Understanding the Links between Agriculture and Health

Agriculture, Food Safety, and Foodborne Diseases

Ewen C. D. Todd and Clare Narrod

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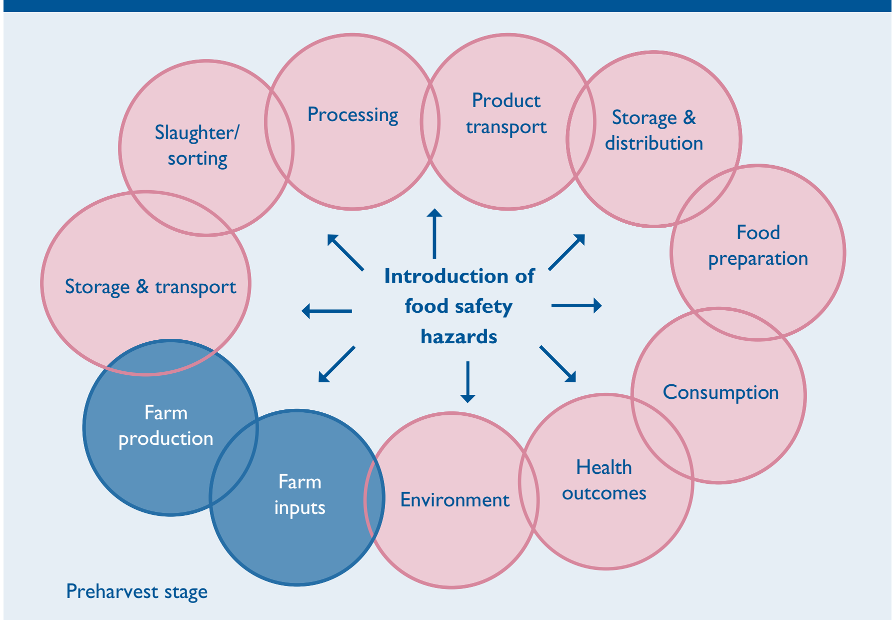
Millions of adults and children suffer from the ill-health effects of foodborne diseases, especially in developing countries. Owing to erratic surveillance systems, estimates of the burden of foodborne diseases are inaccurate and most likely too low. Official reports indicate relatively small numbers of reported cases. The World Health Organization estimates that annually 1.8 million people worldwide (excluding China), most of whom are children, died from diarrheal diseases caused by microbial agents largely attributed to contaminated food and water.

In earlier times, the risks of foodborne illnesses were mitigated by cooking and eating foods immediately or preserving them through fermentation, drying, or cooling. Food supply chains are now more complex, thus increasing the number of potential points of contamination from farm to table (see figure). Agricultural production and the inputs into that production—the preharvest stage—are important potential points of contamination. Owing to globalization, food contaminated on one farm can now cause multiple outbreaks all over the world.

Potential Points of Contamination with Food Safety Hazards along the Farm-to-Table Food Supply Chain



RISKS IN AGRICULTURAL PRODUCTION PRACTICES

Foodborne illnesses stem from a wide variety of microbiological and chemical hazards, many of which are introduced during agricultural production. Microbiological contaminants include bacteria, viruses, and parasites, while chemical contaminants include natural toxicants such as mycotoxins and environmental hazards such as mercury. The ingestion of certain pesticides and antibiotics accumulated in food is also thought to pose health risks. The safety of genetically modified foods has been subject to much debate since they may contain allergens or toxins not found in conventional foods, although this has yet to be shown.

Notable agricultural sources of foodborne disease are zoonotic pathogens, pathogens from contaminated water, and mycotoxins. Zoonotic pathogens—pathogens transmitted from animals to humans—are the most common cause of foodborne diseases. In recent decades several serious zoonotic diseases have emerged—*Salmonella* Enteritidis and *Campylobacter* from poultry; *Salmonella* Newport, *E. coli* O157:H7, and bovine spongiform encephalopathy (BSE) from cattle; the severe acute respiratory syndrome (SARS) virus originating from palm civet cats; and highly pathogenic avian influenza from ducks, geese, and chickens (see Brief 9). All of these risks are linked to animal production practices. Farm animals carry zoonotic pathogens in their gastrointestinal tracts, from where they spread to other animals, crops, and water. Intensified animal production, in which animals are kept at high densities, raises animals' risk of infection and thereby increases the risk that the pathogens will be passed to humans. Zoonotic pathogens can also enter the human food chain on crops treated with inadequately composted animal manure.

Another agricultural source of foodborne pathogens is contaminated water, such as inadequately treated or inappropriately applied wastewater, used in irrigation of horticultural crops. Of major concern are waterborne pathogens such as bacteria (*Shigella, E. coli, and Campylobacter*), viruses (such as hepatitis A and rotavirus), and parasites (such as *Giardia* and *Cryptosporidium*).

In tropical climates, staple crops, such as maize and groundnuts, can be the source of mycotoxins—highly toxic metabolites produced by a number of molds that grow on crops during conditions of drought stress, unseasonably high rains, or high moisture, as well as during and after harvest. One notable example is aflatoxin, which develops in drought-stressed maize and groundnuts and proliferates in crops stored in hot, humid conditions.

CONTROLLING FOODBORNE ILLNESS ON THE FARM

Preventing the transmission of foodborne hazards after the food leaves the farm is becoming more difficult owing to the high potential for cross-contamination during processing. Yet apart from basic hygiene practices, efforts to reduce food safety risks have paid little attention to the preharvest stage. The public and private sectors in many developed countries increasingly require the implementation of coordinated systems such as Hazard Analysis and Critical Control Point (HACCP) or Eurep GAP, but they have traditionally focused on processing. Now, however, more focus is being placed on identifying hazards at the preharvest stage to identify options for preventing hazards from entering the supply chain in the first place.

In some cases simple steps can reduce risks. For example, a recent intervention study in West Africa showed that the use of wooden pallets to store crops significantly reduced exposure among local populations. Other risks require far more complex interventions, particularly for zoonotic pathogens for which it is difficult to trace the agricultural point of origin. In the United States, the Centers for Disease Control and Prevention use a system called "PulseNet," which allows for molecular comparison of strains and can help identify the source of widely scattered cases. Still, the complexity of the food supply chain makes source identification a challenge.

Antimicrobial resistance is another challenge because efforts on the farm to control one strain may be ineffective against the development of new strains. Over the past decade, *Salmonella* strains with multiple drug resistance have been distributed widely in many countries. In 2000, 40 percent of 27,059 clinical isolates of *Salmonella* tested were resistant to at least one antimicrobial, with 18 percent exhibiting resistance to four or more antimicrobial agents. This is particularly difficult for developing countries where the supply chain is now often based on anonymous transactions in spot markets, implying limited communication and coordination between farmers, traders, and consumers.

RISK ANALYSIS AS A TOOL FOR REDUCING FOODBORNE ILLNESS

To aid in the evaluation of food safety risks and the effectiveness of potential ways to intervene, decisionmakers in some countries are increasingly relying on risk analysis as a tool to help them choose effective management strategies for many types of foodborne disease hazards. Risk analysis is a scientifically based process that identifies the source of the hazard, its characteristics, the health risks it poses, and the impacts of various control strategies.

In many cases, researchers have found that the outcome of risk assessments is driven by the preharvest prevalence of foodborne pathogens. A risk analysis conducted by the U.S. Department of Agriculture on *E. coli* O157:H7 in ground beef in the United States, for example, showed that the overall level of risk was driven by the preharvest load of *E. coli*. The analysis also showed that a combination of intervention procedures would be more effective than any one intervention in reducing contamination.

Likewise, a U.S. risk analysis of *Listeria monocytogenes* showed that a combination of intervention procedures was needed for effective intervention. In response to this analysis, many meat-processing plants made significant improvements to reduce risk, resulting in a gradual decrease in listeriosis.

CAPACITY IN DEVELOPING COUNTRIES

While risk analysis has proved an effective tool in developed countries, very few developing countries have the capacity to conduct such assessments. In general, developing countries lack the capacity to implement and monitor food safety protection systems. PulseNet, for example, is currently used by several other countries, but no developing countries. The supply chain in many developing countries is still often based on anonymous transactions in spot markets, implying limited communication and coordination between farmers, traders, and consumers. Given this lack of coordination, coupled with poor infrastructure and insufficient cold storage systems, market participants have little knowledge or incentive to reduce microbial pathogens and pesticide residues. Though at one time producers in LDCs were direct sellers of products in the market, the supply chain has now become longer, wider, and anonymous; institutions have not been developed to replace what a handshake could once achieve. Developing countries also tend to have weaknesses in their government public health systems, such as outdated food regulations, lack of capacity for compliance, and conflict between public health objectives and facilitation of trade and industry development.

Yet the need to prevent food safety hazards from entering the food chain is particularly important for developing countries since they suffer the greatest burden of foodborne disease. If small producers are to participate in global markets and take advantage of growing demand for highly perishable foods in developed countries, where food safety concerns are high, they will need greater capacity to implement food safety protection systems. Although most food safety research and management practices have been designed for and applied to developed countries, these approaches can be successfully transferred to developing countries provided there is sufficient local data.

MOVING FORWARD

To improve the ability of farmers in developing countries to reduce the burden of foodborne illness, government agencies need to take the following steps:

- ***Implement a farm-to-table approach*** to agricultural health by focusing efforts on the prevention of potential food safety and agricultural health threats at all stages of the supply chain including production, processing, marketing, and retailing.
- ***Raise awareness*** among decisionmakers, public servants, producers, traders, and consumers about the potential sources of food safety problems and ways to protect against such problems. Encourage a multi-stakeholder approach to improving public health.
- ***Strengthen surveillance and diagnostic capacity*** in all countries to improve measurement of prevalence and detection of outbreaks.
- ***Strengthen risk analysis capacity*** to help decisionmakers in all countries to set strategies and priorities, to consider the many needs of the supply chain, and to increase their focus on the preharvest stage.
- ***Switch from command-control policies to performance-based standards*** to meet national and international food safety goals. Command-control policies are often less flexible and have higher fixed costs, which may result in the displacement of poor producers from the market.
- ***Improve infrastructure and access to cold storage facilities*** to ensure the delivery of highly perishable foods to distant markets.
- ***Support efforts to improve supply chain management*** to improve food safety along the whole supply chain.■

For further reading see D. L. Gallagher, E. D. Ebel, J. R. Kause, *FSIS Risk Assessment for Listeria Monocytogenes in Deli Meats* (Washington, DC: Food Safety and Inspection Service, U.S. Department of Agriculture, 2003); T. Roberts, C. Narrod, S. Malcolm, and M. Modarres, "An Interdisciplinary Approach to Developing a Probabilistic Risk Analysis Model," in *Interdisciplinary Food Safety Research*, ed. N. Hooker and E. Murano (Boca Raton, FL: CRC Press, 2001); L. J. Unnevehr, ed., *Food Safety in Food Security and Food Trade* (Washington, DC: IFPRI, 2004); L. Unnevehr and N. Hirschorn, *Food Safety Issues in the Developing World* (Washington, DC: World Bank, 2000).

Ewen C. D. Todd (toddewen@cvm.msu.edu) is a professor at the National Food Safety and Toxicology Center, Michigan State University, East Lansing, Michigan. Clare Narrod (c.narrod@cgiar.org) is a research fellow at IFPRI.

International Food Policy Research Institute **www.ifpri.org**
2033 K Street, N.W. • Washington, D.C. 20006-1002 • U.S.A.
Phone: +1-202-862-5600 • Fax: +1-202-467-4439 • Email: ifpri@cgiar.org