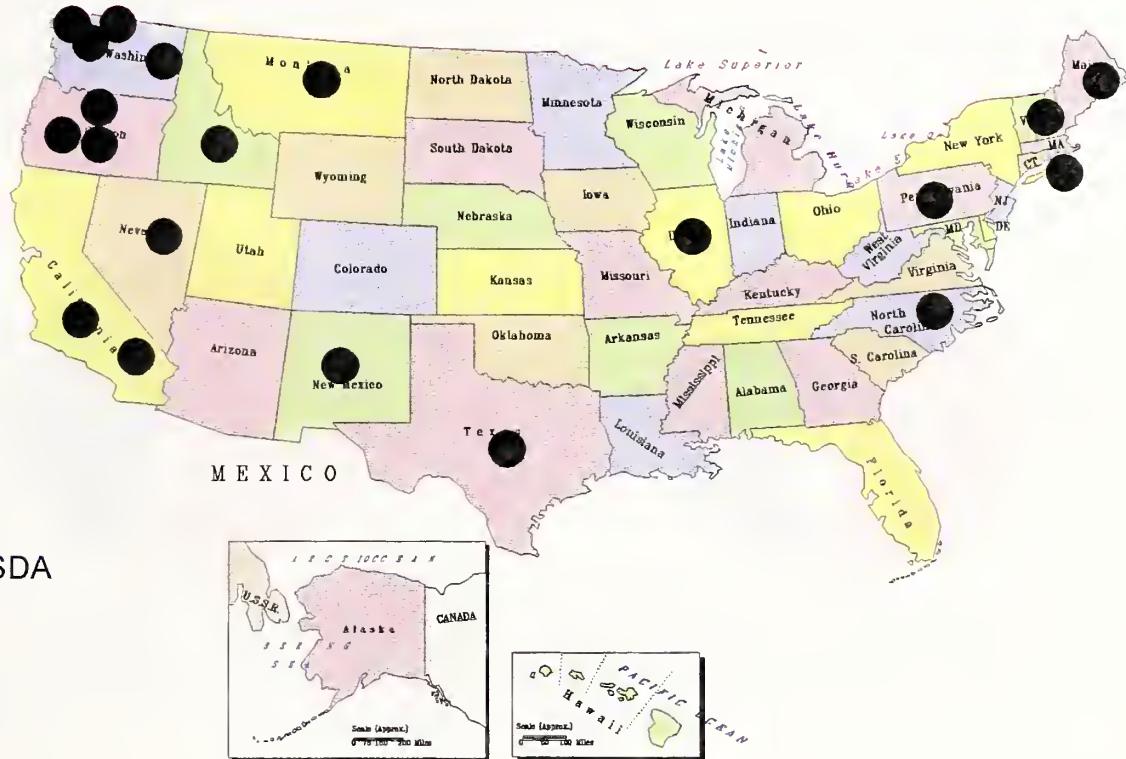


Source: USDA

- ▶ The number of foodborne salmonellosis outbreaks has risen significantly since the 1970's. An outbreak is an incident in which two or more persons experience a similar illness after ingestion of a common food as the source of the illness.
- ▶ *Salmonella enteritidis*, a new strain among the 2,000-plus *Salmonella* serotypes, can be passed to eggs before shell formation occurs if the hen is infected. *Salmonella enteritidis* can also spread within a flock through chicken-to-chicken contact and through contact with feed, equipment, rodents, flies, animals, and human beings.
- ▶ Fresh shell eggs and their products can be contaminated with *Salmonella enteritidis*. Home-made foods containing fresh eggs (e.g., ice cream, egg nog, Caesar salad, mayonnaise, Hollandaise sauce) are potentially risky.



# *E. coli* 0157:H7 Outbreaks, 1993



Source: USDA

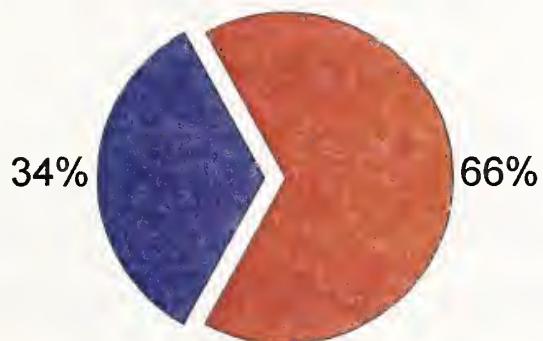
- ▶ *E. coli* O157:H7 is one of many *E. coli* strains; it was not identified until 1982.
- ▶ In 1993, several hundred people in West coast states fell sick and a few even died from *E. coli* O157:H7 present in restaurant-prepared hamburgers. The pathogen has also been found in raw milk, unpasteurized apple cider, processed sausage products, and home-prepared hamburgers.
- ▶ It takes 3-7 days before symptoms occur after eating contaminated foods. Acute symptoms, lasting 6 to 8 days, are diarrhea (often bloody), abdominal pain, fever, vomiting, and neurological complications. Chronic consequences include hemolytic uremic syndrome (HUS) which is characterized by kidney failure and strikes mostly children under 5 years of age. Some proportion of patients will die.



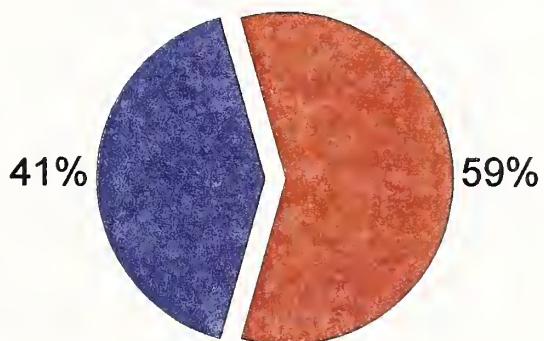
# More Food Dollars Are Being Spent Away from Home

Percentage of Food Dollars Spent for Food At Home

1970



1993



At Home

Away From Home

Source: USDA/ERS

- ▶ The growth in consumption of food away from home reduces consumer control over food preparation, which is the final control point to prevent foodborne illness.





## The Elderly, Pregnant Women, and Infants Are Most At Risk

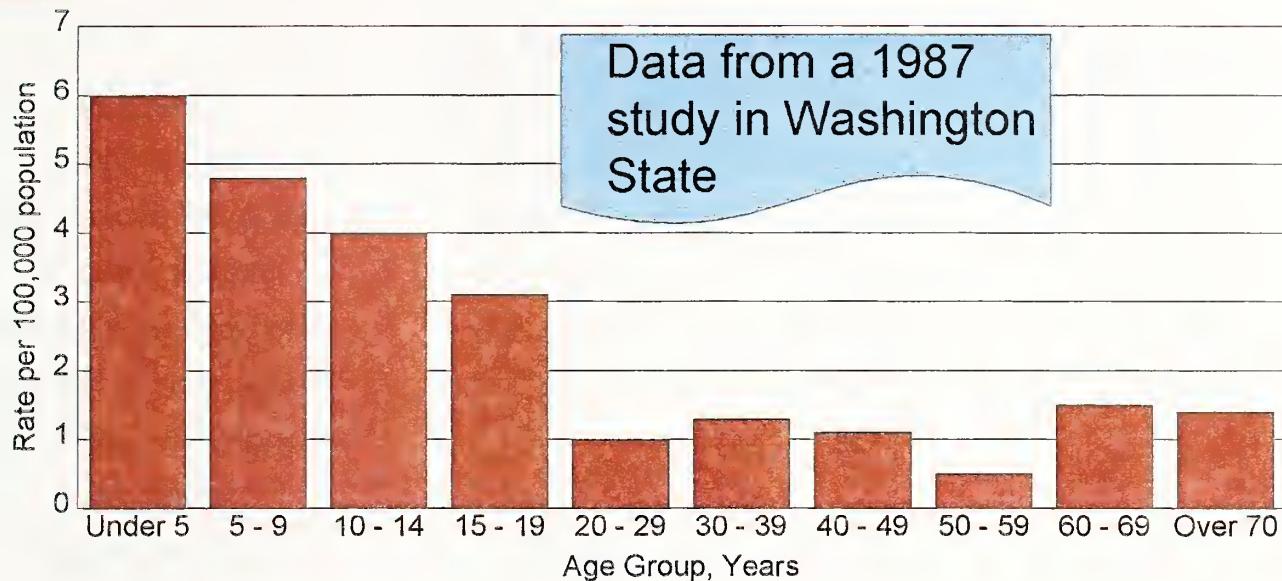
	Individuals
Elderly	29,400,000
Pregnant Women	5,657,900
Neonates	4,002,000
Cancer patients	2,411,000
Nursing Home Residents	1,553,000
Organ Transplant Patients	110,270
AIDS Patients	135,000

Source: US Department of Health and Human Services, 1993

- ▶ Certain population subgroups are more susceptible to the risk of foodborne illness than others. These subgroups include the elderly, pregnant women, children under the age of 1, nursing home residents, and people with compromised immune systems such as cancer patients, organ transplant patients, and AIDS patients.
- ▶ Elderly individuals undergo a decrease in immune function. The immune system of neonates is not yet fully developed. Pregnancy puts a woman and her fetus at special risk of foodborne illness caused by pathogens such as *Listeria monocytogenes* and *Toxoplasma gondii*; miscarriage, stillbirth, or fetal abnormality may occur.



# Age-specific Rates of Infection with *E. coli* 0157:H7



Source: Ostroff, et. al, 1989



# Foodborne Illness Costs from Seven Major Pathogens are \$5-\$9 billion per year

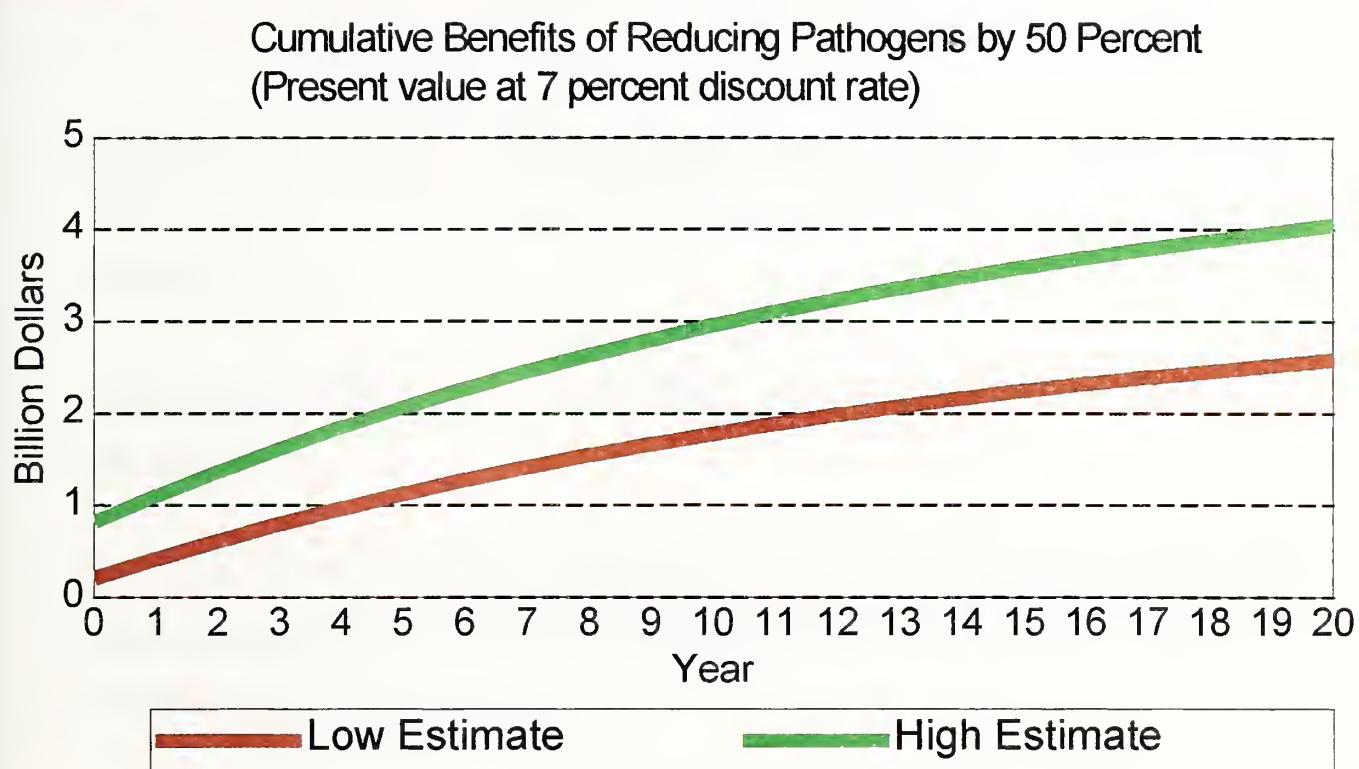
	All Foods	Pct. Meat/Poultry	Meat/Poultry
<b><u>Bacteria</u></b>	\$ Billion (1993)	%	\$ Billion (1993)
<i>Salmonella</i>	0.6 - 3.5	50 - 75	0.3 - 2.6
<i>Campylobacter jejuni or coli</i>	0.6 - 1.0	75	0.5 - 0.8
<i>E. coli O157:H7</i>	0.2 - 0.6	75	0.2 - 0.5
<i>Listeria monocytogenes</i>	0.2 - 0.3	50	0.1 - 0.2
<i>Staphylococcus aureus</i>	1.2	50	0.6
<i>Clostridium Perfringens</i>	0.1	50	0.1
<b><u>Parasite</u></b>			
<i>Toxoplasma gondii</i>	2.7	100	2.7
<b>Total</b>	5.6 - 9.4	n/a	4.5 - 7.5

Source: Roberts, Buzby, et. al., cited in Federal Register, Vol 60, No. 23, 2/3/95

- ▶ Foodborne illnesses from a few selected pathogens cost society at least \$5.6 to \$9.4 billion annually in medical costs and lost productivity. Foodborne illnesses from meat and poultry account for \$4.5 to \$7.5 billion of these estimated costs.
- ▶ The costs of illness include medical costs and lost productivity.
- ▶ Medical costs are expenses to treat the illness such as physician and hospital services, supplies, medications, long-term care or rehabilitation, and special procedures required for specific foodborne illness.
- ▶ Another component of the costs of illness is the lost productivity when workers are unable to perform their jobs or will not be able to function fully in the future. The largest proportion of this component reflects society's lost productivity from premature deaths, especially in young children. Time spent by parents caring for sick children, as well as by paid caretakers, is included as foregone productivity. Data are from the Bureau of Labor Statistics and the Bureau of the Census.



# Reducing Pathogens in Meat and Poultry Generates Benefits over Time



- ▶ Society benefits from increased productivity and resources made available when pathogens and illnesses are reduced. The benefits could be significant over time if pathogen levels could be lowered permanently.
- ▶ For example, suppose pathogen levels of *Salmonella*, *Campylobacter*, *E. coli* O157:H7, and *Listeria monocytogenes* in meat and poultry could be reduced by 50 percent, and the associated costs of illness by the same percentage. Then, over 20 years, ERS estimates the total benefits would be \$3 - \$4 billion in 1994 dollars. The value of money is discounted at 7 percent, the OMB-recommended discount rate.
- ▶ These benefits must be weighed against the costs to producers, processors, and consumers of reducing pathogen levels.





## Foodborne Pathogens: Conclusions

- ▶ Foodborne illness from meat and poultry cost society \$4.5 to \$7.5 billion annually in medical costs and lost productivity
- ▶ Pathogens can be controlled anywhere from the farm to the table
- ▶ HACCP is a proven approach to reducing foodborne pathogens and can be applied at any point in the production process
- ▶ USDA is pursuing a broad, science-based strategy to improve the safety of meat and poultry.



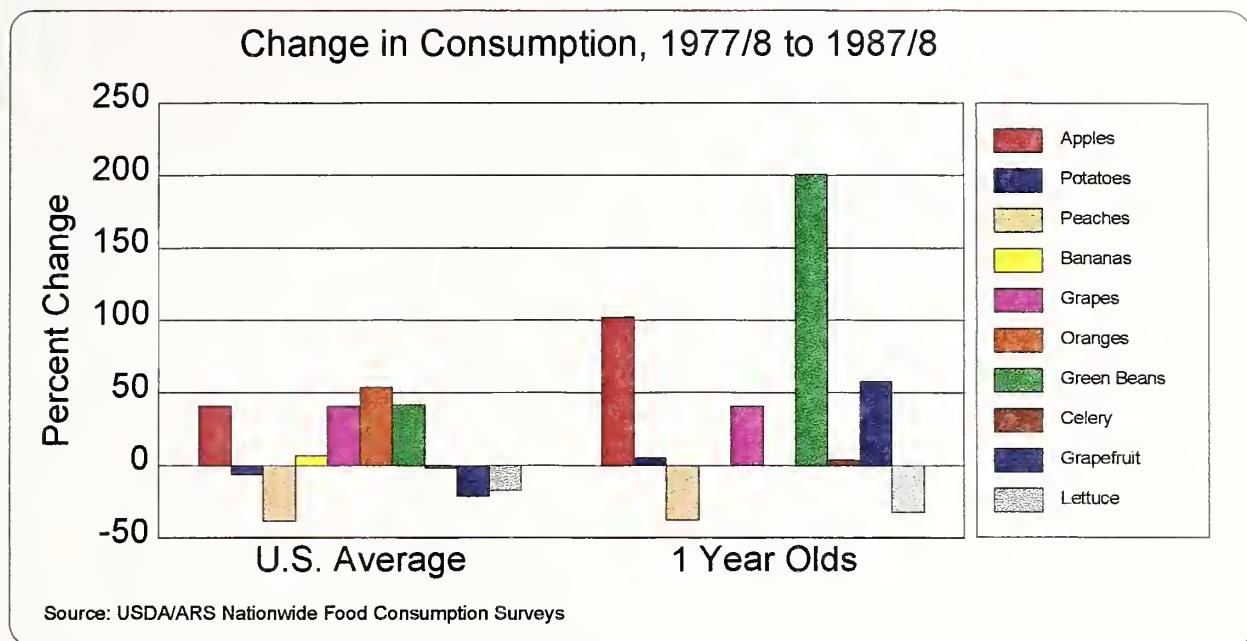


# Pesticide Residues on Fruits and Vegetables are Studied by USDA

- ▶ NASS collects *pesticide use* data
- ▶ AMS collects *pesticide residue* data for fruits and vegetables
- ▶ ERS studies *residue and use* data to help set priorities for pest control research by:
  - Ranking residues according to health risk,
  - Relating consumption to exposure,
  - Linking residue data with use data, and
  - Evaluating alternative pest control strategies



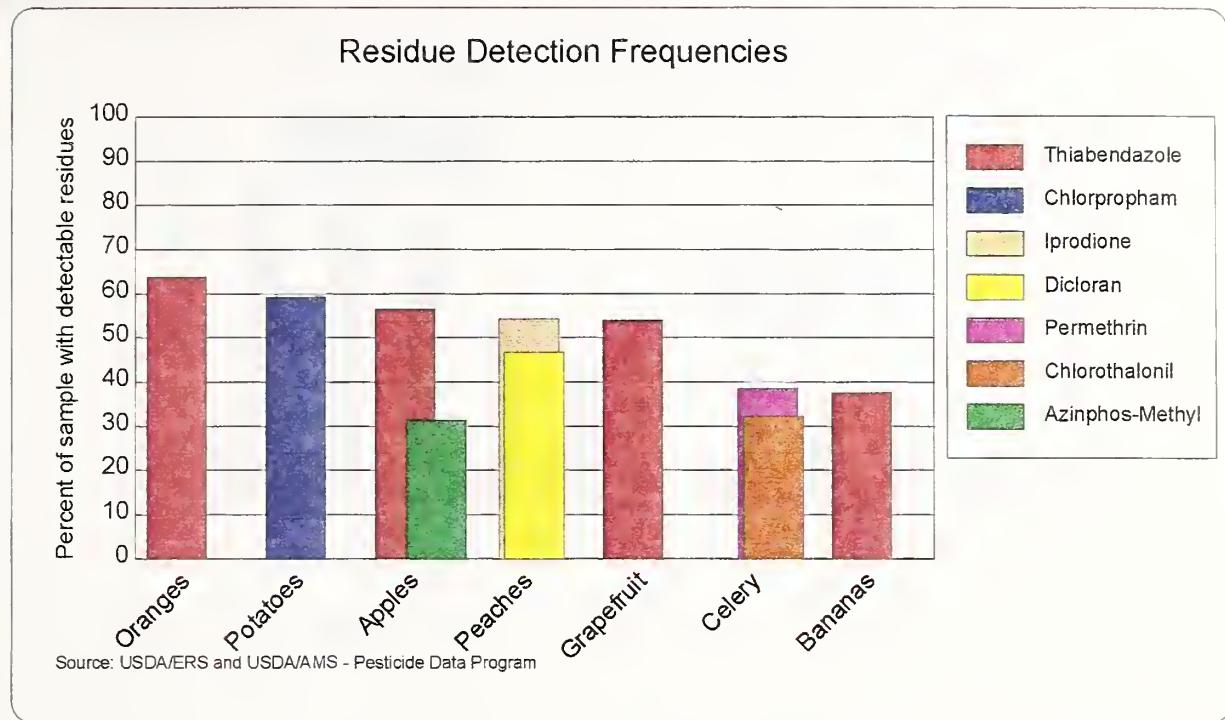
# Fruit and Vegetable Consumption Patterns May Be Changing



- ▶ Estimates are based on USDA's 1987-88 and 1977-78 Nationwide Food Consumption Surveys.
- ▶ Consumption of each commodity includes both fresh and processed forms, and includes the portion of each commodity consumed in mixtures and as ingredients in recipes. For example, apples includes fresh apples, apples consumed in pastries, dried apple pieces in instant oatmeal, apple juice, apple juice used in mixed beverages, etc.
- ▶ Estimates for children are subject to a higher variance due to the small sample of children in each one-year cohort.
- ▶ Other data and analyses show that diets are changing. ERS analysis of trends in food disappearance shows that fresh fruit consumption increased 19 percent over the 1977-87 decade, with most of the change occurring in the mid-1980's.
- ▶ Dietary exposure to pesticide residues depends upon consumption patterns and residue levels. Changing consumption can result in changes in dietary exposure.



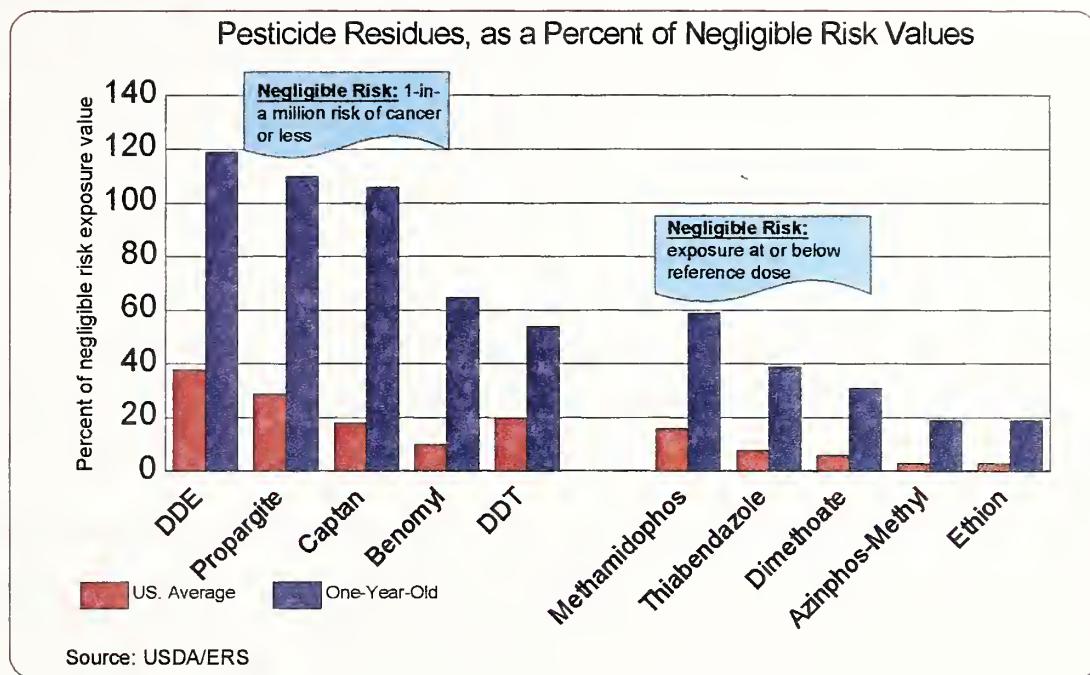
# Ten Most Frequently Detected Pesticides



- ▶ For 23 pesticide-commodity pairs, average residues ranged from 1-12 percent of tolerance (legal limit for residues); all others were less than 1 percent. Approximately 1 percent of samples appeared to violate legal tolerances.
- ▶ Detection rates exceeded 30 percent for ten pesticide-commodity pairs out of nearly 500 pesticide-commodity pairs. Most detection rates were substantially lower.
- ▶ The six largest detection frequencies were the result of post-harvest treatments.
- ▶ AMS uses state-of-the-art testing and lowest possible limits of detection. Testing laboratories treated samples as consumers would: washing, peeling, and coring samples as appropriate before measuring residues.
- ▶ ***Detections are not equivalent to risk.*** Detections only indicate the presence of a residue. Any health implications are determined by dietary exposure and the residue's toxicological properties.



# Pesticide Residue Levels Appear to Pose Very Low Risks



- While these values appear low, the percent of negligible risk exposure value for an individual pesticide is not intended as a quantitative estimate of risk; such estimates would require a much more detailed investigation. It is a qualitative indicator for use in comparing pesticide residues and identifying risk reduction priorities.
- Estimates for children are subject to greater uncertainty due to the small sample of children in each one-year cohort. Additional data on children's diets will contribute to more precise estimates of dietary intake of pesticide residues for children.
- The left side shows exposure values for pesticides classified as possible or probable carcinogens. The right side shows pesticides for which very low levels of exposure cause no ill effect.
- For residues of possible or probable carcinogens, a value of 100 percent is equivalent to a 1-in-1,000,000 cancer risk. (The background risk of cancer is 1 in 4.) For other residues, a value of 100 percent is equivalent to exposure at the reference dose established by EPA.



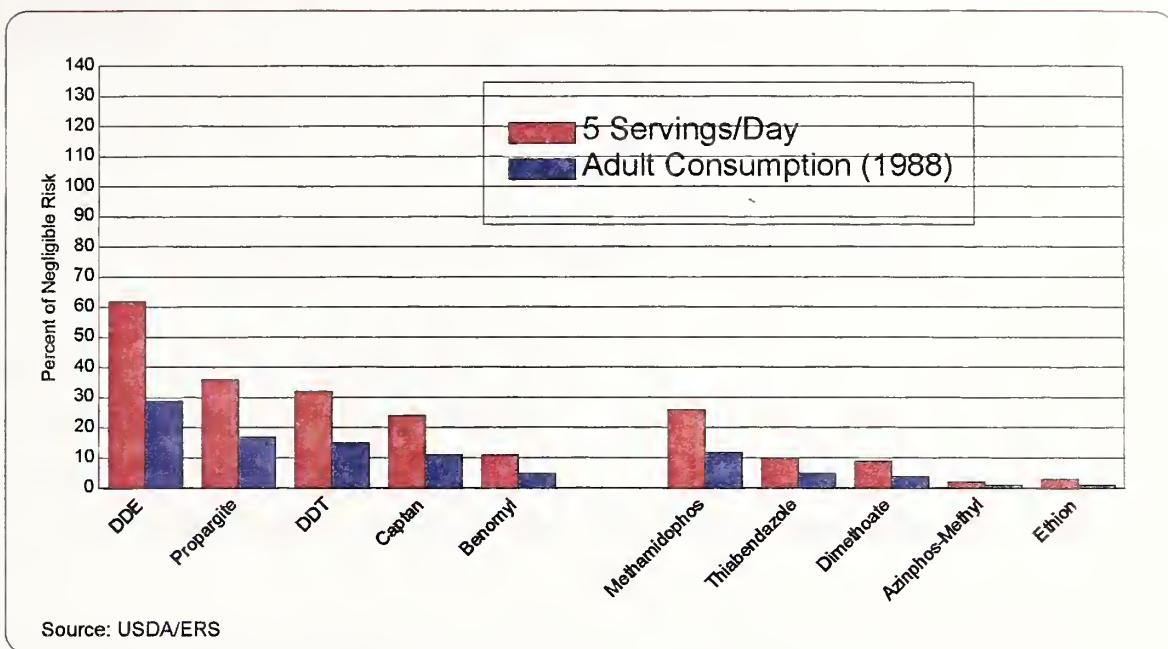


## Pesticide Residue Levels ... (cont'd)

- ▶ These are the 5 pesticides in each category with the highest percent of negligible risk exposure values. Values for the 40 residues not shown are all below 20 percent for both the average consumer and one-year-olds.
- ▶ These results represent consumption of the 10 commodities analyzed by AMS in 1992: apples, bananas, celery, grapes, grapefruit, green beans, lettuce, oranges, peaches, and potatoes. Estimates assume that all residues are carried through in processing with changes in concentration only due to removal of water.



# Eating Five Servings Per Day Poses Low Health Risk



- ▶ Estimates assume an adult over 18 years old with average body weight of 158 lbs. consumes a total of 5 servings of 10 commodities analyzed by AMS. The "5 a day" consumption proportionately scales up the average adult consumption of these commodities from 1987-88 levels.
- ▶ The "5 A Day for Better Health" program is the first national health promotion program to focus on the benefits of daily fruit and vegetable consumption. The program has been jointly promoted by the National Cancer Institute and the Produce for Better Health Foundation, representing the fruit and vegetable industry. Its goal is to increase per capita consumption of fruits and vegetables to 5 servings daily by the year 2000, based on The Dietary Guidelines for Americans issued jointly by USDA and DHHS. It attempts to increase public awareness of the health benefits of 5 servings and to provide consumers with information about incorporating more fruits and vegetables into daily eating patterns.





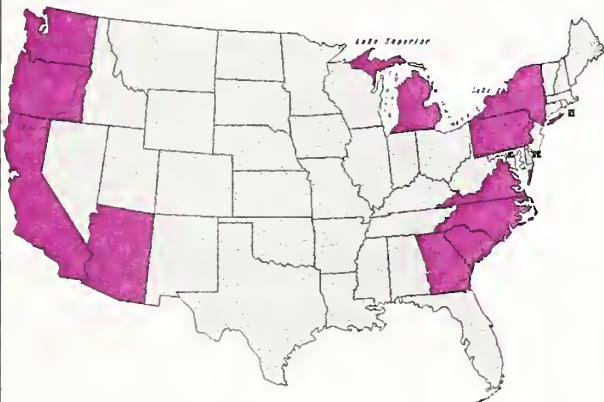
# Pesticide Residues Come From Several Sources

- ▶ Residues on fruits and vegetables come from:
  - Domestic use in production,
  - Domestic use post-harvest,
  - Imported foods, and
  - Banned chemicals which persist in the soil
- ▶ DDT and its degradation product DDE persist in the environment. DDT was banned in 1972.
- ▶ Most dietary exposure is not a result of domestic, on-farm use



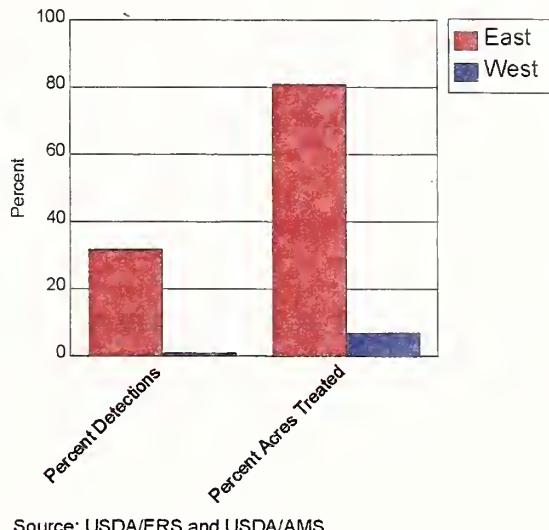
# Detection of Pesticide Residues Mirrors Use

Apple Producing States Surveyed by USDA/NASS



Source: USDA/ERS and USDA/AMS

Captan on Apples: Detections and Acres Treated



Source: USDA/ERS and USDA/AMS

- ▶ ERS research indicates that residue detections mirror pesticide use for nine pesticides (acephate, azinphos-methyl, benomyl, captan, chlorothalonil, dimethoate, ethion, methamidophos, and permethrin) on five commodities (apples, celery, green beans, lettuce, and peaches).
- ▶ For most commodity-pesticide pairs, all residues were below the limits of detection and were therefore unsuitable for attempts to link residues and use.





## Pesticide Residues: Conclusions

- ▶ Pesticide residues of 50 chemicals on 10 fruits and vegetables pose very low health risks, even for consumers who eat five servings per day.
- ▶ Children's dietary exposure to many residues is higher than adults'. More information is needed about children's diets.
- ▶ Most of the dietary exposure does not come from domestic on-farm pesticide use. Other sources are imports, post-harvest use, and persistent banned chemicals.
- ▶ Where residues are a result of on-farm use, detection rates mirror regional use patterns.





## Conclusions

- ▶ Pathogen-related illnesses from meat and poultry cost the U.S. \$4.5 - \$7.5 billion per year. Reducing pathogens would have substantial benefits.
- ▶ Dietary risk from some pesticide residues on fresh fruits and vegetables appears very low. Most exposure is not a result of on-farm domestic use.
- ▶ ERS continues to study the costs and benefits of food safety to help set priorities to reduce risk and illness.



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