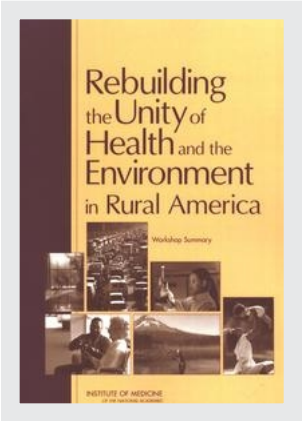

Rebuilding the Unity of Health and the Environment in Rural America: Workshop Summary

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Rebuilding the Unity of Health and the Environment in Rural America

Workshop Summary

James Merchant, Christine Coussens, and Dalia Gilbert, *Editors*

Roundtable on Environmental Health Sciences, Research, and Medicine

Board on Population Health and Public Health Practice

INSTITUTE OF MEDICINE
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This summary is based on the proceedings of a workshop that was sponsored by the Roundtable on Environmental Health Sciences, Research, and Medicine. It is prepared in the form of a workshop summary by and in the names of the editors, with the assistance of staff and consultants, as an individually authored document.

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Willing is not enough; we must do."
—Goethe

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Paul Lasley, Professor and Chair of the Department of Sociology**,** Iowa State University, Ames

David Riley, Program Coordinator, Center for Health Effects of Environmental Contamination, University of Iowa, Iowa City

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the final draft of the report before its release. The review of this report was overseen by **Melvin Worth, M.D.,** Scholar-in-Residence, Institute of Medicine, who was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

Preface

Throughout much of its history, the United States was predominantly a rural society. The need to provide sustenance resulted in many people settling in areas where food could be raised for their families. Over the past century, however, a quiet shift from a rural to an urban society occurred, such that by 1920, for the first time, more members of our society lived in urban regions than in rural ones. This was made possible by changing agricultural practices. No longer was it necessary for each individual to raise his or her own food, and the number of person-hours and acreage required to produce food has steadily been decreasing because of technological advances.

The result has been a changing rural landscape: once dotted with small family farms, the landscape is now being replaced by larger-scale operations. For better or for worse, the reality is that agribusiness has firmly taken over the traditional family farm. The good news is that through research we have learned about pesticide and chemical applications, so that our ecological footprint is now smaller. The bad news is that considerable research on new technological advances (e.g., contained animal feeding operations) and their impacts on human health is still needed.

As people have moved from the farm to the city, the demographics of the rural population have changed. Currently, the rural population tends to be older and poor, and lacks access to adequate health care coverage or services. Although the common perception has been that most people living in rural America are farmers, the reality is that only a small percentage of individuals living in rural regions are farmers. The majority commute to jobs in neighboring cities. In fact, often one or both spouses living on a traditional family farm are often employed at a job away from the farm.

Like many regions in the country, environmental health is a large concern for individuals in rural areas. Whether it is related to preserving the natural environment, addressing adequate housing, providing safe drinking water, protecting migrant workers' health, or creating a healthy social environment, the environ-

ment in which people live influences the status of their health. The population living in rural America (collectively across the United States) makes up a significant proportion of the U.S. population, and its environmental health concerns are distinct, although those concerns do have some overlap with those of the rest of the population.

The Institute of Medicine's Roundtable on Environmental Health Sciences, Research, and Medicine held a regional workshop at the University of Iowa on November 29 and 30, 2004, to look at rural environmental health issues. This workshop was a continued outgrowth from the Roundtable's first workshop, at which its members realized that the challenges facing those in the field of environmental health could not be addressed without a new definition of environmental health—one that incorporates the natural, built, and social environments.

The Roundtable chose to focus this workshop on rural America and concentrated on Iowa as the basis of its discussions. The members of the Roundtable realized that rural America is not homogeneous and that the environmental health challenges in one region of the United States may not be the challenges in other areas of the country. Water was one example, as some regions of the country face problems with water quality issues while other rural regions are experiencing drought conditions. This workshop was not meant to cover environmental health in all rural areas in depth but was conducted to obtain an overview of some of the key environmental health concerns in rural America by using the Midwest as a starting point for discussion.

Early in the planning process, Roundtable members realized that the process of engaging speakers and developing an agenda for the workshop was an important part of the enterprise. In their efforts to encourage the participation of a breadth of participants, the Roundtable members sought the input of individuals from diverse fields—industry, health care, foundations, environmental groups, government, citizen groups, and others. Their input helped shape the agenda. We would like to thank these individuals for their contributions to making this meeting a success.

This workshop summary captures the two-day meeting discussions where the speakers and participants identified areas in which additional research was needed, the processes by which changes could occur, and the gaps in our knowledge. Although the Roundtable defines environmental health in broad terms, not all aspects of environmental health could be discussed in their entirety during the limited time of the meeting. The views expressed here do not necessarily reflect the views of the Institute of Medicine, the Roundtable, or its sponsors.

James Merchant, M.D., member
Roundtable on Environmental Health
Sciences, Research, and Medicine

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Summary*

Throughout much of its history, the United States was predominantly a rural society. The need to provide sustenance resulted in many people settling in areas where food could be raised for their families. Over the past century, however, a quiet shift from a rural to an urban society occurred, such that by 1920, for the first time, more members of our society lived in urban regions than in rural ones. This was made possible by changing agricultural practices. No longer must individuals raise their own food, and the number of person-hours and acreage required to produce food has steadily been decreasing because of technological advances, according to Roundtable member James Merchant of the University of Iowa.

The Institute of Medicine's Roundtable on Environmental Health Science, Research, and Medicine held a regional workshop at the University of Iowa on November 29 and 30, 2004, to look at rural environmental health issues. Iowa, with its expanse of rural land area, growing agribusiness, aging population, and increasing immigrant population, provided an opportunity to explore environmental health in a region of the country that is not as densely populated. As many workshop participants agreed, the shifting agricultural practices as the country progresses from family operations to large-scale corporate farms will have impacts on environmental health.

WHAT IS ENVIRONMENTAL HEALTH?

According to the World Health Organization (WHO), environmental health is defined as "those aspects of human health, including quality of life, that are

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determined by interactions with physical, chemical, biological and social factors in the environment" (WHO, 1986). Thus, environmental health focuses on the quality of life and not simply on the absence of disease, and all the factors that contribute to environmental health, including the environment, are assessed when the environmental health of a population or region is evaluated. The definition of environmental health has evolved with research; therefore, the goals of environmental health should be to establish and maintain a healthy environment, to promote an environment that improves well-being both in function and in structure, and to allow the environment to be sustainable, said Roundtable member Donald Mattison of the National Institutes of Health.

Rural America faces challenges such as poverty and isolation, limited access to health care, increasing prevalence of obesity, exposure to hazardous air and water pollutants, farm injuries, and a shrinking demographic.

WHAT IS RURAL?

Although the definition of "rural" is sometimes subjective, rural areas bring to mind small towns and sparsely populated areas. This definition may vary from one state to another, but in essence it refers to villages, cities, towns, or boroughs and excludes the rural portions of extended cities. According to the U.S. Census Bureau, rural is defined as not being urban, and urban, in turn, is any place incorporated with 2,500 or more individuals. In Iowa, "rural" is exemplified by grain bins, farmland adjacent to housing, small towns, and country roads, said Peter Thorne of the University of Iowa. The percentage of rural dwellers varies greatly by state. For example, Vermont has the highest proportion of rural residents—almost 62 percent—whereas California and Nevada each have less than 10 percent (U.S. Census Bureau, 2000a). However, the percentage for Nevada can be misleading because there are vast areas of open country in Nevada consisting of sagebrush and desert where no people live. In contrast, Iowa's rural areas have a small town almost every 10 miles. Thus, the meaning of "rural" for Iowa and Nevada is very different, noted Sandra Charvat Burke of Iowa State University.

The demographics of the populations in rural areas of the United States also differ. In Iowa, many counties have had and continue to have declining populations, but other nonmetropolitan areas in the western part of the country are growing rapidly. Burke noted that as the population increases, the health care demands in those areas differ from those in areas experiencing population declines.

Families in rural areas often may not have access to health care because they are self-employed on their farms or in some other business that do not have a health plan provided by an employer.

Other socioeconomic aspects, such as education, differentiate metropolitan and nonmetropolitan areas. Metropolitan areas tend to have more people who have completed high school. The difference is even higher in terms of the pro-

portions of people with a college education. Higher levels of education and higher rates of high school completion, in turn, correlate with a lower prevalence of poverty, less unemployment, and greater access to health care.

Nonmetropolitan areas tend to have a higher proportion of people older than 65 years of age. One of the reasons for this disparity is that nonmetropolitan areas have had more outmigration of youth, said Burke.

Nonmetropolitan areas tend to have less ethnic diversity and smaller minority populations—that is, any race other than white—than metropolitan areas, although in this regard there are major differences among nonmetropolitan areas.

Rural Mosaic in America

In Iowa, as in much of the Midwest, African Americans live mostly in metropolitan areas. Historically, Hispanics did not settle in the Midwest. In the central region of the United States, many counties had populations that were less than 1 percent Hispanic as recently as 1990. By 2000, however, the change in some areas was dramatic, largely because of opportunities for employment in food-processing industries, said John-Paul Chaisson-Cardenas of the Iowa Division of Latino Affairs.

Almost all Iowa counties had growth in the Latino population between 1990 and 2000. As a result, a culture and a language different from those of the predominantly white population are becoming part of Iowa and will influence Iowa's future development, said Chaisson-Cardenas. With the growth in the Latino population comes a subpopulation with limited proficiency in English. Latinos are disproportionately affected in many areas of health; 50 percent of Iowa's Latinos do not have health insurance, and they are much more likely than other groups to become diabetic (Iowa Commission, 2004). Young Latino women tend not to receive the prenatal care that they need. The result is an environment in which the institutions created to serve other people are not responding adequately to the growth of the new population, noted Chaisson-Cardenas. One significant reason for the unresponsiveness of the health care system to the needs of Latinos is a lack of "cultural competence," defined as the ability of a professional to be effective with a client who is of a cultural background different from his or her own, said Chaisson-Cardenas.

HEALTH AND THE RURAL ENVIRONMENT

Significant differences exist between rural and urban populations and their health care delivery systems. When actions at the local rural community health level are planned or information on national policy decisions with implications for rural health is sought, it is important to understand the unique characteristics of rural communities, their environments, and the conditions under which health

care is delivered to rural populations. This means the consideration of factors as varied as population density, the remoteness of a community from large urban areas, the characteristics of the local workforce—and, even more specifically, the characteristics of the rural health care workforce—and the cultural norms of the region, all of which influence health and health problems that rural communities face, said Mary Wakefield of the University of North Dakota.

Mental health is a facet of health that undergirds the vitality of all rural life, noted Cecilia Arnold of the Ligutti Rural Community Support Program. The problems associated with mental health in rural areas have many facets. The percentage of working poor in rural areas is higher than that in urban areas, and, in general, rural areas have more poverty. Services like law enforcement, emergency medical services, domestic violence shelters, and mental health services have diminished in rural areas, whereas social problems, such as the scourge of methamphetamine use, have taken hold.

The culture of rural states such as Iowa tends to be one of self-sufficiency, traditional values, and patriarchal social structures, noted Arnold. Rural residents represent several generations who embrace these and other cultural characteristics with varying levels of intensity. The population of Iowa is now more diverse as a result of the immigration and migration of people from many cultures, who face discrimination along with the challenges of assimilation. All these facets of rural life point to the challenges that can distress individuals, families, and communities and act as a catalyst to mental health problems, noted Arnold.

Farming Practices and Rural Health

Today's agricultural farming practices are under a lot of scrutiny, and World Trade Organization negotiations that will have major implications for U.S. agricultural production and production policy on cotton, sugar, and possibly rice are under way. Therefore, systems that minimize ecological impacts and that transition agricultural practice to a new phase that features more renewable energy transformations must be the target of agroecologists and agricultural scientists, said Ricardo Salvador of Iowa State University.

Some agricultural production practices have direct health effects, said Mark Ritchie of the Institute of Agricultural and Trade Policy. For example, an estimated 70 percent of antibiotics are used for nontherapeutic purposes in intensive livestock production; therefore, the risk of contracting an antibiotic-resistant infection could increase for somebody working in an intensive hog-rearing barn. Other farming practices have more indirect effects on health, noted Ritchie, but they affect the environment—the air, the water, and the soil. Furthermore, production practices can affect food quality and have other effects brought about by processing and consumption. For example, workers in meatpacking plants can be infected with tuberculosis as a result of contact with animals.

Initiatives for Improving Rural Health

As mentioned above, air and water quality have improved in rural America, but changes are still needed. Agriculture is a regulated industry now, and farmers are recognizing that they need incentives that will pay for good environmental practices in the future. Alliant Energy incentives were discussed at the workshop as one of the examples of cost-effective conservation measures. The company offers a performance contracting initiative to its customers in Iowa and financial incentives for its larger industrial customers to put energy-saving and energy efficiency devices in place. These incentives are paid for by using the savings from reductions in energy use.

Electric utilities, regulators, legislators, and customers must continue to show initiative to improve air quality in the future, said Erroll Davis, chief executive officer of Alliant Energy. Rural community health can be strengthened with a strong commitment to a new energy economy based on renewable energy and energy efficiency, said Michael Noble of Minnesotans for Energy-Efficient Economy.

The Nebraska Environmental Partnerships (NEP) Program provides environmental health assistance to small communities (those with populations greater than 1,000) that are thought to be out of compliance with state or federal health regulations. The program was created to manage the health concerns that have emerged as a result of complex environmental regulations, limited financial resources, an aging infrastructure, an aging population, and decreasing populations in rural communities. This program works with the towns as a nonregulatory program in a regulatory manner but using a community-based team process that assists local governments with assessing and solving local public health and environmental challenges, and the towns know and respect that, said Jackie Stumpff of NEP. The team helps small communities work through environmental health problems by providing resources and technical assistance, at the request and convenience of local leaders.

The Agricultural Health Study (AHS) was designed to study a wide range of health effects of agricultural exposures in farmers and their families. It is a collaborative venture between the National Cancer Institute, the National Institute of Environmental Health Sciences, the U.S. Environmental Protection Agency, and the National Institute of Occupational Safety and Health (National Institute of Environmental Health Sciences, National Cancer Institute, U.S. Environmental Protection Agency, 1993). The exposures studied by AHS include those to pesticides, animals, diesel, and solvents. The health effects considered by the study include cancer, respiratory health, reproductive outcomes, and neurological disease. In the future, AHS plans to analyze data on specific chemicals and cancer, Parkinson's disease, respiratory disease, rheumatoid arthritis, and the overall rate of mortality among the members of the cohort over time, said Jane Hoppin of the National Institute of Environmental Health Sciences.

2002 Farm Bill

The 2002 Farm Bill covers some environmental health aspects. Senator Tom Harkin of Iowa, who had a brief tenure as chair of the Senate Agriculture Committee, introduced various new ideas and programs into the bill. Eileen Huntoon of Senator Harkin's office provided the Roundtable with an overview of Senator Harkin's contribution to the 2002 Farm Bill. Aside from funding existing programs, his vision was to add new value-added rural development programs and, for the first time ever, to have renewable energy be part of the Farm Bill.

The new Farm Bill included an expansion of land and water conservation programs, said Huntoon. Other grant programs added to the Farm Bill focused on biological product-based energy: ethanol, biodiesel, biomass research and development, and biorefinery development. The Farm Bill is evaluating whether second-generation biorefineries that would produce ethanol biodiesel should be financed. Despite all the efforts and dreams that went into the Farm Bill, some major challenges remain, said Huntoon. Some of the farm programs were not funded, some were reduced, and some were eliminated. Nevertheless, some solid ideas for development of the next Farm Bill, which will be legislated in 2007, have been laid out.

Huntoon pointed out that a strong constituency of individuals from rural areas for rural development and policy issues does not exist. There is no broad collaboration among groups from rural areas, and there is a need to develop such a strong rural constituency of many groups and communities working together.

NATURAL ENVIRONMENT IN RURAL AMERICA

Agriculture provides an economic base for Iowa residents, but at the same time it also has significant environmental impacts. People once had a good connection to their land, and in rural America they still do, but the land and the water are changing, said Jerald Schnoor of the University of Iowa.

When driving around the middle of the United States and looking at farms, one would think that they do not appear much different from they way they did 40 or 60 years ago. Although changes are not obvious by looking at the countryside, U.S. agriculture has undergone a dramatic transformation over the past century-and-a-half, said Neil Harl of Iowa State University.

The change started quite early after settlement, beginning in about 1850. When the land was tilled for farming, it became vulnerable to soil and water erosion. In addition, natural habitat has been destroyed to make way for agricultural development. In fact, Iowa is the most ecologically altered state in the entire union: since 1850 it has lost 99 percent of its prairies, 95 percent of its wetlands have been drained, and 75 percent of its forests have been cut (Iowa Natural Heritage Foundation, 2002). Since 1935 there has been an unbroken succession of reductions in the number of farms in the United States and increas-

es in the average size of farms. In 1900, the average size of a farm was 118 acres. This average increased to 156 acres by 1925, 282 acres in 1969, and 352 acres at present (USDA, KASS, 2003).

Water and Air Quality

In Iowa, seven tons of soil is lost per acre, and each acre yields about 150 bushels of corn, said Jerald Schnoor of the University of Iowa (NRC, 1986). Consequently, for every pound of corn produced, the land loses approximately two pounds of topsoil sediment and farmers are actually "exporting" two pounds of soil annually for every pound of corn harvested. On the basis of this calculation, Iowa has lost approximately half of its topsoil since presettlement times. These extensive changes in land cover and land use cause changes in water quality through runoff, asserted Schnoor.

Increasing nitrate concentrations in the Iowa River, which feeds into the Mississippi River, mirror the applications of nitrogen to Iowa farmland. Nitrogen flows from the Mississippi River to the Gulf of Mexico, and currents pull the nutrients west from the mouth of the river, causing hypoxia—low oxygen conditions, or less than 2 milligrams of nutrients per liter—along the U.S. coast in the Gulf of Mexico, said Schnoor. These conditions affect the shrimping industry and the livelihoods of people who make use of the water and the coastal margins in Louisiana and the Gulf Coast.

Rural residents are also affected by water quality because they are drinking water from their own wells, which are not subject to the Safe Drinking Water Act, noted Schnoor. Shallow groundwater wells less than 50 feet deep are commonly contaminated with pesticides, nutrients, industrial chemicals, and various volatile organic carbon compounds (USGS, NAWQA, 2005). Among other chemicals that have an effect on people who live in rural areas are polybrominated diphenyl ethers, which accumulate in breast milk; polychlorinated biphenyls (PCBs); and mercury. PCBs and mercury are neurobehavioral agents that especially affect unborn and young children.

Air quality has generally improved in rural America because of the Clean Air Act, noted Schnoor, but challenges remain, such as occupational exposures to dust, windblown soil, ammonia, pesticides (especially those from animal feeding operations), endotoxins, mycotoxins, animal dander, and hydrogen sulfite.

THE BUILT ENVIRONMENT AND HEALTH IN RURAL AREAS

Urban encroachment in rural areas creates health problems and issues such as health care access issues, air pollution, water pollution, water availability, and other concerns, said Bernard Goldstein of the University of Pittsburgh. Other health problems due to urban sprawl include heat islands, global climate change, noise, a lack of availability of healthy food choices, public health workforce

issues, and safety issues such as crime and traffic. When a green area is replaced by asphalt, a bigger heat island results in changes in local temperatures and ecosystems. Heat island and temperature changes also affect the rural areas that are near the suburbs, noted Goldstein.

Attempts to try to understand the impact of urban sprawl on the public health workforce are beginning. The workforce is decreasing and the resources are diminishing at a time when the public health system is encountering some of its greatest challenges, said Goldstein. Furthermore, a large turnover of the public health workforce is anticipated because of retirement. The impact is different in different areas, but often the public health workforce in the rapidly growing suburban areas has less expertise because the budget for the public health infrastructure cannot keep up with the growth, noted Goldstein.

Iowa has housing issues both in rural areas and in the inner cities of urban areas. One of the distinguishing features of Iowa's housing, particularly compared with the housing features of its neighbors, is the age of its housing. Although age is not the only thing that describes housing, it is a surrogate for many of the problems associated with housing, said Rita Gergely of the Iowa Department of Public Health. Abandoned housing can become an environmental health and safety issue when, for instance, children play near houses that are in imminent danger of collapse. Abandoned buildings in remote rural areas are perfect places for methamphetamine labs, said Gergely. Also, people are often concerned that abandoned houses are a reservoir for rodents and insects that can travel to nearby homes, particularly in urban areas.

Environmental health issues in the context of occupied housing include lead poisoning in children, carbon monoxide, fire and electrical hazards, water damage and mold, private wastewater treatment systems, the lack of rental housing codes, and improper sanitary conditions. Water damage and mold in homes result from flooding, leaking roofs and windows, plumbing problems, excess humidity in bathrooms and kitchens, and wet basements. These are more likely to be found in older and poorly maintained homes, noted Gergely, and can cause health problems in susceptible people. The awareness that these conditions can lead to the growth of mold, which can be a significant environmental health issue, is increasing.

As in the rest of the United States, obesity is a growing health concern in Iowa. The state has the 17th highest rate of adult obesity in the nation (23.9 percent) and the 10th highest rate of overweight among low-income children ages 2 to 5 years (13.6 percent) (Trust for America's Health, 2005). The built environment, such as residential areas, the grounds, and sidewalks, has a direct impact on obesity, because the physical environment either encourages or discourages people to exercise, noted John Lowe of the University of Iowa. There is no funding within the communities to fix the sidewalks that are deteriorating in most counties in Iowa. Socioeconomic factors, such as personal or household income, material deprivation, unemployment, a lifetime history of poverty, asset

ownership, and the receipt of welfare, affect one's physical activity as well, said Lowe.

The Roundtable addressed rural environmental health issues in an interactive way, with those attending the discussions participating in a free exchange of views on how to rebuild the unity of health and the environment in rural America. Although the Roundtable defines environmental health in broad terms, not all aspects of environmental health could be discussed in their entirety during the limited time of the meeting. This workshop summary captures the presentations and discussions by the speakers and participants, who identified areas in which additional research was needed, the processes by which changes could occur, and the gaps in our knowledge.

Introduction*

The Roundtable on Environmental Health Sciences, Research, and Medicine is a mechanism that the Institute of Medicine (IOM) uses to convene representatives from academia, government, and industry. By bringing together people with diverse views, the Roundtable provides a forum in which environmental health issues can be discussed by looking broadly at the built, the social, and the natural environments, all of which come together in complex interactions. Through their discussions, the members of the Roundtable look beyond narrowly focused topics and consider the larger environmental factors that influence public health.

At a workshop sponsored by the Institute of Medicine's Roundtable on Environmental Health Sciences, Research, and Medicine in June 2000, *Rebuilding the Unity of Health and the Environment: A New Vision of Environmental Health for the 21st Century,* many participants expressed the view that for a long time the world of environment, environmental regulation, environmental control, and engineering had moved in one direction while the world of health had moved in another. From this realization arose the concept of holding a series of workshops on rebuilding the unity of health and the environment in various regions of the United States. The purpose was to bring representatives from the two worlds together to address issues of health and environment specific to each region.

The Roundtable has already hosted regional workshops in Atlanta, Pittsburgh, and Houston, said Roundtable member James Merchant. At the latest workshop of the Roundtable on Environmental Health Sciences, Research, and

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Medicine (held at the University of Iowa, Iowa City, on November 29 and 30, 2004), the Roundtable addressed rural environmental health issues in an interactive way, with those attending the discussions participating in a free exchange of views on how to rebuild the unity of health and the environment in rural America. The remainder of this chapter and the chapters that follow describe and summarize the participants' presentations to the Roundtable members and the discussions that the members had with the presenters and participants at the workshop.

WHAT IS ENVIRONMENTAL HEALTH?

According to the World Health Organization (WHO), environmental health is defined as "those aspects of human health, including quality of life, that are determined by interactions with physical, chemical, biological and social factors in the environment" (WHO, 1986). Environmental health thus focuses on the quality of life and not simply on the absence of disease, and all the factors that contribute to environmental health, including the environment, are assessed when the environmental health of a population or region is evaluated.

Many researchers and investigators have created their own image of the interactions among health, behavior, biology, and genetic factors and the outcome, whether it is disease or health and function. Overlying these interactions are social, natural, and built environmental factors, remarked Roundtable member Donald Mattison. In developmental health, for example, researchers are beginning to realize that many of the events that lead to health disorders occur in utero or early in childhood, so it is important to understand the factors that ultimately lead to these disorders in adults. Most aspects of health are a direct result of the environments in which humans grow up, live, work, and play. Therefore, the solutions to public health problems cannot be left solely to the health care system; they require interactions among a broad group of individuals with expertise in a variety of areas.

Risk reduction and health promotion influence the development of health. Thus, consider a graph with health development—e.g., pulmonary function, cognitive function, or executive function—along the vertical axis and time along the horizontal axis. Mattison noted that because of a range of exposures or other factors, the trajectory that an individual might have followed across some period of time might be lower than what the optimum trajectory for health development for that individual could have been. However, if health promotion and risk reduction strategies had been put into place, the same individual might have been able to move through various stages of life and reach or approach the optimum trajectory. From what is known about the early origin of diseases in adults, it can be concluded that it is most important to act early to reduce risks and put in place strategies that promote health.

Obesity is a good example, noted Mattison. A lot of the focus on obesity has

been straightforward; it is known that the balance between physical activity and caloric intake affects body size. Inactivity plays a major role in child obesity as well. Today, an average child in the United States spends more time watching television than attending school in any given year (Finn, 1980). However, data from a range of population studies demonstrate that intrauterine factors can predispose individuals to increased body size in adulthood. Moreover, policy decisions made in the late 1960s and 1970s that changed the way in which foods are prepared and sold commercially may also have played a role in some of these outcomes, noted Mattison. Therefore, while physical inactivity plays a role, a broad perspective needs to be taken to understand what has led to this change in body size.

> From what is know about the early origin of diseases in adults, it can be concluded that it is most important to act early to reduce risks and put in place strategies that promote health.
>
> *—Donald Mattison*

The proportion of individuals with a body mass index (BMI) higher than 30 kilograms per square meter (kg/m^2) is rapidly increasing. Research on obesity in 1990 found that 10 percent to 14 percent of the population had a BMI higher than 30 kg/m^2 whereas in 2000 in some states more than 20 percent of individuals had BMIs at or above 30 kg/m^2. Currently, in some states the proportion of the population with a BMI of 30 kg/m^2 or more has surpassed 25 percent (Must et al., 1999). The impact on children is similar: the proportions of overweight children in 1963, 1965, and 1999 were 11, 12, and 19 percent, respectively. According to a recent Institute of Medicine (IOM) report, the cost of the obesity problem in adults is between $98 billion and $129 billion annually, said Mattison (IOM, 2004).

> The definition of environmental health has evolved with research; therefore, the goals of environmental health should be to establish and maintain a healthy environment, to promote an environment that improves well-being both in function and in structure, and to allow the environment to be sustainable.
>
> *—Donald Mattison*

Other factors in addition to developmental health could have contributed to the child obesity problem in the United States. The built environment affects the way in which children exercise. For example, in suburbia, fences between houses make the otherwise sculptured environment inhospitable. The result of this inhospitable environment is that children are being driven to their friends' homes rather than biking or walking themselves. According to the Nationwide Personal Transportation Survey issued by the U.S. Department of Transportation's (DOT's) Federal Highway Administration (FHWA), the average number of daily vehicle trips per household grew 12 percent between 1990

and 1995. Also, the average number of annual person trips per household by the use of mass transit systems dropped from 2.6 percent in the 1970s to about 1.8 percent in 1995. Since then it has stayed relatively constant that the main mode of transportation is by car (DOT, FHWA, 1999).

Although the incidence of Type II diabetes among adults over the age of 40 years is increasing at an alarming rate, the gravest concern at the National Institute of Child Health and Human Development is the trend of an increasing incidence of Type II diabetes among children. This increase accounts for the rapidly expanding research and development efforts by the pharmaceutical industry into potential tools for the management of Type II diabetes. Although evidence clearly indicates that fat cells play a role in moderating the insulin response and insulin sensitivity, evidence also indicates that some of the factors that occur during the course of pregnancy play a role as well, noted Mattison.

In 2002, as a response to public health data indicating that prematurity is the one area in maternal and child health that has worsened, the Roundtable conducted a workshop on the role of environmental factors in premature birth (IOM, 2003). Although the incidence of prematurity has increased over the years, the incidences of all other health conditions of concern in maternal and child health, such as maternal mortality, infant mortality, and birth defects, have improved. The problem with prematurity is not only that a child is born before he or she has reached full term and needs special care, but also that the complications or impacts of prematurity, personal as well as familial and societal, are lifelong. The Roundtable activities revealed interesting, emergent themes around prematurity that suggest that gene–environment interactions and social factors affect prematurity.

The definition of environmental health has evolved with research; therefore, the goals of environmental health should be to establish and maintain a healthy environment, to promote an environment that improves well-being both in function and in structure, and to allow the environment to be sustainable, concluded Mattison.

1

Environmental Health in Rural America*

The problems of the rural environment extend well beyond natural factors such as the quality of the water and the air and also include the built environment in terms of human inputs—the buildings placed on the land, the kind of farming performed and the chemicals that are applied to the land, and the types of industries that are built in rural America—noted Peter Thorne of the University of Iowa. A number of health care issues are specific to the rural environment, particularly those relating to the widening gap in health care services between rural and urban populations, because more people in rural America are uninsured, more often have inadequate access to health care services, and must often commute long distances to seek and receive such care.

WHAT IS RURAL?

Although the definition of "rural" is sometimes subjective, rural areas bring to mind small towns and sparsely populated areas. This definition may vary from one state to another, but in essence it refers to villages, cities, towns, or boroughs and excludes the rural portions of extended cities. According to the U.S. Census Bureau, rural is defined as not being urban, and urban, in turn, is any place incorporated with 2,500 or more individuals. Cities often grow out in tentacles, known as urban sprawl, and the areas between those tentacles are often defined as rural. In Iowa, rural is exemplified by grain bins, farmland adjacent to housing, small towns, and country roads, said Thorne. In the western United States, rangelands mark an area as rural, whereas the typical elements of rural in the

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northern United States might be forests and lakes. However, the notion of rural is small communities or individual farmland.

Another aspect that differentiates rural from urban was well captured by Wendell Berry in his book *The Unsettling of America: Culture and Agriculture.* He wrote that "the concepts of country, homeland, and dwelling place, become the environment. Thus, once we see our place, our part of the world, as surrounding us, we have made a profound division between it and ourselves. We have given up the understanding . . . that our land passes in and out of our bodies, just as our bodies pass in and out of the land" (Berry, 1977). According to Thorne, it is the notion of living within the environment, of being part of it in a fundamental way, which rural people experience more often than urbanites. Therefore, one element unique to living in rural America is the feeling of connectedness with the land and the notion that the land is producing food for the nation, so that those who live in the rural environment are somehow connected with this process, regardless of whether or not they are farming. Neighbors become very important in rural areas, partly because they constitute the community. Rural areas also possess a strong heritage of neighbors helping neighbors by sharing the labor involved with daily life in rural settings.

Rural is the notion of living within the environment, of being part of it in a fundamental way, which rural people experience more often than urbanites.

—Peter Thorne

CHALLENGES TO LIFE IN RURAL AMERICA

One of the greatest problems facing rural America has been the loss of small towns and their small schools, said Thorne. As a result of school consolidation, larger schools are increasingly becoming the essence of the rural community.

Rural America faces other challenges as well, including poverty and isolation, as well as the limited access to health care mentioned above. In addition, conditions in rural America—such as unmonitored drinking water, dangerous working conditions, and the notion that it is a shrinking demographic—affect the options and opportunities of its residents.

Seventy-five percent of the land mass in the United States is sparsely populated and is considered rural (USDA, ERS, 2005). In four states—Maine, Vermont, West Virginia, and Mississippi—more than 50 percent of the citizens qualify as rural dwellers. Another 18 states have rural populations of between 30 and 50 percent of the total population, and 8 more have rural populations between 25 percent and 30 percent of the total population. Therefore, in a total of 30 states, at least 25 percent of the citizens live in rural areas, a significant demographic by all accounts. In total, the estimated rural population in the Unit-

TABLE 1-1 Comparison of Key Demographic Parameters Between Rural Citizens and Their Urban Counterparts

Characteristic	Urban	Rural
Population[a]	222,358,000	59,064,000
Percent earning <$7/h[b]	19	33
Percent uninsured[b]	15	24
Percent uninsured who earn low wages[b]	40	60
Percent who obtain drinking water from a public system[c]	~100	30

[a] U.S. Census Bureau (2000).
[b] Kaiser Commission (2003).
[c] U.S. Environmental Protection Agency (2000).

ed States is 59 million people, of which some 56 million are rural dwellers not living on farms (U.S. Census Bureau, 2000c).

According to Thorne, in comparison with their urban counterparts, a disproportionate number of rural citizens are poor, tend to be older, have limited access to health insurance and health care (Table 1-1), make do with few amenities, and do not expect to become wealthy. Indeed, many do not even consider themselves to be poor. Although these individuals meet the demographic definition of "living in poverty," they often think of their economic status as being quite average and place a higher value on the quality of life that they have, noted Thorne. Fully a third of those living in rural areas earn less than $7.00 per hour, whereas a fifth of the population in the urban environment earn this amount (U.S. Census Bureau, 2000b).

Many people in rural areas are either self-employed or work at a low-wage job or for small businesses that, in general, do not provide the medical insurance benefits offered by larger employers. It is estimated that approximately 25 percent of rural citizens in the Midwest are uninsured; and for many who do have medical insurance, it might be rather limited, with high deductibles, and provide tenuous coverage at best, said Thorne (Pol, 2000). It is not uncommon to find rural dwellers who are reluctant to make insurance claims for fear of losing their insurance, said Thorne. This fear may manifest itself in detrimental ways, such as parents not wanting to have a diagnosis of asthma made for their child because such a diagnosis might result in the loss of their medical insurance.

Isolation is an environmental health issue in rural areas. Some people are socially disconnected in the rural environment. As a result of this isolation,

problems such as domestic violence remain hidden and unaddressed. Mortality rates arising from injury, in turn, can be adversely affected by factors such as the long response times to medical emergencies or fires, noted Thorne.

Limited access to health care is also a major problem for rural America. According to the Center for Studying Health System Change, there are 53 primary care physicians per 100,000 rural residents, whereas there are 78 primary care physicians per 100,000 urban residents. The disparity in the availability of specialists is much greater: 54 and 134 specialists per 100,000 residents in rural and urban areas, respectively (Reschovsky and Staiti, 2005). Moreover, the rate of use of preventive care is lower in rural settings, and more rural dwellers than people living in urban areas depend on Medicaid and state-based plans.

Limited access to health care is a major problem for rural America. Twenty-one percent of American citizens live in the rural environment, whereas 90 percent of physicians live and practice in urban areas.

—Peter Thorne

Although the rates of physical inactivity are lowest in rural areas, the prevalence of obesity among adults in rural areas is increasing. Data from the Behavioral Risk Factor Surveillance System indicate increased rates of obesity among rural males and females and whites and blacks who are not Hispanic, and for all age categories (CDC, 2001). Therefore, the obesity problem in rural America cuts across all demographics: gender, race, and age (Table 1-2).

Exposures in the rural environment tend to be less related to national ambient air quality standard criteria—that is, to pollutants such as ozone, sulfur diox-

TABLE 1-2 Rates of Obesity in Urban Versus Rural Populations (percent)

Group	Urban Counties	Small, Nonadjacent Rural Counties
Overall	20.5	**23.3**
Male	20.8	**23.0**
Female	20.1	**23.5**
White	18.9	**22.4**
Black	30.4	**32.5**
Hispanic	**24.7**	23.1
18–34 yr old	15.7	**18.6**
35–49 yr old	22.9	**26.6**
50–64 yr old	25.8	**28.5**

NOTE: Obesity is considered a body mass index of greater than 30 kilograms per square meter. The population size was 385,384 individuals. Boldface indicates higher body mass index as compared urban vs. rural.
SOURCE: CDC (2001).

ide, nitrogen oxide, and particulate matter—unless the area in question is in close proximity to a major metropolitan area. However, hazardous air pollutant exposures are of greater concern in rural areas. In Iowa and other agricultural states, livestock operations are a source of pollutants, such as hydrogen sulfide, ammonia, and odoriferous vapors, that result from animal husbandry activities and manure storage and handling. The organic dust that arises from agricultural environments and the by-products of operations and businesses that process agricultural commodities are also of health concern to rural populations. Additionally, the economy of the rural environment relies heavily on small businesses that often generate exposures associated with manufacturing and farming and that, in comparison with larger industries, receive little scrutiny from the Occupational Safety and Health Administration, noted Thorne.

Water pollutants in the rural environment are derived from nutrient runoff from fields, soil and river bank erosion, and pesticides and other farm chemicals that enter surface water and groundwaters. In Iowa, about 25 large-scale fish kills occur each year, and these are most often attributable to the contamination of surface waters with manure or, in some cases, ammonia. An emerging problem that is receiving more scrutiny is the contamination of water supplies with the growth-promoting agents used to raise livestock, especially nontherapeutic antibiotics. The latter are being examined because of concern over the potential emergence of antibiotic-resistant pathogens that may arise as a result of exposure to antibiotics.

While urban drinking water suppliers provide water to 100 percent of urban dwellers, those who live in a rural environment and who have a rural public water system—estimated to be about 30 percent of rural dwellers—depend on very small systems. Such water systems are cooperative in nature and are defined as having 15 service connections or regularly serving an average of at least 25 individuals daily at least 60 days out of the year. In addition, while urban residents receive an annual Consumer Compliance Report produced by EPA, about the levels of approximately 80 contaminants that are monitored in their water, the majority of rural residents have private wells of various depths, and the owners are responsible for monitoring the water quality. Typically, these wells are monitored only for coliform bacteria and nitrates, but the scrutiny of water from wells is less vigilant than that of water from urban public drinking water supplies, noted Thorne.

> When people were asked during the enrollment to the Agricultural Health Study why they chose rural life, many responded that they love the outdoors and feel the need to see the sun rise and set; some said that cities are concrete jungles where nobody cares about you.
>
> *—Peter Thorne*

A vast consolidation of farms and changes in farming practices toward larger

and less diverse farms have occurred over the past 40 years. Although the amount of farmland and production have not changed much in the United States in the past 60 years, the number of farms has decreased from about 6 million to less than 2 million, and the average number of acres per farm has gone from 175 to close to 500 (USDA, NASS, 2002). Livestock production has changed from being very widely distributed on mostly family farms to being more of a system with an industrial design with vertical integration, in which agribusinesses bring feed from other areas of the country and process animals in slaughterhouses operated by the same company. This takes money away from the local communities and further increases the environmental sustainability problems within them, said Thorne. Furthermore, the fact that the decisions about how these facilities are operated are in the hands of people who are not living in the community can lead to strife between those business owners and the members of the local community.

Farm injuries are an important cause of morbidity and mortality in rural areas. According to the National Institute of Occupational Safety and Health, every day about 228 agricultural workers suffer injuries that result in lost work time, and about 5 percent of these result in permanent impairment. Nationally, farm children and farm visitors (hired workers or visiting youth) experience approximately 22,000 injuries each year; this is equivalent to 12.7 injuries per 1,000 youth, of which about one-third are work related and one-half are in the Midwest (NIOSH, 2005). The injuries include tractor rollovers, all-terrain vehicle or four-wheeler accidents, power-takeoff injuries, suffocations in grain bins and confined spaces, and collisions on or off roads. About one-half of farm injuries among youth occur among those ages 10 to 15 years, and one-third occur among children younger than age 10 years.

When participants were asked during their enrollment in the Agricultural Health Study—discussed in greater detail in Chapter 4—why they chose rural life, many responded that they love the outdoors and feel the need to see the sun rise and set; some said that cities are concrete jungles where nobody cares about you. Many people who have children express a desire to have their children grow up in the way that they did and to be able to allow their children to play outside and not worry about the dangers that they associate with cities. Some have tried living in the city and have come back to what they know and appreciate: the life that they know because they were born on a farm or in the rural environment and the fact that this is what they really call home. In conclusion, Thorne quoted Jacques de Lacretelle, who said, "the city has a face, the country has a soul" (*21st Century Dictionary of Quotations*, 1993).

THE FARM BILL AND ENVIRONMENTAL HEALTH

The 2002 Farm Bill covers some environmental health aspects. Senator Tom Harkin of Iowa, who had a brief tenure as chair of the Senate Agriculture Committee, introduced various new ideas and programs into the bill. Eileen Huntoon

of Senator Harkin's office provided the Roundtable with an overview of Senator Harkin's contribution to the 2002 Farm Bill. Aside from funding existing programs his vision was to add new value-added rural development programs, and, for the first time ever, to have renewable energy be a part of the Farm Bill.

The new Farm Bill included an expansion of land and water conservation programs, said Huntoon. A total of $17 billion in new funding over the life of the bill was added to create new conservation programs and to fund existing conservation programs, such as the Conservation Reserve Program (CRP), which is based on 10- to 15-year contracts to set aside sensitive croplands in grass and trees and targets erodible lands, filter strips, and buffers for water and air quality, and the Wetland Reserve Program (WRP), which is based on permanent and 30-year easements for enhancing wetland wildlife habitat, noted Huntoon. These programs focused on subsidizing farmers who are applying good conservation practices. Conservation programs became more important because, at the time, the United States had ongoing trade discussions in the World Trade Organization (WTO) regarding its heavily subsidized agricultural production—farm subsidies—the solution to which will require the elimination of such subsidies. Other member countries of WTO objected that world competition does not work well with the system that exists in the United States. Therefore, as those farm subsidies decrease, rather than paying farmers to produce more, U.S. farmers need to be offered support in the form of a "green payment," which is $4 billion a year. The Bush administration has endorsed so-called green payments to farmers who practice land, water, and wildlife conservation on the more than 900 million acres of farm, ranches, and forests. Funding for conservation programs would expand greatly under the House and Senate farm bills, which would encourage practices that enhance the environment. The result of these changes will be cleaner water and an opportunity to save the soil.

In the 1980s, most federal funding for conservation was provided under CRP, which takes hilly land out of production and seeds it and which restores wetlands. The Senate Agriculture Committee wanted to keep CRP as well as to spend money on working farmland because land in production also affects water quality. Under the Conservation Security Program, practices such as the placement of more buffer strips, the use of no-till agricultural practices, the use of complete manure management systems on the farm, and the elimination of runoff would receive funding through a tiered process.

Renewable energy systems are also within the scope of conservation. The Senate Agriculture Committee funded a new grant program whereby farmers and small businesses in rural America can obtain a grant for 25 percent of the cost of various projects, such as putting in small wind, geothermal, and solar energy generators or anaerobic digesters. A total of $23 million will be available nationally for these projects, said Huntoon.

The Senate Agriculture Committee also included grants for research and

development on carbon sequestration as well as some money for biodiesel education, but these were not funded.

Similar to the situation years ago, when a whole recycling revolution ensued after the federal government decided to give preference to recycled paper if the costs were the same as those for regular paper, the 2002 Farm Bill includes a new biological products–based program that directs the government to purchase such products if they are available, cost the same as regular products, and perform just as well as regular products. Thus, soybean-based grease for trucks and railroad cars is being made in Iowa. Huntoon noted that if the U.S. Department of Defense were to buy this type of grease, sales would be extremely high. Researchers at Iowa State University are developing another promising product: paper plates made out of cornstarch. In fact, all parts of corn and soybean plants can be used to make something. For example, cornstalks instead of petroleum derivatives can be used to make fiberfill for pillows. Funds for the development of these products have been authorized, but there is a need to work on the marketing of these products so that consumers will purchase them.

Other grant programs added to the Farm Bill focused on biological product–based energy: ethanol, biodiesel, biomass research and development, and biorefinery development. The Farm Bill is evaluating whether second-generation biorefineries that would produce ethanol and biodiesel should be financed.

Nutrition programs are another important part of the 2002 Farm Bill and are important for the health of rural and urban citizens alike. Nationally, the Food Stamp Program typically requires about $27 billion per year—and this amount is increasing—and school lunch programs cost about $960 million per year (USDA, FNS, 2005). The Senate Agriculture Committee added an additional $6 billion over the life of the Farm Bill for some special nutrition programs. Food stamp benefits were restored, without a waiting period, for legal immigrants who were not receiving them and for disabled individuals, said Huntoon.

A pilot program that addresses vending machines in schools was also added to the 2002 Farm Bill. Four states are participating in this program. Children in various schools—28 schools in Iowa—receive free fruits and vegetables as snacks in the morning and in the afternoon. As a result, some schools have removed vending machines, and the program is being expanded to 53 schools, noted Huntoon. The program is managed by the U.S. Department of Education, which selects the schools in rural as well as urban areas.

Research on organic food production was added to the Farm Bill for the first time. Funds were allocated for the collection of data on the cost of organic food production, the fastest-growing sector of agriculture in the United States.

Despite all the efforts and dreams that went into the Farm Bill, some major challenges remain, said Huntoon. Some of the farm programs were not funded, some were reduced, and some were eliminated. Nevertheless, some solid ideas for development of the next Farm Bill, which will be legislated in 2007, have been laid out.

In conclusion, Huntoon pointed out that a strong constituency of individuals from rural areas for rural development and policy issues does not exist. Often, people go to Washington, D.C., and ask for funding for rural water programs but not for rural health programs. There is no broad collaboration among groups from rural areas, and there is a need to develop such a strong rural constituency of many groups and communities working together.

2

The Social Environment in Rural America*

RURAL MOSAIC IN AMERICA

From a demographic standpoint, "rural" refers to very small populations and population densities. Although many of those at the workshop are from Iowa or elsewhere in the Midwest, the United States has many types of rural settings different from those in the Midwest. The almost infinite variety of rural areas means that in terms of health issues, policies, and programs, what might work for one rural area may not be adequate for another because the needs of these various rural areas are different, according to Sandra Charvat Burke of Iowa State University.

The U.S. Census Bureau changed the definition of rural between the 1990 and 2000 censuses. According to the 1990 census definition, rural areas consist of towns that have populations of less than 2,500, open country, and people who live on farms (U.S. Census Bureau, 1990). The 2000 census defines "rural" as "territory, population and housing units not classified as urban. Rural classification cuts across other hierarchies and can be in metropolitan or nonmetropolitan areas" (U.S. Census Bureau, 2000a). By using the 2000 census data but the 1990 census definition of rural, 55 million people live in rural areas in the United States (according to the 2000 census definition, 59 million people live in rural areas) (U.S. Census Bureau, 2000a). In essence, these figures mean that about 20 percent of the U.S. population lives in rural regions, said Burke.

The percentage of rural dwellers varies greatly by state. For example, Vermont has the highest proportion of rural residents—almost 62 percent of the total

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population—whereas California and Nevada each have less than 10 percent (U.S. Census Bureau, 2000a). However, the percentage for Nevada can be misleading because there are vast areas of open country in Nevada consisting of sagebrush and desert where no people live, noted Burke. In contrast, Iowa's rural areas have a small town almost every 10 miles. Thus, the meaning of "rural" for Iowa and Nevada is very different, noted Burke.

The Office of Management and Budget offers another way of looking at "urban" and "rural" by distinguishing between "metropolitan" and "nonmetropolitan" counties. If there is a city of 50,000 people or more, that city and the entire surrounding county are considered a part of a metropolitan county. If a county does not have a city of 50,000 or more but sits next to a county with such a city and more than 25 percent of its population commutes to that city, then that county is considered part of the metropolitan area as well. On this basis, Iowa has 20 metropolitan counties and 79 nonmetropolitan ones. Burke noted that if these definitions were applied to California and Nevada, they would each have many metropolitan areas. In Nevada, for example, the metropolitan area of Las Vegas takes in the entire county, and whereas counties in Iowa are each about 30 square miles, Nevada's counties are significantly larger by comparison. The metropolitan area of Las Vegas comprises a lot of unsettled desert. The same is true of southeastern California, where counties with large areas of desert would qualify as metropolitan counties because they have or are adjacent to a city with a population of more than 50,000.

Burke noted that the rural population can be counted on the basis of agricultural output: The individuals must live on at least one acre of land and sell at least $1,000 of agricultural products per year to be counted as rural. Using this definition, the 2000 census showed that in the United States less than 3 million people, or approximately 1.1 percent of the U.S. population, live on farms. Therefore, the majority of people in the United States are not intimately associated with a farm and may not have an understanding of what happens on a farm, food production activities, or the problems that farmers face, said Burke. Today, less than 6 percent of Iowa's population lives on farms, and farming is a smaller part of rural life than it has been in the past. Not only are fewer people living on farms, but even if they live on a farm, many are working off the farm for their incomes. A U.S. Department of Agriculture (USDA) survey of farmers indicates that for about 33 percent of farm households, neither the farmer nor the farmer's spouse works off the farm, which means that for almost 70 percent of farm households, somebody—either the farmer or the farmer's spouse, or both—works off the farm (USDA, ERS, 2005). Consequently, the majority of the income for even the very small proportion of the U.S. population engaged in farming is coming from off-the-farm sources, noted Burke. Interestingly, she noted that one of the reasons given for off-farm work was that the employment was a way of obtaining health insurance (Figure 2-1).

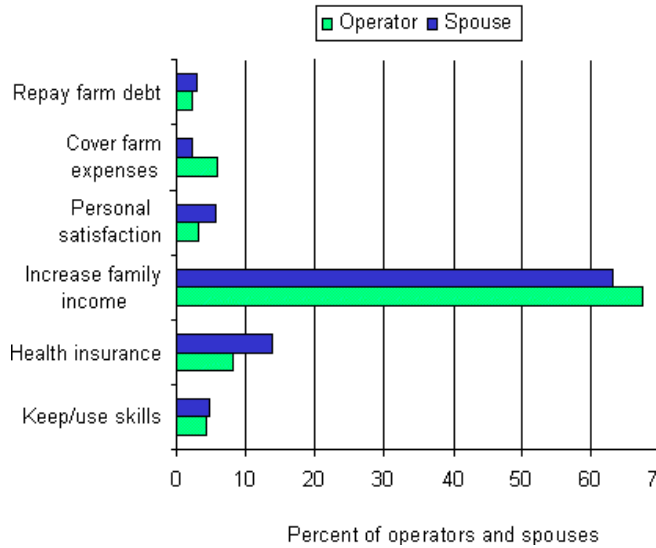

FIGURE 2-1 Reasons why farmers must find a job off the farm.
SOURCE: USDA, ERS (2005).

Population Change in Rural Areas

The demographics of the populations in rural areas in the United States also differ. In Iowa, many counties have had and continue to have declining populations, but other nonmetropolitan areas in the western part of the country are growing rapidly. Burke noted that as the population increases, the health care demands in those areas differ from those in areas experiencing population declines. Maps prepared by the USDA Economic Research Service (ERS) show that some counties in Iowa have above-average population growth of at least 13 percent (USDA, ERS, 2005). Other such areas can be seen in northern Michigan, Minnesota, and throughout the South and Southeast. However, areas in the Central Plains and some areas in Iowa had no population growth or had population declines between 1990 and 2000. Therefore, the population declines seen in some parts of Iowa do not reflect what is happening in other nonmetropolitan areas around the country, said Burke. The nonmetropolitan counties where the population declined between 1980 and 1990 and again between 1990 and 2000 are in Appalachia and an area stretching from the Texas panhandle north through the northern Great Plains to the Canadian border.

Health Care in Rural Areas

Metropolitan and nonmetropolitan areas also have different economic activities, and these differences have effects on access to health care. Counties that remain dependent on agriculture and farming—that is, areas where 50 percent or more of total county earnings are derived from agriculture according to USDA's Economic Research Service (USDA, ERS, 2005)—tend to be those that have also continued to show population declines. Families in those counties in rural areas may not have access to health care because they are self-employed on their farms or in some other business and therefore have no health plan provided by an employer. In addition, Burke indicated that the health needs of populations in mining-dependent counties, historically in Appalachia, Texas, and the West, differ widely from those in farm-dependent counties because of the presence of different diseases and chronic illnesses.

Starting in the 1970s, manufacturers moved to rural areas, particularly in the South, the Midwest, and some central states. Therefore, in some counties in those states, a large number of people are employed in manufacturing. These manufacturers, if they are large, may provide coverage for health care, but others do not or the insurance may be very expensive for the employee. Other counties receive a high proportion of income from employment with federal and state governments, and yet some others—although these are significantly fewer in number—may derive their income mainly from retail, finance, and real estate services. Finally, some counties are not differentiated on the basis of economic activity; these are considered nonspecialized counties.

A special type of county is the recreational or tourism county. There are not many of these in Iowa. Mostly, these areas are around the Great Lakes; in the Northeast; and in the West, where there are mountains. Recreational counties may be very seasonal, depending on the kind of recreational activities that they offer, so they may have many visitors at certain times of the year and few at others, noted Burke. As a result, these counties may experience seasonal peaks and troughs in health care demand and have a particular need for special types of health care services, such as those needed to treat people involved in accidents.

Finally, retirement, although it is not an economic activity, has also influenced the economics and health care situations in various parts of the country. Contrary to popular belief, states where people go for their retirement are not only in the Southeast (Florida) and Southwest (Arizona, New Mexico, and Texas), but also include Minnesota and Wisconsin. Retirees bring with them a whole set of health issues, such that counties with a high proportion of older people have health care delivery needs that differ from those in the rest of the country and may also have seasonal populations if the weather is uninviting during part of the year, such as in Arizona during the summer, said Burke.

Socioeconomic Aspects in Rural Areas

Other socioeconomic aspects differentiate metropolitan and nonmetropolitan areas. The former, for example, tend to have a higher proportion (by 4 or 5 percentage points) of people who have completed high school. The difference is even higher in terms of the proportions of people with a college education. Higher levels of education and higher rates of high school completion, in turn, correlate with a lower prevalence of poverty, less unemployment, and greater access to health care. In Iowa, the problem is not that people are not being educated at the college level. The problem is that young graduates move out of the state or to metropolitan areas upon graduation, noted Burke.

Nonmetropolitan areas also tend to have slightly lower rates of employment than metropolitan areas. As is the case for education and poverty, areas that tend to have low rates of employment tend to have a low proportion of well-educated people. The same is true of income. The median annual household income in nonmetropolitan areas lagged $11,000 behind that in metropolitan areas in 1999. As would be expected, the rate of poverty in nonmetropolitan areas tends to be higher than that in metropolitan areas, and those counties where the population has low levels of education and low rates of employment are the ones with the highest poverty rates (i.e., 20 percent or more of the population is below the poverty level). In addition, pockets of poverty persist in various parts of the country.

Also, as some workshop participants noted, more than 46 percent of land in Iowa is owned by women and the number of female ownership is growing partly because women live longer. A lot of resources in Iowa will be changing hands disproportionately in the near future because, according to a participant, currently the average age of farmland owners in Iowa is over 65.

Age Disparities in Rural Areas

Nonmetropolitan areas tend to have a higher proportion of people older than 65 years of age. One of the reasons for this disparity is that nonmetropolitan areas have had more outmigration of youth. In some areas of Iowa, there has also been the loss of people 65 years of age and older. A small cohort of births occurred during the Depression, before World War II and the Baby Boom. During the Depression, people postponed weddings and having babies, and as result, the birth rates were historically low. That small cohort of individuals born just before the Depression is smaller than the preceding generation and the Baby Boom generation that came after it. That small cohort of individuals is the one that has become age 65 and older in recent years. Thus, in the current decade, the older people died off and those entering the 65-plus age category are a smaller group, noted Burke. Once the large cohort of Baby Boomers starts turning 60 and 65, the cohort of older people will increase as Iowa is already a leading state in the nation in terms of aging population.

Ethnic Diversity in Rural Areas

Nonmetropolitan areas tend to have less ethnic diversity and smaller minority populations—that is, any race other than white—than metropolitan areas, although in this regard there are major differences among nonmetropolitan areas. For example, Alaska shows a high percentage of Native Alaskans, whereas certain areas of the West have large Native American populations that were forced to migrate there. These populations have mostly remained in the same areas and retained their proportion of the total local population between 1990 and 2000. Asians have also continued to settle for decades in the same areas where their ancestors first located, mainly the West Coast and Hawaii. Similarly, from a historical perspective, African Americans have concentrated in metropolitan and nonmetropolitan counties in the South and some other metropolitan areas around the country, but other nonmetropolitan areas continue to have very few African Americans. In Iowa, as in much of the Midwest, African Americans are largely in metropolitan areas. Hispanics from Mexico historically settled in the Southwest, Cubans settled in Florida, and Puerto Ricans settled in the Northeast. In the central region of the United States, many counties had less than 1 percent Hispanics as recently as 1990. By 2000, however, the change in some areas was dramatic, largely because of opportunities for employment in food-processing industries. In Iowa, Kansas, Nebraska, and Minnesota, the proportion of Hispanics has risen rapidly in counties with meat-packing plants. In seven Iowa counties, this increase reached 1,000 percent between 1990 and 2000, so that cities such as Marshalltown and Storm Lakes now have proportions of Hispanics of 15 percent and 20 percent, respectively. A large increase in the Hispanic population can be seen in North Carolina and Arkansas as well, where the proportion of Hispanics increased by more than 300 percent from 1990 to 2000.

Burke concluded that while the patterns for Native American, Asian, and African American populations did not change radically from 1990 to 2000, the size of the Hispanic population changed dramatically across much of the country.

LANGUAGE, CULTURE, AND HEALTH

The issue of demographics is a serious one for Iowa, said John-Paul Chaisson-Cardenas of the Iowa Division of Latino Affairs. The general population of Iowa—the Caucasian population—is growing older, there is a brain drain out of colleges and universities, and the entire labor force will need to be replaced in some communities. In 2000, there were 32.8 million Latinos in the United States, equivalent to approximately 12 percent of the total population (U.S. Census Bureau, 2000a). This proportion had grown to 13 percent by 2004, with steady growth that will continue through the years. The changes taking

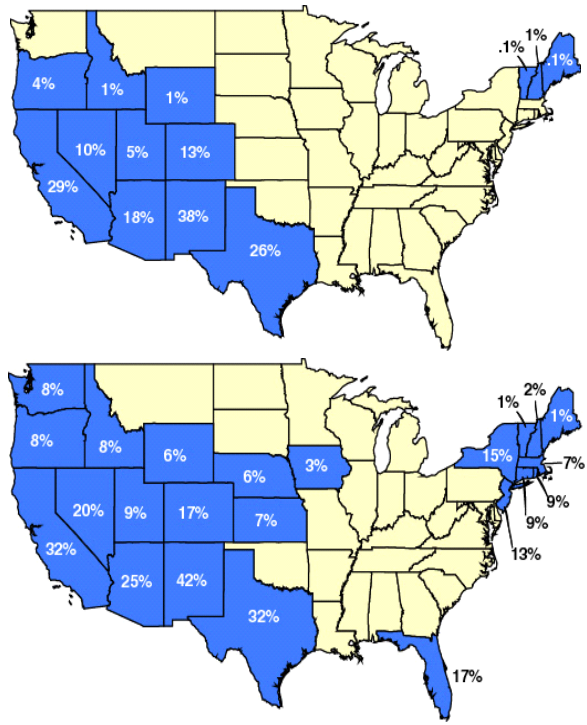

FIGURE 2-2 Growth of the Latino population in the United States from 1990 to 2000. In 1990, Latinos fromed the largest minority in 13 states and by 2000 grew to become the largest minority in 23 states.
SOURCE: U.S. Census Bureau (2000a).

place consist of not only the size of the Latino population, but also the locations where that population chooses to live (Population Resource Center, 2005). In 1990, Latinos were the majority of the minority—the largest minority group—in 13 states; by 2000, this number was 23 states and included Iowa (Figure 2-2) (Ramirez and de la Cruz, 2002). All but one Iowa county had growth in the Latino population between 1990 and 2000, and although the overall growth was 153 percent, in seven counties that growth was over 1,000 percent. As a result, a culture and a language different from those of the predominantly white population are becoming part of Iowa and will influence Iowa's future development.

With the growth in the Latino population emerges a subpopulation of students with limited proficiency in English. This means that the number of Latino students in Iowa schools from preschool through grade 12 grew by 425 percent between 1985 and 2002. In contrast, there was a negative growth (–7 percent) in the propor-

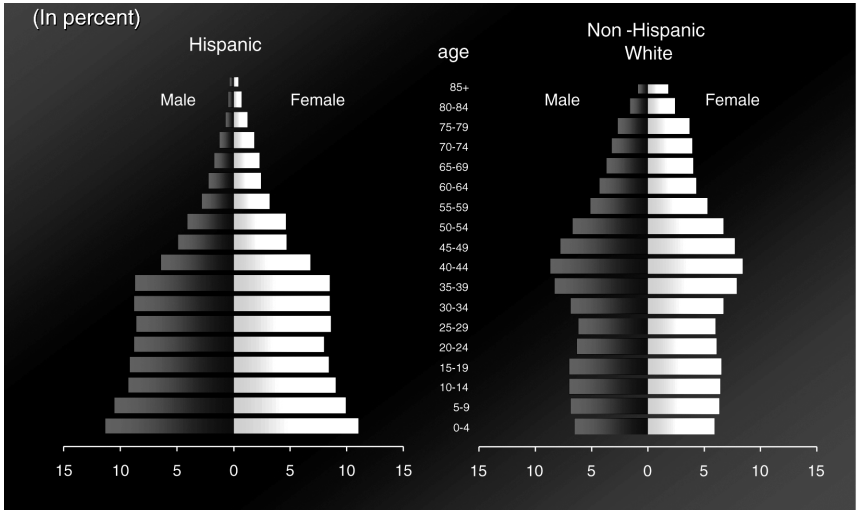

FIGURE 2-3 Growth curves for the Hispanic and the white populations.
SOURCE: Ramirez and de la Cruz (2002).

tion of white students during the same period of time (Iowa Commission, 2004). Although it is hard to assess the number of non-English-speaking Latino adults and Latino adults with a limited proficiency in English, because these schoolchildren have parents or guardians it can be assumed that there are many non-English-speaking Latino adults, and this begins to paint a picture of Iowa different from that which most people perceive, noted Chaisson-Cardenas. In addition, as the demographics of the population in Iowa's schools change, so does the population that will be the service providers in Iowa in the future.

There is a tendency to think of Latinos as immigrants, and indeed, a good proportion of them are, noted Chaisson-Cardenas. However, it is frequently forgotten that Latinos are also a native-born population of the United States and have been since before the United States became a country. As a result, the significant changes in the ethnicity of the population of Iowa result not only from immigration but also from migration from other states.

The growth pyramid for the Latino population is significantly different from that for the Caucasian population. Whereas the graph in Figure 2-3 exhibits a bulge contributed by the Baby Boom generation, which corresponds to the group that is now 41–59 years old, the pyramid for the Latino population shows a large group in its 20s (Ramirez and de la Cruz, 2002). The average age of Latinos is 23 years, a prime reproductive age, indicating that this population will create the most growth in Iowa for at least the next 15 years (Figure 2-3) (Ramirez and de la Cruz, 2002). This should be taken into account as part of the process of

planning for Iowa's environmental health, but this is not being done at present, indicated Chaisson-Cardenas.

Latinos are disproportionately affected in many areas of health. Thus, 50 percent of Iowa's Latinos do not have health insurance, and they are much more likely than other groups to become diabetic (Iowa Commission, 2004). Young Latino women tend not to receive the prenatal care that they need. The result is an environment in which the institutions created to serve other people are not responding adequately to the growth of the new population.

One significant reason for the unresponsiveness of the health care system to the needs of Latinos is a lack of "cultural competence," defined as the ability of a professional to be effective with a client who is of a cultural background different from his or her own, said Chaisson-Cardenas. However, some participants noted that different cultures expect different things from their professionals. For example, in some cultures patients expect doctors to tell them what to do rather than being given options and being part of the decision-making process.

Culture and language are not barriers by themselves; they are simply part of each person's background and the way in which each person was raised. These factors weigh heavily on that particular relationship that must be established between professional and client, doctor and patient, police and civilian, and researchers and those whom they are trying to study. In such a relationship, it is the burden of the professionals to adapt to the culture of the people they are trying to serve. For example, if a Latino is seeking help from a mental health professional and the professional does something that insults the patient or breaks the relationship so that the two individuals cannot build a rapport, the breakdown is not a result of the patient's Latino culture but rather a result of the professional's lack of skills. Is the professional using the appropriate methodology or the appropriate skills that are needed to be effective with the patient? In other words, if the doctor or nurse cannot treat somebody as a patient because he or she cannot speak the person's language, that is not the fault of the language or the patient but rather a result of a lack of skills on the part of the professional, and that particular skill is language—a communication skill, suggested Chaisson-Cardenas.

In addition, cultural competence is a responsibility not only of the individual but also of the entire system. If the population changes, the system must adapt to the change. It then becomes necessary to examine the effectiveness of the system that is treating people who are culturally different from the majority population. This reevaluation is needed in the areas of mental health, general health care, public health, how programs are coordinated, and what research is being done. When professionals try to research Latinos, they often do not have the base level of cultural competence, and their research comes out flawed because they have not reached the population that the research was supposed to reach. Therefore, cultural competence should be viewed as a premise for achieving effectiveness, said Chaisson-Cardenas.

The issue of language was identified in Iowa more than 30 years ago. A report published in 1979 documented the need for interpreters, particularly in health and in the courts (Conóceme en Iowa, 1979). It took about as many years to pass legislation that established standards for qualified interpreters, according to Chaisson-Cardenas. The Interpreter Bill was finally passed in 2004. That legislation gave the state government jurisdiction in setting qualification standards for language interpreters in social services, mental health, general health, the courts, and administrative agencies. The bill recognized the fact that if one cannot communicate as a professional with the client, the tool that a professional needs to become effective is a qualified interpreter—just as much as the professional needs a stethoscope to effectively listen to the patient's heart.

The interpreter, sometimes consciously and sometimes unconsciously, serves as a cultural mediator, because more information than just words to be translated is being collected. The interpreter is able to collect information through body language, context, and perhaps familiarity with the patient's cultural background and interpret that information for the physician. However, many people forget that the interpreter is nothing but a tool; and if one is to focus as a professional, one needs to use all his or her skills—rapport-building skills—and use them directly with the person one is trying to serve, said Chaisson-Cardenas. Nevertheless, the professional tends to focus on the interpreter, and he or she must be taught how to divert his or her attention from the interpreter to focus on the person being served, much in the way that a physician is taught how to use a stethoscope.

People become impatient with interpreters because their use as part of caregiving is tiring, and interpreter fatigue is also a problem. (It has been demonstrated that the longer an interpreter translates, the lower the quality of the translation [House, 1997]). Other interpreter-related issues are evaluations of interpreter performance and the qualifications of interpreters. Iowa has not had a mechanism to qualify interpreters, although some hospitals have dealt with this issue, noted Chaisson-Cardenas. With the new Interpreter Bill, Iowa will put in place a system that actually measures the technical proficiencies of interpreters and second-language speakers.

In conclusion, language and cultural competence are skills that put the focus of responsibility on the professionals, not on the clients. Those professionals who gain such skills become more marketable and much more effective in the long run than those who do not.

RURAL INFRASTRUCTURE: ENVIRONMENTAL HEALTH AND BEYOND

As mentioned above, some significant differences exist between rural and urban populations and between rural and urban health care delivery systems. When actions at the local rural community health level are planned or information on national policy decisions with implications for rural health is sought, it is

important to understand the unique characteristics of rural communities, their environments, and the conditions under which health care is delivered to rural populations. This means the consideration of factors as varied as population density, the remoteness of a community from large urban areas, the characteristics of the local workforce—and, even more specifically, the characteristics of the rural health care workforce—and the cultural norms of the region, all of which influence health and health problems that rural communities face, said Mary Wakefield of the University of North Dakota.

Rural areas tend to have a higher proportion of older residents. This difference, by itself, has immediate implications for the rural health care infrastructure, as well as for the infrastructure of the broader community. Thus, elderly individuals have a greater need for health care services related to chronic disease management and long-term care, and this affects the specific types of health care that are available, noted Wakefield. As an example, some rural communities have an infrastructure of cardiac or stroke rehabilitation facilities but lack an obstetrics unit that would be available in a larger city. Therefore, even the basic infrastructure of health care manifests itself differently to serve the needs of different populations in rural communities. Another example is evidence of differences in health behaviors between rural and urban populations. Individuals in rural areas exhibit poorer health behaviors, as shown by their higher rates of smoking, higher rates of obesity, and lower rates of exercise, noted Wakefield.

The bucolic myth of the fit, trim farmer is often just that, a myth, because many individuals who live in rural areas are not farmers, and many of them are not trim. Rural environmental characteristics, such as the mechanization of farm work and the features of the built environments of small towns—which typically do not include the fitness facilities or the bicycle trails that might be found in an urban landscape—combined with a motorized way of life, necessary to traverse long distances even for children to go to school, contribute to decreased levels of physical activity. Therefore, there are important links between rural population characteristics, the health of individuals and rural communities, and the infrastructure that surrounds them. Those features can often be quite different between rural and urban areas.

The bucolic myth of the fit, trim farmer is often just that, a myth, because many individuals who live in rural areas are not farmers, and many of them are not trim.

—Mary Wakefield

To respond to health care challenges such as obesity in many rural communities, one would generally find strategies that are used in a personal health care delivery system, as opposed to a population health approach, noted Wakefield. Hence, one would likely see a focused health care system response to deal with an individual who is overweight or obese. This focus might be on the use of a dietitian to counsel the overweight or obese individual about dietary intake and

meal planning. To move from a personal to a population health approach or orientation, it would be necessary to engage a group of different stakeholders, in addition to the dietitian, including, for example, public health and environmental health professionals as well as community planners. Thus, in addition to interventions such as meal planning targeted at individuals, the built environment of rural communities could also be modified in meaningful ways to influence the occurrence of overweight, obesity, and comorbidities across rural areas, with a sought-after outcome of positively influencing population health.

Wakefield pointed out that the health care systems in many rural communities truly struggle to sustain their vitality. For too long those involved with the rural health care infrastructure have been excessively focused on the bricks and mortar and the activities that go on inside hospitals and clinics and have not focused enough attention or connected to other sectors within rural communities sufficiently to influence not just the individual's health but the health of the entire community as well. Part of the reason for this has been the difficult challenge facing health care providers in rural communities because their health care infrastructure is financially fragile owing to the difficulties in attracting even an adequate health care workforce. Consequently, it is and has historically been very difficult to invite health care providers to step outside their traditional role inside a health care system—where they are delivering individualized health care—and ask them to step back and conceptualize how they can improve the health of the members of the community by working in tandem with other sectors.

Strategies to Link Health and the Rural Environment

Health care for communities needs to be addressed by the use of a much broader, population-focused approach, said Wakefield. To start the movement toward a broader community health care approach, the Institute of Medicine (IOM) recently released the report *Quality Through Collaboration: The Future of Rural Health* (IOM, 2004), which discusses the need to engage other sectors and focus on community health by addressing issues that include environmental health, business, agriculture, and education. The IOM report begins to build a platform designed to strengthen rural health and the rural environment by meaningfully linking relevant dimensions of the built, the natural, the social, and other environments that characterize rural America and proposes five strategies to achieve that end, noted Wakefield.

One of the five strategies proposed to improve the quality and infrastructure of health care in rural communities is to adopt an integrated, prioritized approach to address personal and population needs at the community level. The second of the five strategies proposed in the IOM report is the establishment of a stronger quality improvement support structure to assist rural health systems and professionals. The third strategy that can be used to address and strengthen the health

care infrastructure in rural communities focuses on enhancing the human resource capacity of rural communities, including the education, training, and deployment of health care professionals and the preparedness of rural residents to actively engage in improving their own health and health care. Therefore, when talking about health care in rural communities, the report suggests not only that the traditional health care environment and health care workforce need to be considered, but also that new, creative, and innovative ways of making rural residents part of their own infrastructure for ensuring access to high-quality health care need to be found. The fourth strategy, monitoring and ensuring that rural health care systems are financially stable, addresses a problem that has a collateral impact on the rural community, in the sense that without a strong health care infrastructure, the economic health of the community may be compromised. Thus, businesses may decide not to locate in those communities or businesses in those communities may decide to relocate away from those communities on the basis of the availability of a health care infrastructure for their employees. Similarly, some senior citizens may decide whether to stay in a rural community or move on the basis of the availability of an appropriate health care infrastructure. As a result, the rural health care sector is tightly linked in important ways to the economic health of rural communities, thereby highlighting the importance of ensuring the financial stability of rural health care systems. Finally, the fifth strategy for ensuring an adequate health care infrastructure in rural communities outlined in the IOM report revolves around investing in and building information and communications technology infrastructure.

The rural health sector is tightly linked in important ways to the economic health of rural communities, thereby highlighting the importance of ensuring the financial stability of rural health care systems.

—Mary Wakefield

Of the five strategies proposed in the IOM report, three can be woven into the discussions of environmental health: (1) the focus on personal and population health, (2) the health care workforce, and (3) building access to information and communication technology.

Personal Versus Population Health Approaches

An overriding theme of the first strategy—personal and population health needs—in the IOM report is the view that rural communities should focus greater attention on improving population health, in addition to meeting personal health care needs. This theme was arrived at through recognition of the fact that health care is only one of a number of determinants of the health of individuals, families, and communities, although access to high-quality personal health care services does increase health and helps to reduce disease. Other important deter-

minants of health status in communities include behaviors; environmental exposures and threats; and social circumstances, such as educational level and socioeconomic status. Therefore, expansion of the focus on health and health care to include facets of that broader infrastructure can have a major impact on community health, said Wakefield.

As a corollary of this principle, the IOM report concluded that health care providers share responsibility with other groups, such as consumers, educators, employers, governments, and religious organizations in rural communities, to work together to achieve positive population health outcomes. Similarly, the local rural infrastructure should reflect collaborative efforts at the community level to create environments that minimize the likelihood of illness or disease and to provide incentives to residents of rural communities to pursue healthier lifestyles.

This reorientation of personal to population health needs and the need to engage other sectors for a broader approach to rural health are consistent with IOM's concept of quality of care as "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes," (IOM, 2004) noted Wakefield. Consequently, a population health focus needs to be built into the decision making of the health care sector as well as that of other sectors of rural communities, such as the community and environmental planning sector and the educational system, as well as rural cooperatives concerned about a strong rural community. An essential vehicle for accomplishing these goals is collaboration across sectors.

The IOM report made various recommendations regarding how the suggested strategies could be tested. One recommendation was that federal funding should be made available to support comprehensive health care system reform demonstration projects in a limited number of communities. These demonstration projects should evaluate alternative models for achieving greater integration of personal and population health services and developing innovative approaches to the financing and delivery of health care services. The new models or prototypes—which should be funded at the federal level and engaged at the local level—should use an integrated approach to improving health care by tying in more tightly and seamlessly the various elements of the rural infrastructure.

The purpose of the suggested demonstrations called for in the IOM report is to achieve six quality aims for improving health care delivery systems in rural and urban areas alike: The care that people receive should be safe, effective, patient centered, efficient, equitable, and rendered in a timely manner, indicated Wakefield. Historically, these aims have been directed almost exclusively at the personal health care delivery system, that is, hospitals, doctors, clinics, nursing homes, and the like. The report takes those concepts to the community and population health system levels. Thus, whereas safety in a hospital means that the patient seeking care is not injured, safety in the community context might mean the adoption of measures that include the avoidance of accidents or inju-

ries that commonly occur in rural communities or rural areas because of compromises in the environmental, occupational, and recreational areas as well as other areas of safety. Adoption of these measures, in turn, might require the adoption of a variety of community planning strategies for improving community-level safety, ranging from the measurement of toxic exposures to the elimination of environmental hazards and the enhancement of traffic safety.

Rural Health Care Workforce

Many external forces impinge on rural communities today, such as government policies, urban issues that are generalized to rural communities, and payment policies. For this reason the IOM report discussed the need for strong leadership to address not only what is going on within rural communities but also those events in the external environment influencing the health status of rural communities, noted Wakefield (IOM, 2004). For example, it is essential to field educated individuals who have management skills and knowledge, some background in community planning and collaboration, a knowledge of epidemiology, and exposure to social and environmental services to practice and work in rural communities, as all of these areas are important to community health leaders. Therefore, the report covered such topics as combined degree programs that diverge from the traditional, narrowly focused programs that have historically prepared health care providers. This implies that students need to work, practice, and live in rural communities to acquire a much broader context than has historically been the case.

Building Access to Information and Communication Technology

The third strategy discussed in the IOM report that could be best woven into rural health today deals with information and communication technology (ICT), which requires a community-based approach that uses public as well as private resources across sectors. To build an ICT infrastructure, the focus must be not only on the health care sector but also on expanding beyond the health care sector to other sectors in local rural communities, such as educational and regional businesses that could also benefit from a stronger communication and information infrastructure. Because the growth of ICT in some rural areas often lags behind that of their urban counterparts, the "digital divide" for health care and other sectors in rural communities is becoming one of the greatest challenges to the rural infrastructure, according to Wakefield.

As part of its ICT-related recommendations, the IOM report focused on the inclusion of a rural component in the plans of the National Coordinator for Health Information Technology, a new position created by Executive Order in 2004 and housed within the U.S. Department of Health and Human Services (Executive Order, 2004; ONCHIT, 2005). The report emphasizes the fact that a

rural component is necessary because whatever is designed for urban areas will likely not be fit for rural communities.

The report also recommended that all rural communities be provided with high-speed access to the Internet and offered details on how that can be accomplished. In addition, the report called for the fostering of information and communication collaborations and demonstrations in rural areas. Finally, the report recommended the provision of ongoing educational and technical assistance to rural communities to make the best use of ICT.

A journalist once said, while capturing the challenges and excitement during the formation of the European Union: "We all share the same sky, we just have different horizons." "What a much better picture of the landscape we would have if we were able to seamlessly share our various views of those horizons," concluded Wakefield.

RURAL MENTAL HEALTH: A MULTIFACETED ISSUE

Mental health is a facet of health that undergirds the vitality of all rural life. The problems associated with mental health in rural areas have many facets, and as a result, many people, institutions, and organizations work diligently to improve the social and mental health of rural Iowa and rural America, said Cecilia Arnold of the Ligutti Rural Community Support Program. Perhaps the best way to examine these many facets of rural mental health is through a review of the overall situation in rural areas that affects the mental health of rural dwellers and then through a specific look at depression and three population groups.

Factors Affecting the Mental Health of Rural Dwellers

In rural Iowa, as in many other states, the farming population is declining because of changes in agriculture and fragile economic systems. Those who remain are increasingly isolated, noted Arnold. The average age of farmers is the mid-50s. Farm children are not encouraged by what they observe and tend to plan their future in urban areas or out of state.

Farm couples today often work off the farm to make ends meet, and more often than not employers are several miles away. This implies transportation costs that affect the family budget. Accessibility to needed services and work is difficult without reliable transportation systems. The available jobs, in turn, are part-time and offer low pay; even full-time jobs provide low pay and often do not offer basic benefits, let alone comprehensive health care coverage that would include mental health treatment, indicated Arnold. Moreover, when large corporate retailers move into small communities, local businesses can seldom compete and are forced to close.

The percentage of working poor in rural areas is higher than that in urban areas, and, in general, rural areas have more poverty, said Arnold. Services like

law enforcement, emergency medical services, domestic violence shelters, and mental health services have diminished in rural areas, whereas social problems, such as the scourge of methamphetamine use, have taken hold.

The culture of rural states such as Iowa tends to be one of self-sufficiency, traditional values, and patriarchal social structures.

—*Cecilia Arnold*

The culture of rural states such as Iowa tends to be one of self-sufficiency, traditional values, and patriarchal social structures. Rural residents represent several generations who embrace these and other cultural characteristics with varying degrees of intensity. The population of Iowa is now more diverse as a result of the immigration and migration of people from many cultures, who face discrimination along with the challenges of assimilation. All these facets of rural life point to the challenges that can distress individuals, families, and communities and act as a catalyst to mental health problems, noted Arnold.

Sixty percent of rural areas in the United States are designated areas with a shortage of mental health professionals; most of Iowa's rural counties have that designation. Regrettably, Iowa does not have data on the incidence or the geographic locations of mental illness in the state, noted Arnold. The existent data cover only those individuals receiving public pay assistance. Complete data would be invaluable for research and to help better serve mentally ill individuals in the state.

Rural Mental Illnesses: Depression

Looking at a general picture of rural mental illnesses—and at depression in particular—the report of the Rural Women's Work Group of the Rural Task Force of the American Psychological Association (APA) and the American Psychological Association's Committee on Rural Health (APA, 2005) describes the mental health care needs of rural women. Suicide rates, particularly in the rural west of the United States, are as many as three times those in urban areas. Forty-one percent of rural women, as opposed to 13 percent to 20 percent of urban women, report high levels of anxiety and depression (APA, 2005).

Regardless of the importance of depression in the overall burden of disease, a study conducted with medical outpatients reported that depression was accurately diagnosed in less than one-half of community and primary care settings (Attiullah and Zimmerman, 2003). Similarly, when they were interviewed as part of an ongoing study, rural physicians in east-central Iowa admitted feeling ill-equipped to diagnose and treat depression. Moreover, they were unaware of the best practices for the treatment of the illness. These same providers are generally overburdened from the running of their rural practices and are vulnerable to distress and depression themselves, noted Arnold.

Clergy are in a similar situation and admit to being at a loss in dealing with mental illness. This is a troublesome admission, considering that members of the clergy are seen as the individuals who are the most likely to be approached by someone in distress, especially in rural regions. Consequently, education about intervention and mental illnesses needs to be readily available to health care and helping professionals, consumers, family members, and the community to change practice patterns, reduce the stigma of mental illness, and improve the outcomes for those with mental illnesses such as depression, said Arnold. This approach would encourage rural dwellers to seek help sooner. It is noteworthy that rural people tend to enter mental health treatment later in the course of disease than their urban counterparts and remain sick longer and at a higher cost compared with the length of illness and the cost of treatment for their urban counterparts (Mohatt, 2003).

The ability to pay is also a factor in early intervention. A study of Wisconsin farmers indicated that the majority were underinsured (PATS, 2002). The Kaiser Commission on Medicaid and the Uninsured says that farmers are 10 times more likely to self-purchase insurance and to have limits on coverage and are less likely to seek preventive services than the general population (Ziller et al., 2003).

Depression is linked to a host of social problems, such as suicide and domestic violence, and the latter is a problem in Iowa, as it is in other states (Hegarty et al., 2004). In small communities, where most people know one another, danger lurks for the victims of domestic abuse. The perpetrator is known and may have friends among local law enforcement personnel and residents, who avoid getting involved in what is seen as a private matter, noted Arnold. Therefore, the proper and early diagnosis and treatment of depression may go a long way toward avoiding more serious problems, like violence in the home.

Education in self-care is another avenue that can be taken to avoid episodes of some types of depression, whereas the examination of environmental impacts may open the door to more prevention. The Department of Psychology at Colorado State University conducted a survey of a cross-section of farm couples in northeastern Colorado and assessed them for depression and pesticide poisoning (Stallones and Beseler, 2004). The conclusion was that exposure to pesticides at a concentration high enough to cause reported poisoning symptoms was associated with high rates of occurrence of the symptoms of depression, independent of other known risk factors for depression, among residents, said Arnold. Those who self-reported pesticide exposures at the level that would cause poisoning were almost six times more likely to have symptoms of depression. This points to the need to do more research about the effects of pesticides and other environmental exposures on mental health.

Another prominent issue in rural America is the abuse of methamphetamine, a drug that is very dangerous to manufacture and seriously addictive. A meeting of the National Catholic Rural Life Conference in early November 2004 listened to various anecdotal reports from farmers and clergy in Kansas, North Dakota,

Ohio, Wyoming, and Wisconsin about the proliferation of methamphetamine in rural areas of their states. In growing numbers, the parents of addicted individuals and those incarcerated for methamphetamine-related crimes are raising their grandchildren. In response to this problem, Iowa has begun a program called Meth Watch, a collaborative effort among government, retail, law enforcement, and religious leaders. The program works by limiting access to the common ingredients for the manufacture of methamphetamine and providing information on such purchases to law enforcement.

Rural Mental Health in Selected Populations

Specific factors affect the mental health of various population groups in rural America. The first of these groups is the elderly. According to the 2000 U.S. census, the age group 80 years old and over is increasing more rapidly than any other age group in the country (U.S. Census Bureau, 2000a). Iowa's proportion of older adults in the population exceeds that of the United States as a whole: It is second in the nation in the percentage of individuals 85 years of age and older, third in the nation in the percentage of people 75 years of age and older, fourth in the percentage of individuals 65 years of age and older, and fourth in the proportion of those 60 years of age and older (U.S. Census Bureau, 2000a).

A statewide assessment of noninstitutionalized older Iowans ranging in age from 60 to 104 years, conducted by the Iowa Department of Elder Affairs (IDEA) Area Agencies on Aging and Iowa State University, indicated that older Iowans do not tend to be poor, although 20 percent have annual incomes below $10,000 (IDEA, 2005). The older a person becomes, the more likely that the individual has an income below the poverty level. Older women living alone are more likely to be in the category of individuals with annual incomes of $10,000 or less (U.S. Census Bureau, 2000a).

Sometimes, as a consequence of advanced age and illness, an individual requires care, said Arnold. As a profession, caregiving in nursing homes and home settings provides low wages and, often ironically, no benefits. In other cases, family members must quit their jobs to become full-time caregivers for a loved one, and although caregiving has its rewards, when a loved one requires extensive care and supervision, caregiving can become considerably stressful, noted Arnold. The caregivers of individuals with cognitive impairment are at an elevated risk of clinical depression. A comparison of elders who served as caregivers for their spouses and elders whose spouses did not need care indicated that the caregivers had a mortality rate 63 percent higher than that of the noncaregivers (Schulz and Beach, 1999). Similarly, the Geriatric Mental Health Foundation (2003) reports that elderly caregivers with histories of chronic illness of their own have a higher mortality rate than their noncaregiving peers, something that has led some doctors to describe such caregivers as "the hidden patient." Professional caregivers also experience stress from such factors as fa-

tigue, low wages, and long hours, which can lead to the actual abuse of the patient or loved one, noted Arnold.

The second population worthy of examination in relation to rural mental health is the immigrant and migrant sector. As noted earlier, Iowa is home to a rapidly increasing Latino population that has come to the state to provide for their families, generally by working in the meatpacking industry. Assimilation is not easy in the best of circumstances, but Hispanic immigrants and migrants working in rural areas have had to face other difficulties, including discrimination (Soto, 2000). According to Arnold, some have been the victims of traffickers, who put them into positions of servitude (Swanson, 2005). Adequate housing has been difficult for them to secure. In addition, they miss their families, who are often left behind. All of these circumstances are setups for a host of mental health problems, and there are few therapists who speak Spanish to work with them, noted Arnold.

The third population is one that constitutes an emerging concern: the National Guard members and reservists returning from the war in Iraq. Many rural residents join the National Guard to supplement their income. A study by Hoge and colleagues (2004) showed that one of every five combat soldiers leaving Iraq does so with a mental illness. With access to health care in rural Iowa diminished, the choice of mental health professionals limited, and the provision of full health care coverage by the military being only temporary, growing mental health care needs in rural areas are anticipated. To further compound the problem, some conditions such as posttraumatic stress disorder may not be known for months or years after the individual returns from the war.

Despite the challenges presented by the special populations described above and other mental health concerns, all of Iowa has many fundamental common strengths. For example, rural people in general are generous and willing to go out of their way to help their neighbors, noted Arnold. In addition, there are rural people with an entrepreneurial spirit who have a realistic vision of hope for new business ventures and for specialty farming. Communication systems such as the Internet and the Iowa Communication Network can link communities throughout the state for meetings and classes.

The challenges and strengths are not the same in every Iowa community, said Arnold. The culture of the residents, the history of the community, and the geography of the area are some of the factors that need to be taken into consideration. Each community is unique and addresses mental health needs in many ways. In some rural communities, churches have provided parish nurses, health ministers, or trained volunteers to fill the gaps in mental health support. By visiting congregants and parishioners going through major events like birth, death, marriage, and illness, church representatives are in a good position to intervene with support or referral to needed services and to initiate health and mental health prevention programs. Another example is the many groups of

concerned Iowans working to bring the Latino and the local residents together through leadership, church, and community activities.

Nevertheless, more can be done, asserted Arnold. At a recent focus group of the Iowa Rural Health Association, it was suggested that as a first step in looking at solutions, an assessment be made of the help needs of each community or region. Knowledge of the specific needs, the existing infrastructure, and the strengths of a community or region would allow meaningful, workable, and sustainable solutions to surface. Deriving from theories such as those found in *Gladwell's The Tipping Point,* planning and strategizing are creative and dynamic processes that make an art—so to speak—of bringing innovative changes to improve mental health care access, treatment, and social response (Gladwell, 2002). From a holistic, creative perspective, this process should not place limits on who takes part. All sectors, including those at the fringes as well as the usual partners and collaborators, must be brought together to create new perspectives and possibilities. Mental health concerns in rural Iowa and rural America are serious but not hopeless. Issues must continue to be studied and researched. Service providers and the community must continue to learn and remain open-minded as they work toward sustainable solutions, concluded Arnold.

3

The Role of the Natural Environment in Rural America*

The entire upper Midwest, including Iowa, is unique because of its intensive agricultural operations. Approximately 90 percent of Iowa's land is now used for agriculture; about two-thirds of this land is used for row crop agriculture, and the remaining is used for grazing (Iowa Department of Natural Resources, 2001). Agriculture provides an economic base for Iowa residents, but at the same time it also has significant environmental impacts. People had a connection to their land, and in rural America they still do, but the land and the water are changing, said Jerald Schnoor of the University of Iowa.

The change started quite early after settlement, beginning in about 1850. When the land was tilled for farming, it became vulnerable to soil and water erosion. In addition, natural habitat has been destroyed to make way for agricultural development. In fact, Iowa is the most ecologically altered state in the entire union; since 1850, it has lost 99 percent of its prairies, 95 percent of its wetlands have been drained, and 75 percent of its forests have been cut (Iowa Natural Heritage Foundation, 2002). Today's agricultural farming practices are under a lot of scrutiny, and World Trade Organization negotiations that will have major implications for U.S. agricultural production and production policy on cotton, sugar, and possibly rice are under way.

ECOLOGICAL FOOTPRINT OF IOWA AGRICULTURE

Colonization of the United States by Europeans has inflicted a dramatic transformation on the environment. Colonization, which took place primarily over the last half of the 19th century, was preceded by intensive, methodical

*The views expressed here do not necessarily reflect the views of the Institute of Medicine, the Roundtable, or its sponsors. This chapter was prepared by staff from the transcript of the meeting. The discussions were edited and organized around major themes to provide a more readable summary and to eliminate duplication of topics.

surveys. Those early surveys allowed the type of land resources that existed in Iowa before colonization to be seen. Iowa began to be colonized in a gradient that began in the southeastern extreme and then migrated along river channels to the northwestern part of the state. The surveys of that period indicate that roughly 20 percent of the area of the state was covered in forest or forest openings, and most of the remaining land was different types of grasslands and wetlands (USGS, NPWRC, 2005). Since the beginning of Iowa's colonization, the ecological transformation has been dramatic. At one time a diverse mix of agricultural species was produced in the state, including about 10 different livestock species and about 30 different crops. The picture today is very different. Ecologically, the system went from that originally encountered by the Europeans—a grassy plain with a complex ecological system similar to that of the Serengeti Plains of Africa—to a simple ecological system but a very complex and highly specialized industrial system, said Ricardo Salvador of Iowa State University.

The system primarily produces two row crop products—corn and soybeans—which are essentially managed as a unit that makes up the row cropping system in Iowa. The soybean crop entered the state in the 1930s and has essentially replaced oats. No state in the country has anywhere near the ecological simplicity of the row crop mixture that Iowa does, said Salvador. With the introduction of modern technology, machinery, pesticides, and fertilizers, the state's agricultural productivity increased from an average of 30 to 182 bushels of corn per acre. However, this gain has not been without trade-offs, noted Salvador. For example, the industrial system of production initially increased soil erosion rates dramatically. In addition, the production of nitrogen for use in fertilizers is energy intensive, as its synthesis requires high pressures and temperatures, but massive amounts of nutrients like nitrogen must be imported to support the row cropping system in this area. These nutrients go through the crop and livestock production systems and end up in the environment, including watersheds, which are susceptible to contamination by imported nutrients. Humans are accustomed to having a natural environment that has a large buffering capacity, and the cognitive behavior of humans suggests that this will continue because historically the environment has always absorbed human waste products. Now, however, the fluxes of these materials are so abundant that the environment is not diluting human waste products to safe levels quickly enough, and there is a lag in recognizing the impacts of this important feature of the system, concluded Salvador.

Wackernagel and Reese (1996) developed a technique to analyze the ecological footprint of urban areas, noted Salvador. The technique has been widely adapted and applied by urban planners. There are four items in ecological footprint: consumed land, built land, energy land (energy consumed within each of consumption categories), and service land (service consumption is translated into land area equivalents based on the resource consumption). The concept of an ecological footprint is based on the premises that (1) any population's consumption of food, housing, transportation, infrastructure, consumer goods, and

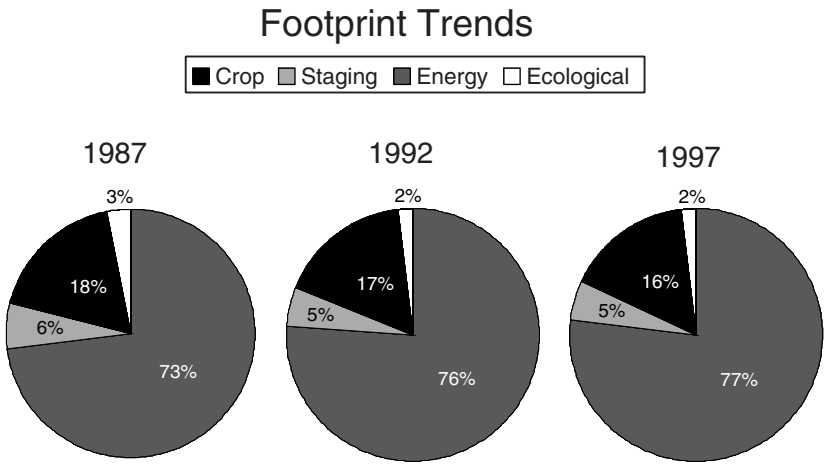

FIGURE 3-1 Assessments show that industrial farmers of the region have been decreasing all the components of their footprints.
SOURCE: R. Salvador, unpublished data.

services can be measured; (2) the population's consumption can be translated into land area equivalent necessary to produce, transport, and dispose of food, housing, transportation, and consumer goods; (3) the total number of acres used to produce the consumed resources and to dispose of the wastes equals that population's ecological footprint.

This ecological footprint technique was adapted to measure agricultural productivity as well, noted Salvador. If one were to measure the productivity of an area in Iowa before it became specialized for industrial agriculture, one would take the sum of all of the different types of plant biomass that existed and divide that over the area where that biomass was produced. That ratio would give the primary productivity of that area in the ecological sense, said Salvador.

The technique for measurement of agricultural productivity estimates only one component of the total ecological footprint of agriculture, however. In 1987, the footprint of the Iowa row crop equaled the actual area in production plus an increment of 27 percent of that area. Ecological footprint assessments were done in 1987, 1992, and 1997, and it appeared that industrial farmers in the region had been decreasing their footprints. In 1997, the footprint was 23 percent of the area in production, a negative 14.8 percent change (Figure 3-1). Therefore, Salvador concluded, it is apparent that all components of the ecological footprint are decreasing. This reflects increases in the internal efficiency of the industrial production system, primarily because of the use of herbicides to replace machinery and fuel for tillage and weed control.

As with other industrial production systems, the increase in agricultural productivity reflects a particular use of energy to boost specific transformations. In terms of the industrial system's long-term viability, it is noteworthy that the source of energy that accounts for its productivity gains is fossil fuel, which is used consumptively. Therefore, systems that minimize ecological impacts and that transition agricultural practice to a new phase that features more renewable energy transformations must be the target of agroecologists and agricultural scientists.

THE FUTURE OF FAMILY FARMS

When driving around the middle of the United States looking at farms, one would think that they do not appear much different from the way they did 40 or 60 years ago. Although changes are not obvious by looking at the countryside, U.S. agriculture has undergone a dramatic transformation over the past century-and-a-half, said Neil Harl of Iowa State University. Although part of the transformation has been institutional, much of it has come from technology—seed and genetics technology and power technology.

Since 1935 there has been an unbroken succession of reductions in the number of farms in the United States and increases in the average size of farms. In 1900, the average size of a farm was 118 acres. This average increased to 156 acres by 1925, 282 acres in 1969, and 352 acres at present. The present average size, however, is deceptive, because the increase in size of the large farms has been weighted down by the many small farms of less than 100 acres (Figure 3-2) (USDA, KASS, 2003).

Another way to capture the change in agriculture is to look at the percent change in sales rather than farm size. The number of Iowa farms with sales of more than $1 million increased 45 percent just in the period from 1997 to 2002; the number with sales between $0.5 million and $1 million grew by 12 percent. All other categories with sales of less than $0.5 million showed a decline. Clearly, farms are getting larger, and the amount of their sales is increasing as well, said Harl.

Since 1935, there has been an unbroken succession of reductions in the number of farms in the United States and increases in the average size of farms.

—Neil Harl

Traditionally, roughly one-half of Iowa's farmed land has been farmed by those who own it and roughly one-half has been rented and farmed by a tenant. Rental agreements are primarily cash or crop share. The proportion of land that is owned by those who farm it has declined in recent years. The organizational structure has not changed much, however. Sole proprietorships accounted for 77 percent of farms in 1969 and just under 87 percent of farms in 2002. The number of partnerships declined slightly

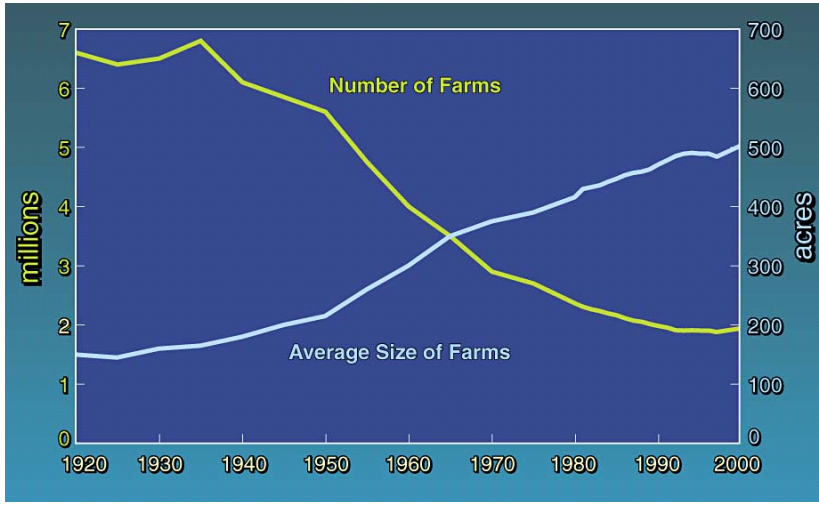

FIGURE 3-2 Number of farms and average farm size in the United States from 1920 to 2000.
SOURCE: USDA, KASS (2003).

whereas the number of corporations increased slightly. The preferred structures of land ownership have been the limited liability partnership, the limited liability company, and the limited partnership. Farmers have learned that if their land is put into a corporation, it is very costly to take it out of a corporation structure later; therefore, this structure is no longer as popular as it was a few decades ago, noted Harl.

The Impact of Technology

The most evident change in farms has been the significant impact of technology. For example, in the mid-1930s a typical farmer had a corn yield of 40–60 bushels per acre (with open pollination). After a change in the use of hybrid seed was made, however, the yield jumped to 60 to 80 bushels per acre. In 2003, as a result of seed and genetics technology and favorable weather, yields reached levels of 220–260 bushels per acre on some farms.

The other element has been power technology, which consisted of a dramatic substitution of capital for labor that set the stage for larger and larger farms. Horses were exchanged for tractors, and harvesting by hand—and later threshing—was replaced by harvesting with combines. The number of hours of labor per 100 bushels of corn and soybeans was also dramatically reduced from more than 40 and 54 hours per 100 bushels of soybeans and corn, respectively, in

1940, to such minuscule amounts in 1998 that the U.S. Department of Agriculture, considering them meaningless, ceased to keep statistics on them.

Economic Impact

Some problems facing American agriculture deserve examination, said Harl. Federal price and income policies, for example, have resulted in landowners being the major beneficiaries of federal subsidies, many of which are built into cash units and capitalized into land values. However, the largest beneficiary of this policy has been consumers, who have also benefited from federal subsidies as commodity prices have been reduced.

The United States has put in place one of the most intricate systems of benefit delivery to the consumer that anyone could have devised. Hence, when food is produced against an inelastic demand curve—a curve that is nearly vertical—and output is increased, the reward is a disproportionate drop in price and profitability to producers and a dip in food prices for consumers, noted Harl. Over the years, supply increases from ever-increasing yields have systematically squeezed the producer and delivered benefits to the consumer in the form of lower and lower food prices. The current low food prices and the architecture of the 1996 and 2002 Farm Bills have produced a situation in which commodities have been sold at less than the cost of production, with the U.S. Treasury making up part of the difference in producer income. The latter does not do much to remedy the basic problem, which is that producers are always being squeezed by the system, with the Treasury making up part of that difference in income through subsidies.

This situation is causing problems worldwide as well. When U.S. agricultural output increases as much as it has, not only U.S. prices but also world prices are driven down, cautioned Harl. Although the difference in lost income to the U.S. producer is made up to some degree, other countries cannot or will not make up that difference to their producers. As a result, the first hit is in land value in Third World countries, where it is already very low in relation to U.S. land values. Then returns to labor are affected, to the point where many small producers—that is, peasant producers—cannot function, which, in turn, has fueled a resistance to the removal of trade barriers. Consequently, over the past few years U.S. policy not only has squeezed U.S. producers to give the benefits to consumers, but also has systematically driven down prices worldwide and created a resistance to trade and, as some believe, created barriers to economic development.

Environmental Health Impact

The largest problems facing American agriculture at present are not fatal and nonfatal injuries, which show steady declines, but environmental health issues, noted Harl. Specifically, one of the areas in current farming that has caused

a great deal of policy concern nationally and in Iowa is the environmental impact of animal production because of the rapid increases in the number of confinement operations. Although cattle-raising operations are not as numerous in Iowa as they are farther west, Iowa has five counties—the largest hog producers in the state—that have more hogs than Iowa has people: 3.3 million hogs. Given that a hog produces roughly twice as much waste as a human, the hogs in those five counties produce more waste than all of Iowa's human population (USDA, NASS, 2002). The 2002 agricultural census indicates that the hog farm capacity, in terms of inventory—which now consists of a thousand or more hogs per farm—has increased so much that there is now a very large move toward large-capacity confinement operations. Smaller producers—those who do not have much of an impact on the environment—have been losing ground for the past 20 years.

> The largest problems facing American agriculture at present are not fatal and nonfatal injuries, which show steady declines, but environmental health issues.
>
> *—Neil Harl*

Hogs raised from birth to market in confinement units—hog finishing buildings—imply cost externalities in farm stream pollution, odors, and waste disposal. Several solutions to these concerns have been proposed. One of them would be to develop an ethic, "thou shall not pollute," said Harl, by

- developing an ethic of environmental preservation,
- imposing legal constraints,
- creating economic incentives, and
- facilitating bargaining between and among parties.

Future Prospects

In the future, approximately, the next 70 or 80 years, farming will be affected by two main forces, and neither of them is technology, said Harl. These forces are international trade and Third World economic development coupled with international competitiveness.

With regard to the first force, international trade, a theorem in economics postulates that if totally free trade is achieved so that goods move without limitation across boundaries, capital will move freely as well; and if technology were equally available everywhere, there would be a trend toward equal returns to labor and land of the same quality everywhere. That means a leveling effect around the world if the quality of the land and labor was equal everywhere. It follows, then, that to avoid the leveling effect, the country should be investing more in education and those things that affect the quality of labor. The biggest factor that would affect the quality of labor would be improving the level of health. In this respect, if one asks whether the relative health position of people

in rural areas has deteriorated compared with that of urban Americans over the past 80 years, the answer is probably affirmative. The U.S. agricultural sector has certainly lost people, and this loss will likely continue to put pressure on rural health care and delivery systems.

The international competitiveness effect relates to outsourcing. Anything that is mobile today is coming under pressure to be outsourced to another part of the world where labor costs are lower. However, although U.S. jobs are being lost to locations overseas in many industries, this is not likely to affect crop production because climate and soils are not mobile. On the other hand, although livestock are mobile and their production could be moved overseas, it is unlikely that this will happen because livestock production is tethered rather tightly to the cost of feed grains, and the lowest-cost feed grains in the world are in the United States. Therefore, international competitiveness could well benefit American agriculture in the sense that if trade policy continues to favor free trade, it could increase the demand for food worldwide. This not only would be good for U.S. agriculture but also would help alleviate world hunger and eliminate one of the causes of disharmony in the world, concluded Harl.

FARMING PRACTICES: FROM SOIL EROSION TO PESTICIDES

Some agricultural production practices have direct health effects, said Mark Ritchie of the Institute of Agricultural and Trade Policy. For example, an estimated 70 percent of antibiotics are used for nontherapeutic purposes in intensive livestock production; therefore, the risk of contracting an antibiotic-resistant infection could increase for somebody working in an intensive hog-rearing barn. As a result, insurance companies may have to pay the bill for antibiotic resistance, including the extremely expensive alternative therapies that may be necessary to overcome infections caused by antibiotic-resistant microorganisms. Other farming practices have more indirect effects on health, noted Ritchie, but they affect the environment—the air, the water, and the soil. Furthermore, production practices can affect food qualityand have other effects brought about by processing and consumption. For example, workers in meat-packing plants can be infected with tuberculosis as a result of contact with animals.

The question of the unity of health and the environment can be a guide for assembling the political coalitions that are needed to bring about policy changes, noted Ritchie. For example, many people are interested in the shift to a grass-based feeding approach in dairy production. This particularly interests people in the shrimp and fishing industries off the coast of Louisiana. The intensive growth of corn for cattle feed in the Midwest deposits more nutrients and soil into the Mississippi River, which ultimately affects fish off Louisiana's coast. Many people involved in the dairy industry, as well as people who are breeding new, highly nutritious grasses, people interested in animal welfare, hunters, and even

bird-watchers, are helping to make the transition from intensive feeding to cattle grazing, noted Ritchie. A shift to grazing has multiple health benefits both from a mental health standpoint, derived from improvements in family life, and from the perspective of physical health benefits, said Ritchie.

Sizable benefits to the environment and biodiversity, as well as human and animal health, can be achieved by exploring new agricultural production methods, such as integrated pest management and organic production, which lead to the use of less pesticide. A number of coalitions are forming in this arena. For example, many restaurants, food stores, and food suppliers are trying to find more affordable organic food supplies that would make organic foods more competitive in the larger food market.

> The question of the unity of health and the environment can be a guide for assembling political coalitions that are needed to bring about policy changes.
>
> *—Mark Ritchie*

However, there are many barriers to finding unity and creating the political coalitions necessary to affect policy change. The opposition to the proposed changes in farming practices is strong, asserted Ritchie. One of the more popular responses among the opposition is to say that a particular approach is inadequate—for example, "We have to feed the world, so we need chemical fertilizers to achieve target production levels" or "We have to be competitive and therefore cannot take time to care for the environment or pay the externalized costs." The power of the standard model of agricultural practices—particularly the embedded notion of the inevitability of some of these practices—is overwhelming for those who have been farming for years and who are then asked to make changes, said Ritchie.

Aside from opposition to changes, elements of agricultural practices may also make change difficult. For example, genetic contamination of seed stocks, extensive topsoil damage, or groundwater contamination can make organic production impossible.

There are links between how the policy drives the pricing and how the pricing drives the formulation and preparation of foods. Abundant knowledge about production practices and how they are linked to various health questions is available, but little is known about the links between policies, particularly the Farm Bill and agricultural policy, and how the food reaches the table and what it does to people. An inventory of what is known—perhaps in the form of an audit—is needed so that what is not known can be revealed. For example, the Central American Free Trade Agreement would dramatically lower the price of sugar in the United States. The question is whether such an outcome would move the United States in the direction of better public health, given the propensity for food producers to use sugar as an additive or filler in various processed foods.

Issues such as antibiotic resistance and other health- or environment-related

issues can be given a place in an environment–health section of the Farm Bill and can be evaluated, for example, as built-in studies. However, to do this it will be necessary for individuals interested in these issues to become more political, said Ritchie. There is an opportunity for people with health credentials, experience, and a background and jobs in the medical and health care sectors to be spokespeople.

To address some of the most central public health, social, and political issues confronting the nation, the manner in which food is produced on the nation's lands must be addressed. The area in which a difference can be made is in the unity of the environment and health, since upper limits exist on how much humans can damage their own health and the environment and how much this nation can go into debt under the current scenario, concluded Ritchie.

WATER AND AIR QUALITY: CHALLENGES FOR ENVIRONMENTAL HEALTH

In the book *History of Johnson County, Iowa, 1836–1882* (Iowa City, Iowa, 1883), the Iowa River water is described as follows: "Old settlers say that the Iowa River used to be a clear stream except during high water, but now it is always muddy or slimy, and stones or boulders lying in the water that used to be clean are now found to be invested with a coating of nasty, slimy sediment from the unclean water. The plowing and cultivation of the land causes more loose soil and vegetable debris to be washed into the river than could be washed in from the prairie sod."

In Iowa, 7 tons of soil is lost per acre, and each acre yields about 150 bushels of corn, said Jerald Schnoor of the University of Iowa (NRC, 1986). Consequently, for every pound of corn produced, the land loses approximately 2 pounds of topsoil sediment and farmers are actually "exporting" 2 pounds of soil annually for every pound of corn harvested. On the basis of this calculation, Iowa has lost approximately half of its topsoil since presettlement times. These extensive changes in land cover and land use cause changes in water quality through runoff, asserted Schnoor.

The Mississippi River watershed covers about two-thirds of the United States, that is, 31 of the 48 continental states; the flux of nitrate from the Mississippi River to the Gulf of Mexico has nearly tripled in the past 30 years; and the principal sources of that nitrate are streams draining largely agricultural watersheds in southern Minnesota, Iowa, Illinois, Indiana, and Ohio (USGS, 2005). Increasing nitrate concentrations in the Iowa River, which feeds into the Mississippi River, mirrors closely the applications of nitrogen to Iowa farmland. Nitrogen flows from the Mississippi River to the Gulf of Mexico, and currents pull the nutrients west from the mouth of the river, causing hypoxia—low oxygen conditions, or less than 2 milligrams of nutrients per liter—along the U.S. coast in the Gulf of Mexico (Figure 3-3). A section of the Gulf of Mexico about the size of

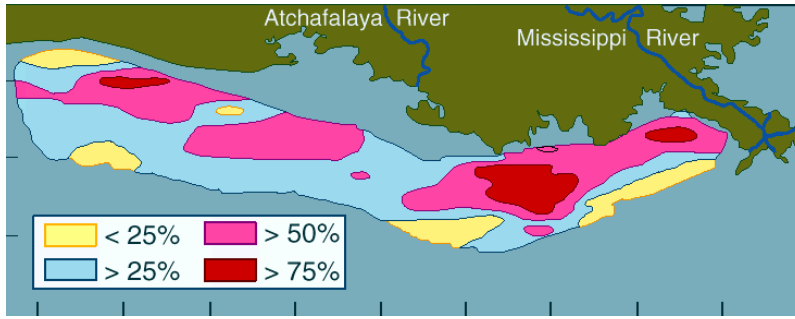

FIGURE 3-3 Extent of hypoxia in midsummer in the Gulf of Mexico from 1995 to 1999.
SOURCE: Rabalais et al. (2001).

New Jersey currently suffers from hypoxia. These conditions affect the shrimping industry and the livelihoods of people who make use of the water and the coastal margins in Louisiana and the Gulf Coast.

Rural residents are also affected by water quality because they are drinking water from their own wells, which are not subject to the Safe Drinking Water Act, noted Schnoor. Shallow groundwater wells less than 50 feet in depth are commonly contaminated with pesticides, nutrients, industrial chemicals, and various volatile organic carbon compounds (USGS, NAWQA, 2005). According to U.S. Geological Survey (USGS) data, nitrate concentrations exceed the maximum contaminant level—that is, 10 milligrams per liter—in about half of all the groundwater sampled below agricultural areas (USGS, NAWQA, 2005). Additionally, agricultural pesticides are commonly detected in groundwater in both agricultural and urban areas, but most of the time they do not exceed the maximum contaminant levels. Another recurring problem is that an increasing number of potentially toxic pesticides, such as diazenon, are detected in urban areas as a result of pesticide application on lawns and golf courses.

Radon is a naturally occurring geochemical that is particularly common in the Midwest. Iowa in particular has high concentrations of radon because of its thick and dense soils. Half of all water samples taken from the Jordan aquifer are in violation of the radon standard safety levels, noted Schnoor.

Among other chemicals that have an effect on people who live in rural areas are polybrominated diphenyl ethers, which accumulate in breast milk; polychlorinated biphenyls (PCBs); and mercury. PCBs and mercury are neurobehavioral agents that especially affect unborn and young children. Some 7.8 percent of the women of childbearing age in the United States have in their blood and sera levels of mercury higher than those recommended as safe by the U.S. Environmental Protection Agency (EPA). People who have a great deal of fish in their diet, which includes many rural Americans and Native American tribes, are much more vul-

nerable to mercury exposure. Perchlorate contamination of groundwater is also an issue in 23 states, mostly in rural areas. These emerging contaminants and concerns are new to agriculture, especially because of the expanded animal feeding operations and the pharmaceuticals and antibiotics used in those operations.

Conservation tillage practices are having a positive effect in the Midwest. The total levels of suspended solids in the Iowa River, as well as the total levels of phosphorus in other rivers, have declined as a result of the increased use of conservation tillage practices. Studies show that a 50 percent decrease in soil delivery can be achieved with low-till agriculture. Other practices that are more expensive but very effective include terracing, grass waterways, and contour farming. Despite improvements, the concentrations of solids and sediments in water are still too high. These solids and sediments cover habitats and are responsible for aquatic impairments in much of the waterways. However, with some resolve in the form of the Conservation Reserve Program and a Farm Bill that dates back to 1985, some progress is beginning to be seen, but much more progress is needed, asserted Schnoor.

Future Challenges

Water availability is becoming a challenge in the traditionally water-rich Midwest. With continued groundwater use, both water quantity and water quality issues arise, suggested Schnoor. Even though irrigated agriculture is not commonly practiced in the Midwest, aquifer storage and recharge are becoming common in Des Moines, Iowa; Milwaukee, Wisconsin; and Minneapolis, Minnesota. Water is beginning to be reused, and eventually it will affect agriculture in the western United States. Overpumping of aquifers is a significant concern locally, nationally, and globally, asserted Schnoor. People will need to stop thinking of wastewater practices and water supply practices as separate. Rather, they are all part of the same hydrologic cycle. Therefore, after water is withdrawn for use in urban areas and agriculture, it is put back onto the land and becomes a part of the aquifer and the water resource system, which must not be polluted and contaminated.

Air quality has generally improved in rural America because of the Clean Air Act, noted Schnoor, but challenges remain, such as occupational exposures to dust, windblown soil, ammonia, pesticides (especially those from animal feeding operations), endotoxins, mycotoxins, animal dander, hydrogen sulfite, and ammonia, odor, and particles.

Global warming will also affect rural populations and agriculture, noted Schnoor. According to predictions of the Union of Concerned Scientists, winters in Iowa are going to become drier and warmer, much like those in Kansas, and summers are going to be much wetter and warmer, much like those in Arkansas, as a result of climate change.

Schnoor concluded that air and water quality have improved in rural America, but changes are still needed. Agriculture is a regulated industry now, and

farmers are recognizing that they need incentives that will pay for good environmental practices in the future.

ENERGY TECHNOLOGY: EVOLVING TECHNOLOGIES FOR IMPROVING HEALTH

Consumers in the United States are dependent on electricity; it powers not only their possessions but also their lives, said Erroll Davis, chief executive officer of Alliant Energy. The electric utility industry, however, is essentially an old-line industry that is trying to be largely responsible for powering a new economy. According to the U.S. Energy Information Administration (EIA), U.S. energy demand continues to grow each year by about 1 percent to 2 percent (EIA, 2005). Davis pointed out that as the demand for electricity continues to grow, the energy business has a dilemma: how to respond to the increasing energy needs while responding to both present and future environmental needs. A 1 percent increase in energy demand means about 10,000 megawatts of new capacity per year, the equivalent of two new companies the size of Alliant Energy annually. The industry's dilemma is to protect and sustain the country's natural resources while providing the increased energy needed to meet the needs and demands of the customers and at the same time trying to replace an increasingly aging infrastructure. Whether the energy comes from a large coal-fired power plant, a nuclear power plant, a wind farm, a series of gas-fired combustion turbines, or a hydroelectric facility, it will affect the environment, said Davis.

To meet the challenge of providing cost-effective, affordable, and environmentally responsive energy, the company created a balanced portfolio of fuels and generation sources that meet the needs of its customers. Coal is the country's most abundant fossil fuel and the backbone of the electric utility industry. There is more energy in coal reserves in the United States than in the entire oil reserves of the Middle East. Coal churns out between 50 percent and 60 percent of the electricity in the United States. It is cheap and plentiful, it works, and the industry knows how to use it. However, it is also the most environmentally challenging fuel source. Even though the industry understands the environmental challenges related to the use of coal, it cannot stop using it. However, steps can be taken to reduce the emissions of coal-burning facilities.

Natural gas is a cleaner-burning alternative to coal; however, gas-fired facilities have efficiency problems. Also, gas is costly and its markets are increasingly volatile. Nuclear power is the source of up to 20 percent of energy in the United States, and its use results in better environmental outcomes than the use of coal or natural gas. Nuclear power plants have virtually no airborne emissions. However, nuclear power has its own challenges; the nuclear accidents at Three Mile Island and Chernobyl are firmly etched into history and into the minds of people as well, noted Davis.

Alliant Energy has taken an active role in developing renewable energy

through biomass projects, that is, programs that make use of farm or industrial by-products or waste. However, biomass projects typically do not get the same publicity and exposure that wind programs do, said Davis. The company's main focus is on farm digester projects, in which it taps the energy potential of methane from animal waste. Digester systems typically reduce the odor from livestock waste by 95 percent to 98 percent, while at the same time eliminating greenhouse gas, methane, which is 20 times more potent as a greenhouse gas than carbon dioxide (Atcheson, 2004). While these systems have their challenges, the company is very optimistic about their future, said Davis.

According to the U.S. Department of Energy (DOE), the use of renewable energy worldwide is expected to increase by 56 percent between 2001 and 2025, maintaining its 8 percent share of world commercial energy consumption throughout the forecast period. Because fossil fuel prices are expected to remain relatively low, renewables are not expected to be widely competitive, and their share of energy use will not increase. Much of the increase in renewable energy use is expected to be driven by new, large-scale hydroelectric projects, particularly in developing countries in Asia (DOE, 2003). Other factors relate to increased renewable production. Today, it is virtually impossible in the United States to put a new hydroelectric facility in place, said Davis, because companies do not want to displace people, wildlife, flora, or fauna to create hydroelectric facilities. On the contrary, an increasing number of hydroelectric facilities are being dismantled.

According to the U.S. Department of Energy, the use of renewable energy worldwide is expected to increase by 56 percent between 2001 and 2025, maintaining its 8 percent share of world commercial energy consumption throughout the forecast period.

—Erroll Davis

The challenge for Alliant Energy is to create energy at an affordable price, in a reliable manner, and with a minimal impact on the environment by applying fuel sources and technologies that are available today. There are no easy answers to that challenge, said Davis. Since 1999, however, Alliant Energy has reduced its sulfur dioxide emissions by 20 percent and its nitrogen oxide emissions by nearly 30 percent. While these improvements were being made, the company's overall generation capacity increased significantly. The most important thing is for the company to continue searching for new technologies for the future, improve the existing technologies, use a diversified energy portfolio, and provide the appropriate market incentives to mitigate the damage to the environment. This approach will help balance energy needs, environmental concerns, and economic realities most effectively.

Each year, the company makes substantial investments in environmental technologies to comply with both state and federal regulations intended to protect the environment. For example, the company has installed electrostatic precipitators and other pollution abatement equipment at most of its facilities. Cur-

rently, Alliant Energy is studying the installation of scrubbers and select catalytic reduction units (SCRs). Similar to a catalytic converter in a car, SCRs remove emissions, but on a much larger scale.

Additionally, the company tries to go outside its industry to create new paradigms. The electric industry is run by electrical, civil, and mechanical engineers. When an emissions problem occurs, the first instinct is to build a mechanical device, put it on the end of the system, and assume that it solves the problem. However, such a solution often degrades the process and increases the price of the product. Alliant Energy tried to go outside the paradigm and look at solutions offered by the chemical industry, which solves problems from a process optimization perspective. For example, chemical engineers helped reduce the company's emissions, particularly those of nitrogen oxides, by inventing a technology called "Smart Burn." The technology uses combustion optimization science to increase boiler efficiency and has substantially reduced nitrogen oxide emissions with little capital investment. It is possible to reduce nitrogen oxide by 50 percent in coal-burning plants with little capital investment, said Davis. Another by-product of Smart Burn was that the boilers were operating more efficiently and cleanly, which reduced operations and maintenance expenses.

Alliant Energy has made great strides in reducing carbon dioxide emissions from its coal-fired plants through operational efficiencies. However, unlike other pollutants, such as mercury, sulfur dioxide, or oxides of nitrogens, which are by-products of the process, there is a debate in the industry as to whether carbon dioxide is a pollutant or a process itself. Levels of carbon dioxide cannot be reduced beyond a certain point because burning generates carbon dioxide. If carbon dioxide cannot be eliminated, ideas for capturing and sequestering it need to be developed. Future carbon sequestration possibilities will be based on sound science; appropriate public policies that will include the trading of credits, other trading regimes, as well as other market mechanisms; and incentives to reduce emissions, asserted Davis.

Incentives for Improving Air Quality

According to the Foundation for Clean Air Progress, from 1970 to 2002 the U.S. population grew by 42 percent to 291 million, the number of registered vehicles increased by 111 percent to 235 million, the gross domestic product increased by 175 percent to $10.4 trillion, and energy consumption increased by 41 percent. However, according to EPA, over the same period, nitrogen oxide emissions declined by 17 percent, sulfur dioxide emissions were cut almost in half, lead emissions were reduced by 98 percent, and carbon monoxide emissions decreased by 41 percent. These numbers indicate that substantial and steady progress has been made.

Electric utilities, regulators, legislators, and customers must continue to show initiative to improve air quality in the future, said Davis. Through its initiatives,

> Electric utilities, regulators, legislators, and customers must continue to show initiative to improve air quality in the future.
>
> —*Erroll Davis*

Alliant Energy works with its customers on cost-effective conservation measures. The company offers a performance contracting initiative to its customers in Iowa and financial incentives for its larger industrial customers to put energy-saving and energy efficiency devices in place. These incentives are paid for by using the savings from reductions in energy use.

The company believes that standards for a portfolio of renewable energy sources can provide certainty and create a more stable investment environment for the development of renewable energy. It also believes that the best way to ensure cleaner air is to take a multiemission approach. Attempts to mitigate one pollutant at a time are costly because the facilities need to be modified and then remodified to address another pollutant. Any standard that is put in place should be properly constructed and appropriately applied not only at the state level but at the national level as well. The best answers to the energy policy debate will most likely come from collaboration and debate among serious stakeholders, concluded Davis.

RENEWABLE ENERGY PRODUCTION

Linkage Between Sources of Energy Production and National Security Issues

National security, climate stability, and rural community health can be strengthened with a strong commitment to a new energy economy based on renewable energy and energy efficiency, said Michael Noble of Minnesotans for Energy-Efficient Economy.

National security problems in the United States are mounting, and they are closely linked with the country's energy system. For example, U.S. nuclear power plants are vulnerable to terrorism because most of them were built in the 1970s, when less consideration was given to the possibility of an assault on U.S. soil. However, a much greater national security issue is U.S. dependency on foreign oil, said Noble. The security of the United States is deeply challenged by the U.S. commitment to access the world's oil and the presence of U.S. troops in Mideast countries. Only 3 percent of the proven oil reserves in the world are under U.S. soils, including the North Slope of Alaska, whereas nearly 70 percent of the proven reserves are in the Middle East countries of Saudi Arabia, Iran, Iraq, the United Arab Emirates, Kuwait, and Libya. The top 10 oil-producing states also include politically unstable countries such as Venezuela, Russia, and

Nigeria, noted Noble. Most of the oil and gas energy resources are concentrated in such unstable parts of the world.

The United States is growing increasingly dependent on foreign oil. Approximately 55 percent of the country's oil is imported today, but with the consumption trajectory climbing and domestic production gradually declining, the business-as-usual forecast is that the United States will receive 70 percent of its oil from foreign sources within 20 years. Today, U.S. oil businesses receive numerous tax breaks, subsidies, and public incentives to obtain as much domestic oil out of the ground as quickly as possible; therefore, it is likely that the United States will be in the unenviable position of depleting its own resources the most rapidly—a public policy that could be dubbed "Exhaust America First."

The situation with world natural gas markets is similar. The Middle East and Russia each have about 10 times the proven oil reserves as Canada and the United States combined. In the near future, natural gas markets will be dominated by liquid natural gas (LNG), which will be shipped in tankers across the ocean like oil is today. A further security issue is that the gas will enter the United States through LNG ports on the West Coast and on the Eastern Seaboard. These LNG ports will again create a considerable debate about public security and national defense, because natural gas ports will be particularly vulnerable to terrorist attack, which may result in a massive explosion.

Hypothetically, electricity services and the coal industry could contribute to securing domestic energy, especially if coal electricity can be produced without new emissions of pollutants that contribute to global warming. With the help of urban transportation systems that are powered by electricity, such as trains, light rail, subways, streetcars, and other urban transport, the average vehicle miles traveled in the United States could be reduced from 10,000 to 5,000 vehicle miles per year. Additionally, plug-in electric hybrid vehicles have the potential to get the equivalent of 500 miles per gallon by primarily running on electricity from the electric grid, plus battery storage, if the vehicle is used primarily for short trips or commuting. This strategy could significantly reduce in the level of U.S. reliance on foreign oil, but it would put increasing pressure on the electricity-generating system and put upward pressure on the system's push toward new coal-burning technologies. If most of the energy for U.S. cars came from electricity, long-distance travel could be fueled by biofuels, and ethanol, increasingly from cellulosic sources, could make a meaningful contribution to energy independence, unlike it does today.

Renewable Energy and Climate Change

The health problems that result from the burning of fossil fuels, especially coal, can be significantly reduced with new technologies, but an important component of the energy use question is global climate change. Global warming is a difficult problem, and to stabilize the climate the Intergovernmental Panel on

Climate Change indicates that U.S. emissions need to be reduced by approximately 70 percent. New energy sources that do not contribute to the global warming problem are thus needed. Global warming is the single most difficult technological engineering, economic, and policy question facing the world, with the possible exception of issues of world poverty and world development, said Noble.

It is accepted science that because of global warming significant disruptions and uncertainties in farming are expected, along with severe weather occurrences, such as extreme storms and heat waves. A heat wave in Europe in August 2003 killed 30,000 people when the temperature in Paris reached 117°F. In 1995, the National Oceanic and Atmospheric Administration assigned a 95 percent probability to the possibility that the increasing storms in rural America were in part related to global warming, noted Noble.

Global warming will have international impacts as well. Rising seas will cause the loss of island nations such as Kiribati and Tuvalu, resulting in tens of thousands of climate refugees. When the sea level rises a meter or two, the people of The Netherlands will build better dikes, but the people in Bangladesh may no longer be able to live in that part of the world, said Noble. This situation is going to produce increasing tension between the have and have-not nations, resulting in the increasing international isolation of the United States at the time of the greatest need for cooperation among nations.

According to several studies summarized by the Intergovernmental Panel on Climate Change, it will cost between 1 percent and 4 percent of the world's gross domestic product to stabilize the climate by reducing emissions 60 percent to 80 percent. If the gross domestic product expands 2 percent per year, on average, stabilizing atmospheric concentrations at 450 parts per million will cost 1 percent of the global gross domestic product over the next 50 years. In the words of the British foreign secretary, fixing global warming would mean 50 years of economic expansion in 50 years plus 6 months instead.

An influential study by Princeton researchers S. Pacala and R. Socolow published in 2004 summarized the fundamental scientific, technical, and industrial know-how required to achieve material reductions in emissions by 2054 (Pacala and Socolow, 2004). The authors identified 15 strategies that are technologically ready to go, with the finding that a dramatic expansion of any seven of these strategies, or "wedges," could put the world on the trajectory to solving the climate problem. Potential "climate stabilization wedges" that would be of significant importance to rural economies include the substitution of wind power for coal-fired power plants, expansion of conservation tillage to all croplands, substitution of biofuels for fossil fuels, and the expansion of reforestation activities and tree plantations.

According to the U.S. Department of Energy, the United States could meet 20 percent of its total electric supply needs with renewable energy in the next 15 years at no net cost to consumers (DOE, 2001). This is largely based on the

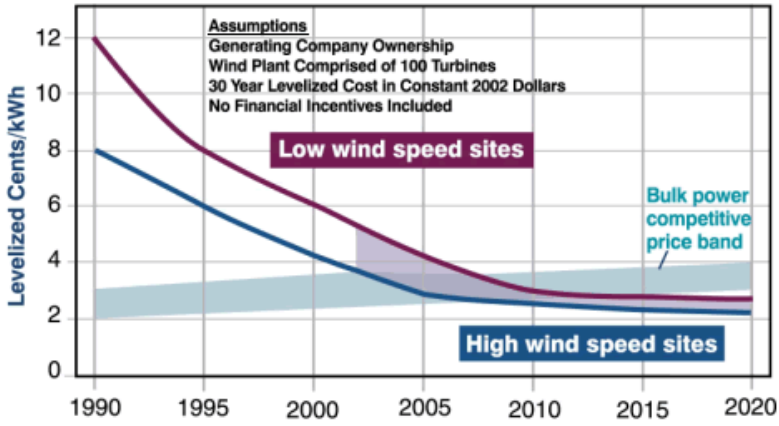

FIGURE 3-4 Cost of wind energy from 1990 to 2020. Wind power is expected to be the lowest-cost source of new power within the decade (kWh = kilowatt-hour).
SOURCE: DOE (2002).

finding by the National Renewable Energy Laboratory that wind energy prices are expected to continue to fall over time, with the costs at sites with lower wind speeds closing the gap with the very low costs at sites with high wind speeds (Figure 3-4).

The Europeans have developed and sustained climate and economic development policies and are leading the way in wind power, which is a popular and environmentally sound choice. Denmark and many other European countries are starting to put their wind turbines out at sea at nearly twice the cost of land-based turbines; the Germans have invested the equivalent of over $15 billion in wind energy, with more than 40,000 workers in the industry to date. In Europe, government and industry officials work jointly on climate change policy and wind energy. Unfortunately, because of the uncertain on and off policy in the United States, wind energy production has lagged behind, despite vastly superior wind energy resources, especially in rural areas of the Great Plains states, said Noble. He urged the United States to develop a strong domestic demand for these technologies so that there would be the opportunity to export rather than import these technologies. Wind energy would provide jobs; rural economic development; infrastructure; and investments for schools, hospitals, and technology.

Community ownership and involvement in the financing of wind energy projects would be one way to approach wind energy ventures in the United States. However, community-based wind energy projects face policy barriers, said Noble. The support from utilities in the marketplace is uncertain, and there are problems with handling the transmission capacity or transmission rules. In

addition, farmers and local entrepreneurs would face many technical problems that would be a challenge to overcome.

Noble suggested that partnerships of community-based wind energy system owners, large wind energy system developers, and transmission owners are needed to help realize the potential for the technology. Such coalitions could build large projects that would deliver bulk power to population centers and provide the political coalition needed to help pass renewable energy standards in many more states. Only 17 states in the United States have renewable energy standards. In addition to the on again–off again federal energy production tax credit, passage of state renewable energy standards is the key policy tool that drives renewable energy in the United States. Also, a broader coalition that would involve environmental groups, clean energy advocate groups, forward-looking businesses, economic development groups, the health care community, the science community, and doctors is needed. Such a coalition could help pass national standards and a national policy of mandatory market-based reductions in global warming emissions, concluded Noble.

OPPORTUNITIES FOR COMMUNITIES: NEBRASKA ENVIRONMENTAL PARTNERSHIPS

The Nebraska Environmental Partnerships Program (NEP) was created in 1994 to provide environmental health assistance to small communities (those with populations greater than 1,000) that were thought to be out of compliance with state or federal health regulations. The program was created to manage the health concerns that have emerged as a result of complex environmental regulations, limited financial resources, an aging infrastructure, an aging population, and decreasing populations in rural communities. This program works with the towns as a nonregulatory program in a regulatory manner but using a community-based team process that assists local governments with assessing and solving local public health and environmental challenges, and the towns know and respect that, said Jackie Stumpff of NEP. The team is flexible and helps small communities work through environmental health problems by providing resources and technical assistance at the request and convenience of local leaders.

NEP partners daily with the U.S. Department of Health and Human Services (DHHS). In Nebraska the Health and Human Services System, Department of Regulations and Licensure is the primary agency overseeing the state drinking water act, and the Department of Environmental Quality (DEQ) is the primary agency regulating wastewater. NEP also partners with the University of Nebraska's Center for Applied Rural Innovation; Partnership for Rural Nebraska; Community and Regional Planning group; and the Public Policy Center.

Other partner organizations include regional nongovernmental organizations, such as the Midwest Assistance Program, which is a rural community assistance

provider that covers the states of Iowa, Missouri, Nebraska, and Kansas; the Nebraska Rural Water Association, which has a contract with the Health and Human Services System, Department of Regulations and Licensure to work with the communities on water issues; and Natural Resources Districts (NRDs). Nebraska has 23 NRDs that simulate the watersheds throughout the state. NEP's partnerships with federal agencies include EPA and the Rural Development section of the U.S. Department of Agriculture (USDA).

Nebraska Environmental Partnerships Program Activities

Nebraska has developed a number of programs and grants to improve environmental health in the state. Stumpff described some of those programs, which are also described below in greater detail.

Community Assessment Grants

The primary activity of NEP is the management of community assessment grants. These grants consist of a $3,000 award for independent engineering services. With the community assessment grant monies, communities can hire a consultant of their choice to have their water, wastewater, and solid waste infrastructures reviewed. The grant helps towns address possible infrastructure problems or determine the development projects that they might need and provides information for communities to discuss and prioritize problems. A total of $50,000 was allotted for this grant from the State Revolving Fund in fiscal years 2005 and 2006.

State Revolving Fund

The State Revolving Fund is divided into two sections: the Drinking Water State Revolving Fund (DWSRF) and the Clean Water State Revolving Fund (CWSRF). CWSRF and DWSRF were created from a series of EPA capitalization grants. The needs of the two funds are determined by DEQ and the state's Health and Human Services System after reviewing needs surveys submitted by communities each December. For fiscal year 2005, State Revolving Fund allocations for drinking water needs were $329 million, and the fund has $9.9 million available; allocations for clean water needs for the same fiscal year were $320.6 million, and the fund has $17.34 million available.

NEP, in conjunction with the State Revolving Fund, identifies many issues that have a direct impact on public health and that are in need of attention. It

- identifies communities without sewer systems and works with as many of them as possible to get grants and assist them if they want to become served so that they will have healthy sewer systems;

- assists communities in meeting water quality standards;
- provides non-point-source pollution funding for projects associated with wellhead protection;
- funds land acquisition and source water protection;
- meets critical public health needs associated with a natural or manmade disaster that may or may not activate the State Emergency Operations Plan; and
- works with systems with technical, financial, and managerial problems or concerns in the towns.

Water Wastewater Advisory Committee

The Water Wastewater Advisory Committee (WWAC) was created in 1997. WWAC consists of individuals from different agencies, including USDA's Rural Development; the Nebraska Health and Human Services System, Department of Regulation and Licensure; the Nebraska Department of Economic Development; and the Nebraska Department of Environmental Quality. The purpose of WWAC is to optimize the sources and uses of funding for water and sewer projects, provide the best funding package to a community, and work with communities as a team to assist them in building a project. WWAC meets once a month to find the best funding sources (a loan or a grant) for community water or wastewater projects.

Small Town Dynamics

Small town dynamics focus on individual responsibility. Government organizations are often constrained by their own organizational cultures or lack or resources. Effectively changing the way in which an organization operates or relates to small town Nebraska relies primarily on changes that individuals within the organization make in their work and profession. Small town dynamics charge government workers with thinking about their own behavior and attitude toward Nebraska's smaller communities. Government workers are challenged to become agents of change within their departments to better address issues with officials from small communities. By using this bottom-up approach within the organization, it is anticipated that the relationships and approach of government workers to small town officials and communities will also change over time.

Partnership for Rural Nebraska

The Partnership for Rural Nebraska (PRN) is a cooperative commitment by the state of Nebraska, the University of Nebraska, the federal government, and other stakeholders to address the opportunities and challenges identified by rural Nebraskans. Other organizations and activities affiliated with PRN include *Rural News Bits* and the Nebraska Rural Poll. *Rural News Bits* is a newsletter

published 10 times a year. Its objective is to provide timely information to people involved in Nebraska's rural development efforts. Contributing organizations share ideas, educational and financial opportunities, announcements, and general news. More than 6,000 people working on rural development in Nebraska receive *Rural News Bits*.

The Nebraska Rural Poll is conducted through the University of Nebraska's Center for Applied Rural Innovation. It conducts high-quality, comprehensive research and provides information on the trends in rural Nebraska. The attitudes of the people who live there are gathered and analyzed. This information provides an invaluable snapshot of rural Nebraska that can be considered in public policy. The Nebraska Rural Poll results have been cited in the *Wall Street Journal, New York Times,* and *USA Today*.

Other Activities

Other NEP activities include a few innovative projects that involve decommissioning of abandoned wells, in which approximately 268 wells or cisterns were closed to help improve the quality of the source water; wetlands construction and cattail growth; and nitrate removal. Partnering can sometimes be challenging, but it can be accomplished, concluded Stumpff.

4

The Built Environment and Health in Rural Areas*

Low population density, land use mix, and connectivity define urban sprawl, and urban sprawl is a major outcome of development strategies in the United States. Since the early 20th century, the population of the United States has shifted from living predominantly in rural areas to living predominantly in urban regions. The first year in U.S. history in which more people lived in cities than in rural areas was 1920 (U.S. Census Bureau, 2000a). Suburban growth was fueled by many factors, including the desire to avoid polluted cities. People considered suburban living to be healthier. Urban encroachment in rural areas creates health problems and issues involving health care access, air pollution, water pollution and water availability, and other concerns, said Bernard Goldstein of the University of Pittsburgh.

THE HEALTH IMPACT OF URBAN ENCROACHMENT ON RURAL AREAS

Specific health issues in rural areas need to be considered, said Goldstein. Access to health care, which can be difficult in rural areas, is such issue. For example, it is common for there to be only one main road going from a rural area into the nearest city with a hospital. Traffic congestion on that key road may impede ambulances from getting to the tertiary-care hospital. Also, the more rural the area, the more likely it is that people will die if they are in an automobile accident because people drive at higher speeds in rural areas.

Air pollution caused by automobile exhaust, traffic drive times, and stop-and-go traffic brings urban problems into rural areas. According to Goldstein,

*The views expressed here do not necessarily reflect the views of the Institute of Medicine, the Roundtable, or its sponsors. This chapter was prepared by staff from the transcript of the meeting. The discussions were edited and organized around major themes to provide a more readable summary and to eliminate duplication of topics.

the areas with the worst ozone levels are usually not within the city but are immediately downwind of the city because ozone is formed relatively slowly by the action of sunlight on oxides of nitrogen and hydrocarbons.

Urban sprawl also creates water availability and water pollution issues. Suburban development has an impact on groundwater availability because in suburban areas water from rain and other precipitation is moved off the land and immediately enters rivers; thus, the groundwater does not get recharged appropriately. That is, the water rapidly enters the rivers instead of circulating through the ground until it eventually reaches the river. Also, water draining right off a parking lot may create storm water and sewage overflows.

Other problems in suburbia include the presence of optimal conditions for the transmission of Lyme disease and mosquito-borne disorders because of the interface between mosquitoes and humans.

Other health problems due to urban sprawl include heat islands, global climate change, noise, a lack of availability of healthy food choices, public health workforce issues, and safety issues such as crime and traffic. When a green area is replaced by asphalt, a bigger heat island results in changes in local temperatures and ecosystems. Heat island and temperature changes also affect the rural areas that are near the suburbs, noted Goldstein.

Attempts to try to understand the impact of urban sprawl on the public health workforce are beginning. The workforce is decreasing and the resources are diminishing at a time when the public health system is encountering some of its greatest challenges, said Goldstein. Furthermore, a large turnover of the public health workforce is anticipated because of retirement. The impact is different in different areas, but often the public health workforce in the rapidly growing suburban areas has less expertise because the budget for the public health infrastructure cannot keep up with the growth, noted Goldstein.

Is Europe the Answer?

Europeans have done an excellent job of keeping their cities and rural areas separate, said Goldstein. The Europeans protect their rural agricultural land and enforce their zoning laws rigidly, making it more difficult to build out from the existing areas of the community. European zoning laws encourage populations to be dense in urban areas by promoting the use of mass transit and the development of bikeways and walkways and by reducing the need for cars.

In Europe, political power and budgets are centralized. In almost every Western European country, its capital is also its largest and most powerful city. This is almost never true in U.S. states, as Americans culturally have less trust in the centralization of power, said Goldstein. The United States has a municipality or some governmental organization for every 3,500 citizens. Most of the local funding in the United States is derived locally, whereas most of the local funding in

Western Europe, including funding for police, fire, rescue, and schools, is derived from the central government.

Americans have a frontier mentality, said Goldstein. Europeans do not move as frequently as Americans. The average American moves approximately seven times in his or her lifetime, whereas the average European moves less than two times. Between 1995 and 2000, 120 million (46 percent) Americans moved homes. Homes in the United States average 718 square feet per person, whereas in The Netherlands the average home size is 256 square feet per person.

The average American moves approximately seven times in his or her lifetime, whereas the average European moves less than two times. Homes in the United States average 718 square feet per person, whereas in The Netherlands the average home size is 256 square feet per person.

—Bernard Goldstein

It is overly simplistic to believe that the United States can or will follow the European example, concluded Goldstein.

ENVIRONMENTAL ISSUES ASSOCIATED WITH IOWA'S ABANDONED AND OCCUPIED HOUSING

Iowa has housing issues both in rural areas and in the inner cities of urban areas. One of the distinguishing features of Iowa's housing, particularly compared with the housing features of its neighbors, is the age of its housing. According to the 2000 census, Iowa is fifth in the country in the percentage of houses built before 1950 and third in the percentage of houses built before 1940 (the District of Columbia is first and Massachusetts is second in the percentage of houses built before 1940). Although age is not the only factor that describes housing, it is a surrogate for many of the problems associated with housing, said Rita Gergely of the Iowa Department of Public Health. Rural counties in Iowa have the largest percentage—55 percent to 60 percent—of housing built before 1950 (Figure 4-1). Some of the houses that were built in the 1960s were not of good quality, and they have been abandoned and torn down, noted Gergely.

According to a study of the Department of Urban and Regional Planning at the University of Iowa, dilapidated units are estimated to need more than $25,000 to $30,000 in repairs, but in some parts of the state, that amount might be more than the sale price of the house if those repairs were made (MacDonald, 2003). In rapidly growing areas, the proportion of units reported to be in poor and dilapidated condition ranges from 0.02 percent to 3 percent, whereas in the areas with declines in growth—which are largely rural areas—that proportion ranges from 3 percent to 9 percent (MacDonald, 2003).

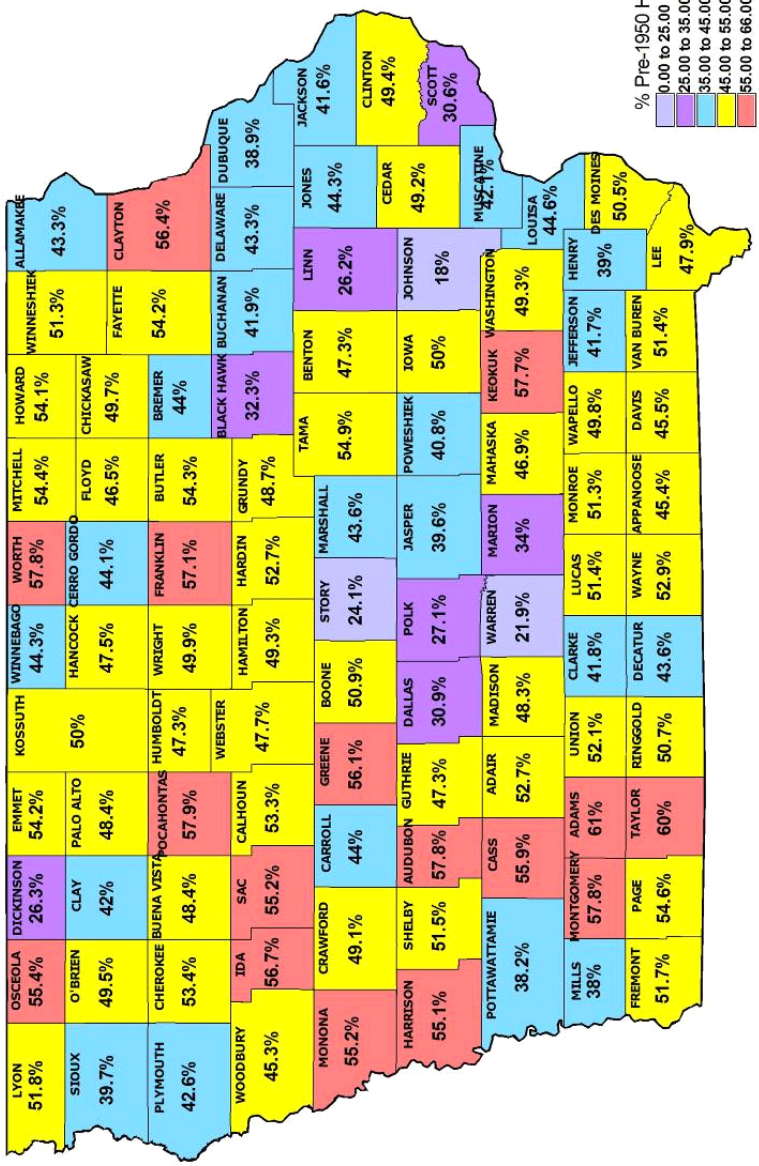

FIGURE 4-1 Percentage of housing built before 1950 in each Iowa county. Although age is not the only factor that describes housing, it is a surrogate for many of the problems associated with housing.
SOURCE: U.S. Census Bureau (2000a).

Abandoned Housing

In general, abandoned housing is not an environmental health issue in Iowa, said Gergely. Rather, it is a nuisance that can impede economic development. However, housing is an issue in southern Iowa, where counties are trying to attract industry to the smaller towns. The executives who decide whether or not they are going to bring a company to a town base their decision on whether that town has decent places for their employees to live. If dilapidated housing is mixed in with better-quality housing, property values are lower.

Abandoned housing can become an environmental health and safety issue when, for instance, children play near houses that are in imminent danger of collapse. Abandoned buildings in remote rural areas are perfect places for methamphetamine labs, said Gergely. Also, people are often concerned that abandoned houses are a reservoir for rodents and insects that can travel to nearby homes, particularly in urban areas.

Iowa's infrastructure has a very fragmented system for taking care of abandoned and nuisance houses. Iowa Code 657A defines an abandoned house as one that has been vacant and in violation of the city or the county housing code for at least 6 months. If a house can be defined as an abandoned house, a neighbor or a nonprofit housing organization can petition the court to order the property owner to make repairs. If the property owner is not willing to make the repairs or cannot afford it, the court can appoint a receiver to make the repairs.

The cities and counties in Iowa have some additional powers to take care of abandoned homes. Iowa Code 331.384 provides for special assessments for the abatement of public health and safety hazards. A county can require the abatement of a nuisance in any reasonable manner; it may require the repair, removal, or dismantling of an abandoned or dangerous building or structure. Chapter 364 of Iowa Code 331 states that a city can condemn a residential building that is found to be a public nuisance and that the city can take title to the property so that it can dispose of it by conveying it to a private individual to rehabilitate or demolish and construct new housing.

Occupied Housing

Environmental health issues in the context of occupied housing include lead poisoning in children, carbon monoxide, fire and electrical hazards, water damage and mold, private wastewater treatment systems, the lack of rental housing codes, and improper sanitary conditions. Water damage and mold in homes result from flooding, leaking roofs and win-

Environmental health issues in the context of occupied housing include lead poisoning in children, carbon monoxide, fire and electrical hazards, water damage and mold, private wastewater treatment systems, the lack of rental housing codes, and improper sanitary conditions.

—Rita Gergely

dows, plumbing problems, excess humidity in bathrooms and kitchens, and wet basements. These are more likely to be found in older and poorly maintained homes, noted Gergely, and can cause health problems in susceptible people. The awareness that these conditions can lead to the growth of mold, which can be a significant environmental health issue, is increasing.

In Iowa, only communities with populations of at least 15,000 are required to have rental housing regulations. Communities of this size have 173,186 units of rental housing built before 1950, which represents about 36 percent of Iowa's rental housing stock built before 1950. According to Gergely, the housing code options listed in the Iowa Code are obsolete. No state agency has the authority to ensure that the cities that are required to have rental housing codes actually have them and are enforcing them, said Gergely. If a community has no rental housing code, the only option for a tenant dissatisfied with the condition of a house is to move or to bring civil action under the Iowa Landlord Tenant Act.

Lead poisoning is essentially a housing issue, said Gergely. Lead poisoning among children is a statewide issue in Iowa. When lead poisoning tests were performed for 55 percent of the children statewide, 9.4 percent of the children tested were found to have lead poisoning. According to the National Health and Nutrition Examination Survey (NHANES), the current national average rate of lead poisoning among children is 2.2 percent (CDC, 2003). Lucas and Wayne Counties have the highest prevalence of lead poisoning in the state. These two counties have high poverty rates, and almost half of all houses in the counties are more than 50 years old.

Another issue in Iowa is carbon monoxide. If appliances that are fueled with gas, oil, kerosene, or wood are not installed, maintained, and used properly, they are bound to cause death from carbon monoxide poisoning. More recent evidence also indicates that carbon monoxide poisoning can cause some long-term sudden neurological effects, even if those who are exposed do not die. Moreover, attempts to tighten up houses to make them more energy efficient can lead to indoor air quality issues, including high levels of carbon monoxide.

Outdated and improperly maintained electrical wiring of furnaces, water heaters, dryers, and other appliances can cause fires in older homes. Additionally, inadequate wiring in older homes leads to the more extensive use of extension cords and power strips, which, if improperly used, can cause fires.

It is estimated that 4.5 billion gallons of untreated or improperly treated human waste is being discharged from the 400 to 600 small rural communities (existing areas and new subdivisions) in Iowa that do not have appropriate wastewater treatment facilities. These numbers do not include private systems outside communities or subdivisions. An estimated 80 percent of these existing systems are not property constructed and are causing problems. There is little evidence that improper private wastewater treatment systems are actually making people sick. However, if sewage is being discharged to the surface, it may cause illness in children and pets playing in it, noted Gergely.

The Iowa Department of Public Health receives many complaints about people living in extremely unsanitary conditions, such as in the presence of extreme clutter; with no running water or indoor plumbing; and with large numbers of pets, which could be reservoirs for diseases carried by rodents or insects. Unfortunately, government cannot do anything about a lack of running water or indoor plumbing if the property is owner-occupied unless there is a violation of city codes or zoning regulations, the conditions are endangering the health of a child or an elderly person who has no choice in the matter, or animals are being neglected.

Because housing quality is a problem in so many communities, it is difficult to determine priorities for action, and the rural areas are always the ones to lose out when funds are cut, concluded Gergely.

THE BUILT ENVIRONMENT AND OPPORTUNITIES FOR RURAL HEALTH

As in the rest of the United States, obesity is a growing health concern in Iowa. The state has the 17th highest rate of adult obesity in the nation (23.9 percent) and the 10th highest rate of overweight among low-income children ages 2 to 5 years (13.6 percent) (Trust for America's Health, 2005). In 2003, the state spent an estimated $266 per person on medical costs related to obesity, which was the 21st largest amount in the nation (Trust for America's Health, 2005). Most Americans are eating too much for a variety of reasons. One of the reasons is that many people do not understand exactly what they are eating because the community does not understand many of the healthy diets that are being promoted, said John Lowe of the University of Iowa. People living in the United States consume a lot of inexpensive, high-calorie, dense food with large portion sizes, and at the same time they are less physically active, noted Lowe. If energy intake is greater than energy expenditure, one gains weight. The large numbers of eating establishments and other social institutions, such as fast-food outlets, convenience and grocery stores, bars and liquor stores, parks, and recreational facilities, influence caloric consumption and activity levels. Opportunities for the infrastructure to be used to help people participate in physical activity are not present at proportional densities, noted Lowe.

There are different types of physical activity: (1) programmed physical activity and exercise; (2) occupational physical activity, which is decreasing in rural areas; (3) lifestyle physical activity, which is when, for example, people take the stairs instead of an elevator; and (4) transportation physical activity, such as walking or bicycling. The physical environment, such as residential areas, the grounds, and sidewalks, has a direct impact on obesity because the physical environment either encourages or discourages people to exercise, noted Lowe. Unfortunately, the sidewalks in most counties in Iowa are deteriorating, and there is no funding within the communities to fix them. The grass continues

to overgrow, which makes it difficult for the aged population to walk; thus, injuries related to physical activity are a concern. Socioeconomic factors, such as personal or household income, material deprivation, unemployment, a lifetime history of poverty, asset ownership, and the receipt of welfare, affect one's physical activity as well, said Lowe.

> There are different types of physical activity: programmed physical activity and exercise; occupational physical activity, which is decreasing in rural areas; lifestyle physical activity, which is when, for example, people take the stairs instead of an elevator; and transportation physical activity, such as walking and bicycling.
>
> *—John Lowe*

To address some of the issues mentioned above, the University of Iowa's College of Public Health established a partnership in Keokuk County called Community Health Action Partnership (CHAP). The partnership is community driven, with 18 organizations and about 40 members currently involved. The community chooses the topics and the university provides expert consultation to help facilitate activities and make sure that what they do is evidence based. The community group identified three areas in which it wanted to work: physical activity, nutrition, and adolescent alcohol use. As a result of the partnership's activity, Keokuk County is the first county in Iowa to have passed a beer keg registration ordinance, which requires people who get a beer keg to register it in their name. Therefore, when the keg is found it can be traced back to the individual who purchased it. On the basis of some of the proximal data, alcohol consumption by youths appears to be going down, said Lowe, and the partnership wants to take the same initiative statewide.

The nutrition group of CHAP is chaired by the owner of the local supermarket. Pepsi and Coca-Cola have seats on the county's CHAP group as well. (Both of these businesses have seats on CHAP because they are willing to explore less harmful ways of making profits for their stockholders.) The university works with the local supermarket, and the university's data helped the supermarket revisit the selection of goods on its shelves. The result was the promotion of water and reductions of Pepsi and Coca-Cola beverage choices, said Lowe. The partnership worked with the school district and superintendent, and it is now permissible to take water into class, which encourages schoolchildren to purchase and drink water.

Furthermore, the community proposed that a walking trail be built, and the proposal became an issue of discussion. Some people were opposed to it because they did not want the trail to go through their backyards but the positive outcome of the discussion was that physical activity became the topic of conversation. It increased the proportion of people who talked and thought about physical activity. The trail is under construction, and the community is very proud of it. However, issues of safety and lighting on the trail remain, because it may not be safe to walk on the trail after dark.

There are no data to support the concept "if you build it, they will come," said Lowe. Community acceptance of the idea of exercising is key to getting families to use the walking trail.

The idea of increasing physical activity and decreasing consumption is going to take a social, cultural, and physical environmental change, concluded Lowe. It is not enough for health professionals to tell people to eat less and to go out and exercise more. The community, along with work sites and faith institutions, will have to get involved in promoting healthier lifestyles and will play a key role in changing the social acceptance of and social environment for physical activity.

INVESTIGATION OF ENVIRONMENTAL EXPOSURES AND CHRONIC DISEASE IN RURAL COMMUNITIES: THE AGRICULTURAL HEALTH STUDY

In general, farmers are healthier, live longer, smoke less, and are more physically active than the general population, although they are still at higher risk for some diseases compared with the risk for the general population, said Jane Hoppin of the National Institute of Environmental Health Sciences. Respiratory morbidity, hearing loss, suicide, and neurological diseases such as Parkinson's disease are more common among farmers. The rates of specific cancers, including prostate cancer, lip cancer (which is associated with sunlight exposure), and lymphomas are increased among farmers. Other widely spread morbidities and causes of mortality among farmers are adverse reproductive outcomes and accidents.

In general, farmers are healthier, live longer, smoke less, and are more physically active than the general population, although they are still at higher risk for some diseases compared with the risk for the general population.

—Jane Hoppin

Farmers grow up and spend most of their lives on a farm, where they are exposed to pesticides, both organic and inorganic fertilizers, dust, grains, animals, diesel exhausts, and solvents, said Hoppin. They live where they work and may carry home their occupational exposures. According to Hoppin, pesticide exposures on farms are infrequent compared with the frequencies of exposures to other products. The lengths of pesticide applications range from 1 day to more than 100 days per year, and the pattern of pesticide use is influenced by the crop planted, including genetically modified crops; the weather conditions; the region; and the calendar year. Pesticide products contain other ingredients, such as silica and solvents, which are often present at much higher concentrations than the pesticides themselves and may influence the toxic exposure to pesticides.

The Agricultural Health Study

The Agricultural Health Study (AHS) was designed to study a wide range of health effects of agricultural exposures in farmers and their families. It is a collaborative venture between the National Cancer Institute, the National Institute of Environmental Health Sciences, the U.S. Environmental Protection Agency, and the National Institute of Occupational Safety and Health (National Institute of Environmental Health Sciences, National Cancer Institute, U.S. Environmental Protection Agency, 1993). The exposures studied by AHS include those to pesticides, animals, diesel, and solvents. The health effects considered by the study include cancer, respiratory health, reproductive outcomes, and neurological disease. The study population is a prospective cohort of farmers and their spouses in Iowa and North Carolina. Having the two states in the study provides diversity, because Iowa's agricultural methods are very homogeneous, whereas North Carolina's agricultural methods are very diverse; in North Carolina, even tobacco-growing methods in the mountains are different from those in the coastal regions, noted Hoppin. Furthermore, the study included only farmers and their spouses and not farmworkers because the study was designed to monitor individuals over time, and long-term studies of farmworkers were outside the scope of the study.

People who obtained their pesticide license between 1993 and 1997 were enrolled in the study by completing a questionnaire, which gathered information not only on their pesticide use, but also on their smoking and disease histories. Exposure-related information was gathered from the farmers and their spouses and included information on the agricultural application of pesticides; the crops and animals that they raised; their various farming activities, including whether they drove a diesel tractor or used natural as well as chemical fertilizers; where they get their drinking water; and aspects of home hygiene, such as whether they wear work boots in the house and whether clothing worn while working in the field is mixed with the family laundry. Approximately 84 percent of the people who were licensed private pesticide applicators in the two states between 1993 and 1997 enrolled in the study, and 75 percent of the married applicators had their spouses enroll. The researchers reinterview the farmers every 5 years—regardless of whether they are currently farming and whether they are currently married to each other—and the cohort is linked annually to the National Death Index and each state's Cancer Registry. Validation of exposure is estimated through field monitoring.

Study Participants' Characteristics

The study cohort contained 52,000 private pesticide applicators and 32,000 spouses, and two-thirds of the cohort lived in Iowa. The study participants were predominantly white, because African American farmers have left farming at a more rapid rate than white farmers, noted Hoppin. There were more male appli-

TABLE 4-1 Mortality Rates from Agricultural Health Study, 1993–2000

	Applicators		Spouses	
Cause of Death	No. of Individuals	SMR	No. of Individuals	SMR
All causes	1,558	0.5	497	0.6
All cancers	514	0.6	239	0.7
Colon cancer	56	0.7	31	1.2
Lung cancer	129	0.4	29	0.3
Breast cancer	3	0.9	54	0.9
Prostate cancer	48	0.7		
Non-Hodgkin's lymphoma	33	0.9	16	1.2
Leukemia	27	0.8	14	1.4
Cardiovascular disease	537	0.5	82	0.4
Chronic obstructive pulmonary disease	35	0.2	15	0.3
Diabetes	26	0.3	18	0.6
Motor vehicle accidents	56	0.8	14	0.8
Non–motor vehicle accidents	74	1.0	8	0.6
Suicide	46	0.6	7	0.7

NOTE: The standardized mortality ratio (SMR) compares the rates of mortality of the pesticide applicators and their spouses with those of other people living in Iowa of the same race, sex, and age.
SOURCE: Blair et al. (2005).

cators and more female spouses in the cohort, and slightly less than half of the participants were more than 50 years old when they enrolled in the study. The individuals ranged from 18 to 88 years of age, and the majority of them had more than a high school education.

AHS Mortality, 1993–2000

Since the beginning of the study in 1993, there have been approximately 1,500 deaths among the participants in the cohort. The death rate is half of what is expected on the basis of a 0.5 standardized mortality ratio (SMR), which compares the rates of mortality of the pesticide applicators and their spouses with those of other people living in Iowa of the same race, sex, and age (Table 4-1). The rates of death from all causes, with the exception of non–motor vehicle accidents, are lower among the pesticide applicators. The rates of cardiovascular disease and chronic obstructive pulmonary disease among the pesticide applicators are considerably lower than those among the general population, and it is likely that this is due to their high rates of physical activity and low rates of smoking.

AHS Cancer Incidence

Compared with the general population, the AHS cohort had no elevated risks of cancer. Similar to the general population, the most common cancer among the men in the cohort was prostate cancer, and the most common cancer among the women in the cohort was breast cancer. By comparison of the chemical exposures among individuals within the cohort, only 1 of more than 40 chemicals tested—a common soil fumigant, methyl bromide—was associated with prostate cancer. Additionally, there was a slight association between the application of chlorinated pesticides and prostate cancer. However, older people, who are more likely to get prostate cancer, were also more likely to have applied chlorinated pesticides, said Hoppin. Because prostate cancer is such a common cancer, the study needs to be repeated in 2 or 4 years to conduct a new analysis to see if the previous results are replicated.

According to the findings of the study, the overall breast cancer rates in the cohort are not elevated compared with the rate in the general population. However, when the cohort spouses were separated out by women who reported pesticide use and women who did not, women who reported that they applied pesticides had much lower rates of breast cancer than women who did not. This could be because women who are doing farmwork are more physically active, but more studies are needed to understand this finding, said Hoppin.

Compared with the rates in the general population, both the overall rates of lung cancer and the smoking rates were lower in the cohort. However, the study showed that some individual chemicals, such as the herbicides metolachlor and pendimethalin and the insecticides chlorpyrifos and diazinon, may be associated with lung cancer risk. Whether this association is due to the chemicals themselves or silica, which may be an inert ingredient in some of the chemicals, will require further investigation, said Hoppin. Some participants noted that in general there is no variety of lung cancer that is more common to farmers. According to Hoppin, researchers do not yet have enough lung cancer incidences to break them out into various subtypes. It is possible that in four years researchers will be able to determine whether there are different lung cancer types that are more common among farmers.

AHS Findings on Neurological Effects

The findings on neurological effects are based on cross-sectional data from information that the study participants reported in the questionnaire when they enrolled in the study, noted Hoppin. Recently, the second phase of the study was completed, and the follow-up data will allow prospective examination of the exposures.

Pesticides are designed to interfere with the neurological systems of insects; therefore, it is expected that they would have neurological effects in humans as

well. In general, exposure to high levels of insecticides, particularly the organophosphates, can cause a disease called organophosphate-induced peripheral neuropathy, which is a long-term consequence of exposure to a very high dosage. However, little is known about chronic, moderate, or low-level exposures. Approximately 19,000 male private pesticide applicators were studied for neurological effects. The study evaluated 19 symptoms as a whole, including headache, fatigue, tension, insomnia, irritability, dizziness, numbness, depression, vision, sweating, tremor, nausea, and balance. By considering these symptoms as a whole, the researchers were able to look at the various constructs of the central nervous system and see how people might be affected by these vague symptoms and if they are associated with application of a particular type of pesticide. The study found that chronic neurological symptoms were associated with the lifetime use of insecticides and fumigants. The strongest associations were with organochlorines and organophosphate insecticides and a history of pesticide poisoning. Furthermore, insecticides in general were associated with all aspects of neurological function, including affect and cognition functions, systemic and peripheral nervous system functions, and motor and vision functions.

Retinal degeneration is a leading cause of visual impairment in older adults. It is more common among white women; people with light eye color, cardiovascular disease, or hypertension; and people with a family history of the condition, noted Hoppin. The risk factors for this condition are not known, and there is no occupational exposure literature suggesting that occupational exposures could be associated with retinal degeneration. However, there is also no literature that says that retinal degeneration is *not* associated with occupational exposures, said Hoppin. In experiments with animals, there is evidence of a possible risk of retinal degeneration from organophosphate insecticides. In the AHS cohort, individuals with retinal degeneration were more likely to report the use of fungicides and the production of orchard fruit (Kamel et al., 2000). The odds ratio for fungicide use among the farmers with retinal degeneration was 1.8, which suggests an 80 percent increase in retinal degeneration among people who reported that they used fungicides. In a more recent analysis among the farm women, an odds ratio of 1.9 was observed for women who reported using fungicides and having retinal degeneration (Kirrane et al., 2004).

Farmers and Respiratory Disease

Respiratory disease among farmers is one of the first occupational diseases described in the literature dating back to the 1500s. The exposures on farms have changed since then, but the disease continues among farmers, said Hoppin. Farmers have some common respiratory health outcomes, such as asthma, declines in pulmonary function, and increased bronchial hyperresponsiveness. Also, farmers get a unique disease called farmer's lung, which is primarily related to handling moldy hay and grain and is associated with living in more northerly latitudes.

TABLE 4-2 Rates of Respiratory Outcomes Among Participants in the AHS at Enrollment (percent)

Respiratory Outcome	Applicators	Spouses	U.S. Rates	
			NHIS,[a] 1999	NHANES,[a] 1999
Asthma	4.9	4.7	8.5	12.3
Bronchitis	4	4.3	4.4	3.2
Emphysema	1	0.3	1.4	1
Farmer's lung	2	0.2		
Hay fever	9.6	9.9	8.9	4.6
Wheeze	19			13

[a]NHIS = National Heath Interview Survey; NHANES = National Health and Nutrition Examination Survey.
SOURCE: J. Hoppin, unpublished data.

One of the strengths of the AHS is that it has the power to assess the wide array of possible respiratory toxicants in the same group of individuals. At enrollment, the participants were asked about the occurrence of asthma, bronchitis, emphysema, farmer's lung, hay fever, and the common respiratory symptom wheeze (wheeze is the whistling sound made while breathing; it is associated with bronchial constriction or chest tightness and is the cardinal symptom of asthma).

The cross-sectional data on the rates of these symptoms show that the rate of asthma seems to be lower among the farmers than among those in the general population; the rates of bronchitis and emphysema are similar; the rate of farmer's lung in the general population is not researched because of its low prevalence; and hay fever is slightly more common in the farmers than it is in the general population, particularly when the data for the farmers are compared with the NHANES data for the U.S. population (Table 4-2). The rate of the respiratory symptom wheeze is striking among farmers: 19 percent of the applicators reported wheeze, whereas only 13 percent of the general population reported the same symptom. Three different types of exposures—pesticides, animals, and other farm exposures—were evaluated as causes of wheeze. Eleven of 40 pesticides were positively associated with wheeze, and the dose trends for 10 of those were significant. Three organophosphates—parathion, malathion, and chlorpyrifos—were associated with wheeze. The highest odds ratio (1.5) was observed for parathion, which is one of the most potent organophosphates (Hoppin et al., 2002). The study revealed that the risk of wheeze increased with the overall number of days of pesticide, insecticide, and herbicide use. No trend with the number of days of total use of any organophosphates or carbamates was observed, which suggests a role for individual chemicals.

Animal exposures are associated with wheeze as well. People who have contact with animals, who work with dairy cattle or poultry and eggs, or who

perform veterinary procedures are more likely to report wheeze. People who raise hogs, however, had almost no evidence of wheeze.

Other agricultural exposures associated with increased rates of respiratory symptoms, particularly wheeze, were exposure to manure as a natural fertilizer, exposure to diesel while driving diesel-fueled tractors (people who drove gasoline-fueled tractors did not have the same symptoms), and exposure to solvents for cleaning.

The AHS will continue with its next round of interviews and plans to analyze data on specific chemicals and cancer, Parkinson's disease, respiratory disease, rheumatoid arthritis, and the overall rate of mortality among the members of the cohort over time, concluded Hoppin.

References

21st Century Dictionary of Quotations. 1993. Edited by the Princeton Language Institute, produced by the Philip Lief Group, Inc. New York: Dell Publishers.

Agricultural Health Study. 1993. National Institute of Environmental Health Sciences, National Cancer Institute, U.S. Environmental Protection Agency. Available online at http://www.aghealth.org.

APA (American Psychological Association). 2005. *The Behavioral Health Care Needs of Rural Women*. Rural Women's Work Group of the Rural Task Force of the American Psychological Association and the American Psychological Association's Committee on Rural Health. Available online at http://www.apa.org/rural/ruralwomen.pdf. Accessed September 30, 2005.

Atcheson J. 2004. Methane burps: Ticking time bomb. *Energy Bulletin*. Available online at http://www.energybulletin.net/3647.html. Accessed September 30, 2005.

Attiullah N, Zimmerman M. 2003. Update on the diagnosis and treatment of depression. *Medicine and Health of Rhode Island* 86:310–314.

Berry W. 1977. *The Unsettling of America: Culture and Agriculture*. San Francisco, CA: Sierra Club Books.

Blair A, Sandler DP, Tarone R, Lubin J, Thomas K, Hoppin JA, Samanic C, Coble J, Kamel F, Knott C, Dosemeci M, Zahm SH, Lynch CF, Rothman N, Alavanja MCR. 2005. Mortality among participants in the Agricultural Health Study. *Annals of Epidemiology* 15:279–285.

CDC (Centers for Disease Control and Prevention). 2003. HIPAA Privacy Rule and public health: Guidance from CDC and the U.S. Department of Health and Human Services_*Morbidity and Mortality Weekly Report Surveillance Summaries* 52(S-1):1–12.

CDC. 2001. *Behavioral Risk Factor Surveillance System*. Atlanta, GA: National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention. Available online at http://www.cdc.gov/brfss. Accessed September 30, 2005.

Conóceme en Iowa. 1979. The official report of the Governor's Spanish Speaking Task Force. Submitted to Governor Robert D. Ray and the 66th General Assembly. Des Moines, IA: The Task Force 1979.

DOE (U.S. Department of Energy, Energy Information Administration). 2001. Analysis of Strategies for Reducing Multiple Emissions from Electric Power Plants, July 2001, Table E3. Washington, D.C.: U.S. Department of Energy.

DOE (U.S. Department of Energy, National Renewable Energy Laboratory). 2002. [from Chapter 3].

DOE (U.S. Department of Energy, Energy Information Administration). May 1, 2003. News release. Available online at http://usinfo.state.gov/gi/Archive/2003/May/29-133549.html. Accessed September 30, 2005.

DOT, FHWA (U.S. Department of Transportation, Federal Highway Administration). 1999. Summary of Travel Trends 1995 Nationwide Personal Transportation Survey. Available online at http://npts.ornl.gov/npts/1995/Doc/trends_report.pdf. Accessed September 30, 2005.

EIA (Energy Information Administration). 2005. *Annual Energy Outlook 2005 with Projections to 2025*. Available online at http://www.eia.doe.gov/oiaf/aeo/. Accessed September 30, 2005.

Executive Order. April 27, 2004. Incentives for the Use of Health Information Technology and Establishing the Position of the National Health Information Technology Coordinator. Washington, D.C.: The White House. Available online at http://www.whitehouse.gov/news/releases/2004/04/20040427-4.html. Accessed September 30, 2005.

Finn P. 1980. Developing critical television viewing skills. *Educational Forum* 44:473–482.

Gladwell M. 2002. *The Tipping Point: How Little Things Can Make a Big Difference*. New York: Little Brown & Company.

GMFH (Geriatric Mental Health Foundation). 2003. Caring for the Alzheimer's Disease Patient. Available online at http://www.aagponline.org/p_c/caregiver_broch.pdf.

Hegarty K, Gunn J, Chondros P, Small R. 2004. Association between depression and abuse by partners of women attending general practice: Descriptive, cross sectional survey. *British Medical Journal* 328:595–596.

Hoge CW, Castro CA, Messer SC, McGurk D, Cotting DI, Koffman RL. 2004. Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. *New England Journal of Medicine* 351:13–22.

Hoppin JA, Yucel F, Dosemeci M, Sandler DP. 2002. Accuracy of self-reported pesticide use duration information from licensed pesticide applicators in the Agricultural Health Study. *Journal of Exposure Analysis and Environmental Epidemiology* 12:313–318.

House J. 1997. *Translation Quality Assessment: A Model Revisited.* Germany: Gunter Narr Tubingen.

IDEA (Iowa Department of Elder Affairs). 2005. Aging Statistics & Information. Available online at http://www.state.ia.us/elderaffairs/resources/agingstats.html. Accessed September 30, 2005.

IOM (Institute of Medicine). 2003. *The Role of Environmental Hazards in Premature Birth*. Washington, D.C.: The National Academies Press.

IOM. 2004. *Quality Through Collaboration: The Future of Rural Health*. Washington, D.C.: The National Academies Press.

Iowa City, Iowa. 1883. *History of Johnson County, Iowa, Containing a History of the County, and Its Townships, Cities and Villages from 1836 to 1882*. Author.

Iowa Comission. Department of Human Rights. Commission of Latin Affairs. 2004. *Annual Report. Fiscal Year 2003–2004*. Available on-line at http://www.state.ia.us/government/dhr/la/Resources(new)/publications/2005anualreport.pdf.

Iowa Department of Natural Resources. 2001. I*owa Statewide Comprehensive Outdoor Recreation Plan*. DNR Publication, Des Moines.

Iowa Natural Heritage Foundation. 2002. *Annual Report*. Available online at http://www.inhf.org/2002annualreport.htm. Accessed September 30, 2005.

Kaiser Commission on Medicaid and Uninsured. 2003. Washington, D.C. Available online at http://www.kff.org/uninsured/upload/The-Uninsured-in-Rural-America-Update-PDF.pdf. Accessed October 4, 2005.

Kamel F, Boyes WK, Gladen BC, Rowland AS, Alavanja MC, Blair A, Sandler DP. 2000. Retinal degeneration in licensed pesticide applicators. *American Journal of Industrial Medicine* 37: 618–628.

Kirrane EF, Hoppin JA, Umbach DM, Samanic C, Sandler DP. 2004. Patterns of pesticide use and their determinants among wives of farmer pesticide applicators in the Agricultural Health Study. *Journal of Occupational and Environmental Medicine* 46:856–865.

MacDonald H. 2003. *Meeting the Challenges of the Next Decade. Housing and Community Development in Iowa in 2000: A Report to the Iowa Finance Authority and the Iowa Department of Economic Development*. January. Iowa City: Graduate Program in Urban and Regional Planning, University of Iowa.

Mohatt D. 2003. *Report of the Subcommittee on Rural Issues. President's New Freedom Commission on Mental Health Meeting*. January 7–9. Available online at http://www.mentalhealthcommission.gov/minutes/jan03.htm. Accessed October 4, 2005.

Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. 1999. The disease burden associated with overweight and obesity. *Journal of the American Medical Association* 282:1523–1529.

National Institute of Environmental Health Sciences, National Cancer Institute, and U.S. Environmental Protection Agency. 1993. *Agricultural Health Study*. Available online at http://www.aghealth.org. Accessed September 30, 2005.

NIOSH (National Institute of Occupational Safety and Health). 2005. Traumatic Occupational Injuries. Agricultural Safety. Available online at http://www.cdc.gov/Niosh/injury/traumaagric.html. Accessed September 30, 2005.

NRC (National Research Council). 1986. *Soil Conservation: An Assessment of the National Resources Inventory*, Vol. 2. Washington, D.C.: National Academy Press.

ONCHIT (Office of the National Coordinator for Health Information Technology). Incentives for the Use of Health Information Technology and Establishing the Position of the National Health Information Technology Coordinator. 2005. Available online at http://www.os.dhhs.gov/healthit. Accessed September 30, 2005.

Pacala S, Socolow R. 2004. Stabilization wedges: Solving the climate problem for the next 50 years with current technologies. *Science* 305:968–971.

PATS (University of Wisconsin Program on Agricultural Technology studies). 2002. The Health Care Crisis Among Wisconsin Dairy Farmers. *Wisconsin Family Farm Facts No. 17*. Available online at http://222.pats.wisc.edu/ubs.htm.

Pol L. 2000. Health Insurance in Rural America. *Rural Policy Brief* 5:1–10.

Population Resource Center. 2005. A Demographic Profile of Hispanics in the U.S. Available online at http://www.prcdc.org/summaries/hispanics/hispanics.html. Accessed September 30, 2005.

Rabalais NN, Turner RE, Wiseman WJ Jr. 2001. Hypoxia in the Gulf of Mexico. *Journal of Environmental Quality* 30:320–329.

Ramirez RR, de la Cruz PG. 2002. *The Hispanic Population in the United States: March 2002*, Current Population Reports, P20-545, U.S. Census Bureau, Washington D.C. Available online at http://www.census.gov/population/socdemo/hispanic/p20-535/p20-535.pdf. Accessed September 30, 2005.

Reschovsky JD, Staiti A. 2005. Physician Incomes in Urban and Rural America. Issue Brief No. 92. Center for Studying Health System Change. Available online at www.hschange.com/CONTENT/725/. Accessed September 30, 2005.

Schulz R, Beach SR. 1999. Caregiving as a risk factor for Mortality: The Caregiver Health Effects Study. *Journal of the American Medical Association* 282:2215–2219.

Soto JJ. 2000. Mental health services issues for Hispanics/Latinos in rural America. *In Motion Magazine* May 30, 2000. Available online at http://www.inmotionmagazine.com/soto4.html.

Stallones L, Beseler C. 2004. Safety practices and depression among farm residents. *Annals of Epidemiology* 14:571–578.

Swanson A. 2000. United Press International Analysis: Trafficking Modern-Day Slavery. National Immigration Forum, March 22, 2005. Avialable online at http://www.immigrationforum.org/documents/NewsClips/0305/DC032205.pdf#search='latinostraffickersservitude'.Accessed September 30, 2005.

Trust for America's Health. 2005. "F" as in fat: How obesity policies are failing in America. Available online at http://healthyamericans.org/reports/obesity/release.php?StateID=IA. Accessed September 30, 2005.

University of Wisconsin–Madison, University of Wisconsin Extension, Program of Technology Studies. 2002. *Wisconsin Family Farm Facts, #17.* Madison: University of Wisconsin–Madison.

U.S. Census Bureau. 1990. *1990 Census of Population and Housing: 1990 Population and Housing Unit Counts: United States*. Washington, D.C.: U.S. Census Bureau.

U.S. Census Bureau. 2000a. *2000 Census of Population and Housing: 2000 Population and Housing Unit Counts: United States*. Washington, D.C.: U.S. Census Bureau. Available online at http://www.census.gov/main/www/cen2000.html. Accessed September 30, 2005.

U.S. Census Bureau. 2000b. 2000 Summary File 3 (SF 3). Available online at http://factfinder.census.gov/servlet/GCTTable?_bm=y&-geo_id=D&-ds_name=D&-_lang=en&-mt_name=DEC_2000_SF3_U_GCTP14_US1. Accessed September 30, 2005.

U.S. Census Bureau. 2000c. 2000 Summary File 4 (SF 4) Available online at http://factfinder.census.gov/servlet/DTTable?_bm=y&-geo_id=D&-ds_name=D&-_lang=en&-mt_name=DEC_2000_SF4_U_PCT002. Accessed September 30, 2005.

USDA, ERS (U.S. Department of Agriculture, Economic Research Service). 2005. Enhanced Quality of Life for Rural Americans. Available online at www.ers. usda.gov/Emphasis/Rural/. Accessed September 30, 2005.

USDA, FNS (U.S. Department of Agriculture, Food and Nutrition Service). Program Data. Available online at http://www.fns.usda.gov/pd/cnpmain.htm.

USDA, KASS (U.S. Department of Agriculture, Kentucky Agricultural Statistic Service). 2003. Available online at http://www.nass.usda.gov/ky/B2004/p010.pdf. Accessed September 30, 2005.

USDA, NASS (U.S. Department of Agriculture, National Agricultural Statistics Service). 2002. Census of Agriculture. Available online at http://www.nass.usda.gov/census/. Accessed September 30, 2005.

USEPA (U.S. Environmental Protection Agency). 2000. Factoids: Drinking Water and Ground Water Statistics for 2000. Available online at http://www.epa.gov/safewater/data/pdfs/data_factoids_2000.pdf.

USGS (U.S. Geological Survey). 2005. Hypoxia in the Gulf of Mexico. Available online at http://co.water.usgs.gov/hypoxia/html/newpubs.html. Accessed September 30, 2005.

USGS, NAWQA (U.S. Geological Survey, National Water Quality Assessment Program). 2005.Available online at http://water.usgs.gov/nawqa. Accessed September 30, 2005.

USGS, NPWRC (U.S. Geological Survey, Northern Prairie Wildlife Research Center). 2005. Wetlands of the United States, Their Extent and Their Value to Waterfowl and Other Wildlife: A Century of Wetland Exploitation. Available online at http://www.npwrc.usgs.gov/resource/1998/uswetlan/century.htm. Accessed September 30, 2005.

Wackernagel M, Reese W. 1996. Our ecological footprint: Reducing human impact on the earth. Gabriola Island, B.C., and Philadelphia, PA: New Society Publishers.

WHO (World Health Organization). 1986. Constitution. In *World Health Organization: Basic Documents*. Geneva, Switzerland: WHO Press.

Ziller E, Coburn AF, Loux SL, Hoffman C, McBride T. 2003. Health Insurance Coverage in Rural America. The Kaiser Commission on Medicare and the Uninsured Report. Available online at http://www.kff.org/uninsured/upload/Health-Insurance-Coverage-in-Rural-America-PDF.pdf. Accessed September 30, 2005.

APPENDIXES

Appendix A

Workshop Agenda

REBUILDING THE UNITY OF HEALTH AND THE ENVIRONMENT IN RURAL AMERICA

Sponsored by
The Institute of Medicine's Roundtable on Environmental Health Sciences, Research, and Medicine
The University of Iowa's College of Public Health
The University of Iowa's Environmental Health Sciences Research Center
Iowa City, Iowa

MONDAY, NOVEMBER 29, 2004

8:30 a.m. **Welcome**
James Merchant
Member, Roundtable on Environmental Health Sciences, Research, and Medicine
Dean, School of Public Health
University of Iowa

8:40 a.m. **What Is Environmental Health?**
Donald Mattison
Member, Roundtable on Environmental Health Sciences, Research, and Medicine
Senior Adviser to the Directors of the National Institute of Child Health and Human Development and Center for Research for Mothers and Children, National Institutes of Health, U.S. Department of Health and Human Services

9:10 a.m. **Environmental Health in Rural America**
Peter Thorne
Director, Environmental Health Sciences Research Center
University of Iowa

9:40 a.m. **The Farm Bill and Environmental Health**
Ellen Huntoon
Rural Development Coordinator
Office of Senator Tom Harkin

10:15 a.m. **Break**

The Social Environment in Rural America

Moderator: Joan Blundall, Director of Community-Based Initiatives, Higher Plain, Inc.

10:30 a.m. **Future of Family Farms**
Neil Harl
Charles F. Curtiss Distinguished Professor in Agriculture
Iowa State University

11:00 a.m. **From Young to Old, Immigrants to Long-Time Residents: How Demographics Are Shaping Rural America**
Sandra Charvat Burke
Research Scientist
Community Vitality Center
Iowa State University

11:30 a.m. **General Discussion**

12:00 p.m **Lunch**

1:00 p.m **Language, Culture, and Health**
John-Paul Chaisson-Cardenas
Administrator, Commission on Latino Affairs
Iowa Division of Latino Affairs

1:30 p.m. **Rural Infrastructure: Environmental Health and Beyond**
Mary Wakefield
Director, Center for Rural Health
University of North Dakota School of Medicine and Health Sciences

2:00 p.m. **Rural Mental Health: A Multifaceted Issue**
Cecilia Arnold
Mental Health Director
Ligutti Rural Community Support Program
National Catholic Rural Life Conference

2:30 p.m. **General Discussion**

3:00 p.m **Neworking**

TUESDAY, NOVEMBER 30, 2004

8:30 a.m. **Welcome Back**
James Merchant
Member, Roundtable on Environmental Health Sciences, Research, and Medicine
Dean, School of Public Health
University of Iowa

The Role of the Natural Environment

Moderator: David Osterberg, Associate Professor, University of Iowa College of Public Health

8:50 a.m. **Farming Practices: From Soil Erosion to Pesticide**
Mark Ritchie
President, Institute of Agricultural and Trade Policy

9:20 a.m. **Water and Air Quality: Challenges for Environmental Health**
Jerald Schnoor
Allen S. Henry Chair of Engineering
Department of Civil and Environmental Engineering
University of Iowa

9:50 a.m. **Ecological Footprint of Iowa Row Crop Agriculture**
Ricardo Salvador
Professor, Iowa State University

10:20 a.m. **Break**

10:35 a.m. **Keeping it Clean: Balancing Energy Demand and Air Quality**
Erroll Davis
Chairman and CEO
Alliant Energy

11:05 a.m. **Renewable Electricity: America's New Cash Crop**
Michael Noble
Executive Director
Minnesotans for Energy-Efficient Economy

11:35 a.m. **Opportunities for Communities: Nebraska Environmental Partnerships**
Jackie Stumpff
Coordinator
Nebraska Environmental Partnerships Program
Nebraska Department of Environmental Quality

12:05 p.m. **General Discussion**

12:20 p.m **Lunch**

The Built Environment and Health

Moderator: Robert Mulqueen, Iowa Environmental Council

1:20 p.m. **Urban Encroachment into Rural Areas**
Bernard Goldstein
Dean, School of Public Health
University of Pittsburgh

1:50 p.m. **Environmental Health Issues Associated with Iowa's Occupied and Abandoned Housing**
Rita Gergely
Chief, Bureau of Lead Poisoning Prevention
Iowa Department of Public Health

2:20 p.m. **Opportunities for Rural Health: Bike Trails, Exercise, and the Built Environment**
John Lowe
Professor and Head, Department of Community and Behavioral Health
University of Iowa College of Public Health

2:50 p.m. **Investigation of Environmental Exposures and Chronic Disease in Rural Communities: The Agricultural Health Study**
Jane Hoppin
Environmental Epidemiologist
National Institute of Environmental Health Sciences
National Institutes of Health

3:10 p.m. **General Discussion**

3:40 p.m. **Summation**
James Merchant
Member, Roundtable on Environmental Health Sciences, Research, and Medicine
Dean, School of Public Health
University of Iowa

4:00 p.m. **Adjourn**

B

Speakers and Panelists

Cecilia Arnold
Mental Health Director
Ligutti Rural Community Support Program

John-Paul Chaisson-Cardenas
Administrator, Commission of Latino Affairs
Iowa Division of Latino Affairs

Sandra Charvat Burke
Research Scientist
Iowa State University

Erroll Davis
CEO
Alliant Energy

Rita Gergely
Chief
Bureau of Lead Poisoning Prevention
Iowa Department of Public Health

Bernard Goldstein
Dean
School of Public Health
University of Pittsburgh

Neil Harl
Charles F. Curtiss Distinguished Professor in Agriculture
Iowa State University

Jane Hoppin
Environmental Epidemiologist
National Institute of Environmental Health Sciences
National Institute of Health

Ellen Huntoon
Rural Development Coordinator
Office of U.S. Senator Tom Harkin

John Lowe
Professor and Head
Department of Community and Behavioral Health

Donald Mattison
Senior Adviser to the Directors of theNational Institute of Child Health and Human Development and Center for Research for Mothers and Children
National Institutes of Health

James Merchant, M.D.
Dean, School of Public Health
University of Iowa

Robert Mulqueen
Project Coordinator
Iowa Department of Public Health

Michael Noble
Executive Director
Minnesotans for Energy-Efficient Economy

David Osterberg
Associate Professor
Department of Occupational and Environmental Health
University of Iowa

Mark Ritchie
President
Institute of Agricultural and Trade Policy

Ricardo Salvador
Professor
Iowa State University

Jerald Schnoor
Allen S. Henry Chair of Engineering
Department of Civil and Environmental Engineering
University of Iowa

Jackie Stumpff
Coordinator
Nebraska Environmental Partnerships Program
Nebraska Department of Environmental Quality

Peter Thorne
Director
Environmental Health Sciences Research Center
University of Iowa

Mary Wakefield
Director
Center for Rural Health
School of Medicine and Health Sciences
University of North Dakota

C

Meeting Participants

Francois Abboud
University of Iowa

Sherri Baltonado
Planned Parenthood of East Central Illinois

Annette Bitto
Iowa State University

Joan Blundall
Higher Plain, Inc.

Joe Bolcom
Iowa State Senator

Kathleen Buckwalter
University of Iowa

Don Buzzingham
Iowa State University

Jack Cameron
University of Iowa

Lynne Cannon
Learning Disabilities Association of America

Don Cell
Cornell College

Jane Colacecchi
Iowa Department of Agriculture and Land Stewardship

Andrea Dodd
University of Iowa

Jan Drury
Iowa Veterans Home

Jim Ellerhoff
State of Iowa Pesticide Bureau

Susan Erickson
Iowa State University

Edith Fernandez-Baca
Iowa State University

Renèe Ferre
Marah International

Eileen Fisher
Iowa's Center for Agricultural Safety and Health

Meggan Fisher
I-CASH

Mary Gilchrist
University of Iowa

Jim Gill
University of Iowa

Jeanne Goche
Manning Regional Healthcare Center

Isabel Gutierrez-Montes
Iowa State University

Suzana Hadina
University of Iowa

Cindy Hadish
The Gazette

Brian Hanft
Cerro Gordo County Department of Public Health

Molly Hartman
Mercy Medical Center

Betty Johnson
SAFE Coalition of ECI

Deb Kazmerzak
Iowa Nebraska Primary Care Association

Richard Kelley
University of Iowa

Deb Kozel
Fiscal Services

Mark Kresowik
Engineers for a Sustainable World

Katarina Kulhankova
University of Iowa

Nora Ladjahasan
Iowa State University

Carrie La Seur
Environmental Policy and Law Center

Paul Lasley
Iowa State University

Cathy Livingston
Sierra Club/Soil and Water Commissioner

Amanda Long
The Soyfoods Council

Matt Lozier
Iowa Department of Public Health

Kelly Mellecker

Nervana Metwali
University of Iowa

Dave Miller
Iowa Farm Bureau Federation

Dan Mineck
Alliant Energy

Thomas Newton
Iowa Department of Public Health

Marsha O'Neill
University of Iowa

Dawn Price
Planned Parenthood of East Central Illinois

Susan Roberts
Jefferson Agricultural Institute

Mindy Rohlfs
Iowa Department of Public Health

Duane Sand
Iowa Natural Heritage Foundation

Jane Schadle
The Wellmark Foundation

Deb Scholten
Northeast Nebraska Public Health Department

Angela Schroeder
University of Iowa

Georgette Stern

Shirley Stern

Stephen Treimer
University of Iowa

Mike Welsh
University of Iowa

Teresa Welsh
Iowa Policy Project

Peter Weyer
University of Iowa

Kathy Williams
Office of Rural Health

Ralph Wilmoth
Johnson County Public Health Department

Charles Winterwood
Sierra Club