Chapter 1

Introduction and Overview
Kelley J. Donham and Anders Thelin
Reviewer: Susan Brumby

1.1 Introduction to the Professional Specialty of Agricultural Medicine (Agricultural Safety and Health)

Those working in the agricultural industry producing food, fiber, and fuel experience one of the highest risks factors among all occupations for injury, illness, and death. This is true for developed economies as well as developing and the least developed economies of the world. (Note: The categorical terms for nation state development are those of the United Nations). The aim of this chapter is to provide the introduction and background to the developing specialty field of agricultural medicine/agricultural safety and health to a multidiscipline audience of health and safety professionals and students. Our intermediate goal is to increase the knowledge of this field in health and safety among rural professionals and students, and instill passion among them to apply their skills to keep farmers, their families, and their workers alive and well in agriculture. The long-term goal is to reduce adverse occupational health, economic, social, and emotional problems to at least a level comparable to all other occupations.

1.2 Terminology and Definitions

Most countries' agricultural industrial classification schemes include production agriculture (farming and ranching), forestry, and fishing. This book is about the occupational health and safety of people working in production agriculture—those who produce food, fiber, and bio-fuels for the world. In this chapter, there are nine main topic areas that will be covered: (1) a history and definition of terms relevant to agricultural safety and health, (2) a description and background of an agricultural safety and health professional, (3) the training required of the latter, (4) the demographics of the agricultural workforce, (5) types of farms, (6) the health status of the agricultural workforce, (7) the occupational health status of the agricultural workforce, (8) persistent and emerging megatrends shaping agriculture, and (9) a brief overview of the major occupational health and injury issues in agriculture and their prevention.

Regarding historical perspectives and terminology, several terms have been used to describe the fields of endeavor aimed at the health of our rural and agricultural communities. Donham and colleagues
described the historical context of these terms, although today they are often used interchangeably. Figure 1.1 illustrates the various terms used and their relationships. The two primary terms used to describe health-related activities in rural areas are rural health and agricultural health and safety. Rural health is defined by the National Rural Health Association as a field of endeavor aimed at the development and support of health-care services (providers and facilities) that are accessible and appropriate for all rural residents. The field of rural health does not focus on any particular diseases, occupation, ethnic group, or prevention, but on provision of services (healthcare personnel and facilities) aimed to take care of the usual episodic illnesses of rural residents. Agricultural health and safety, on the other hand, is a broad term that is used to describe a field of practice and associated endeavors aimed at prevention and treatment of occupational injuries and illnesses in agricultural populations.

Underneath this latter umbrella term are several interrelated terms: agricultural medicine, agromedicine, and agricultural safety. Although each term is associated with activities aiming to reduce injuries and illness in agricultural populations, each term has a slightly different history, concept, focus, professional make-up, and culture.

Within the broader field of agricultural safety and health, the term “agricultural medicine” has been used since the 1950s to describe a specialty discipline of the broader field of occupational medicine and occupational health. Although this latter umbrella term is several interrelated terms: agricultural medicine, agromedicine, and agricultural safety. Although each term is associated with activities aiming to reduce injuries and illness in agricultural populations, each term has a slightly different history, concept, focus, professional make-up, and culture.

Bernardo Ramazzini, an Italian physician of the early 1700s, has been generally recognized as the father of occupational medicine. He is credited with being the first to systematically study the effects of working conditions on the health of workers. Ramazzini’s work laid the foundation for the field of occupational medicine, which has evolved to encompass the study of the health effects of a wide range of working conditions, including exposure to physical, chemical, and biological hazards. Ramazzini’s emphasis on the importance of workplace health has had a lasting impact on the development of safety and health regulations in the workplace.

Figure 1.1Terminology/fields of endeavor addressing the health of rural residents, owners/operators, and workers in production agriculture.
Table 1.1 A brief history of agricultural safety and health

- 1713 Bernardo Ramazzini published his book *Diseases of Workers* (4)
- 1945 Toshikazu Wakatsuki established an outreach medical and prevention program for the farming community at Saku Central Hospital, Japan (5)
- 1945 Founding of the Institute of Farm Safety Specialists, which became the National Institute for Farm Safety in 1962 and in the International Society for Agricultural Safety and Health in 2012
- 1951 Founding of the Institute of Rural Occupational Health, Lublin, Poland
- 1955 Founding of the Institute of Agricultural Medicine, University of Iowa
- 1961 Founding of the International Association of Agricultural Medicine and Rural Health in Tours, France
- 1965 Founding of the *Journal of the International Association of Agricultural Medicine and Rural Health*
- 1973 Founding of the Institute of Rural Environmental Health (Occupational Health and Safety Section), Colorado State University (now the High Plains Intermountain Health and Safety)
- 1973 The term “agromedicine” first used by John Davies (6)
- 1974 The agricultural medicine training program at the University of Iowa started
- 1976 The peer-reviewed article “The Spectrum of Agricultural Medicine” outlining the didactic areas of agricultural medicine published in *Minnesota Medicine* (7, 11)
- 1977 Founding of farmers’ occupational health services in Sweden and Finland
- 1979 Article published by Elliott in the *Journal of the Royal Society of Medicine* that gave the first definition of agricultural medicine (8, 13)
- 1981 Founding of the National Farm Medicine Center, Marshfield, Wisconsin
- 1982 Article published by donham that gave a more detailed definition of agricultural medicine, differentiating it from the field of rural health (9, 14)
- 1984 Establishment of the first agromedicine program as a consortium of the Department of Family Medicine at the Medical University of South Carolina and Clemson University
- 1986 Founding of the Institute for Agricultural Medicine and Rural Environmental Health, University of Saskatchewan, Canada (now the Canadian Centre for Health and Safety in Agriculture)
- 1988 Founding of the North American Agromedicine consortium
- 1988 Agriculture at Risk Report (10)
- 1988 Founding of the Australian Center for Agricultural Health and Safety at Moree, New South Wales
- 1990 Founding of Iowa’s Center for Agricultural Safety and Health
- 1990 Founding of the National Institute of Occupational Safety and Health Program on Agricultural Safety and Health, leading to 10 regional centers across the United States
- 1991 Surgeon General’s Conference on Agricultural Safety and Health
- 1992 Publication of the text *Safety and Health in Production Agriculture* (11)
- 1994 Founding of the *Journal of Agromedicine*
- 1994 Founding of the *Annals of Agricultural and Environmental Medicine*
- 1995 Founding of the *Journal of Agricultural Safety and Health*
- 1997 Publication of the reference book *Safety and Health in Agriculture, Forestry and Fishing* (86)
- 2002 Founding of Norway’s Farmer Health and Safety Program (Landbrukets HMS-tjeneste)
- 2003 Publication of *Looking Beneath the Surface of Agricultural Safety and Health* (13)
- 2003 Transition of the Iowa Agricultural Health and Safety Network to a new national non-profit organization, the AgriSafe Network
- 2006 Publication of the text book *Agricultural Medicine: Occupational and Environmental Health for the Health Professions* (14)
- 2006 Publication of *Agricultural Medicine: A Practical Guide* (15, 85)
- 2006 University of Iowa founded the first specifically titled MS and PhD graduate degrees and a certificate program in agricultural safety and health
- 2006 Founding of the University of Iowa’s program Building Capacity in Agricultural Medicine Training, which initiated sustainable training programs in agricultural medicine. Programs have been initiated in nine US states (Iowa, Illinois, Wisconsin, North Dakota, Nebraska, Vermont, North Carolina, Alabama, and Texas), and in Australia and Turkey
- 2007 Founding of the Agricultural Safety and Health Council of America
- 2008 Founding of the Australian Center for Farmers’ Health at Hamilton, Victoria
- 2011 National Institute for Farm Safety changed its name to the International Society for Agricultural Safety and Health to reflect an emphasis on safety as well as health, with an international focus
- 2012 First agricultural medicine course in the Middle East at University of Harran, Sanliurfa, Turkey
of occupational medicine. His book (*Diseases of Workers*, translated from Latin) describes in detail many occupationally related diseases (which he observed in his farm patients), many of which we still recognize today (4). The history of occupational medicine and occupational health generally (and agricultural medicine specifically) can be traced to his writings.

In more modern times, a physician named Toshikazu Wakatsuki in Japan developed a strong outreach program to his farming patients following World War II. Wakatsuki began his tenure at Saku Central Hospital in the Nagano Prefecture of central Japan in 1945. He spent his professional lifetime transforming the care of the rural farming community from what may have been considered benign neglect to a world model outreach and prevention program. He established the Japanese Rural Medicine Association, and was one of the principal founders of the International Association of Agricultural Medicine and Rural Health. His humble, dedicated, humanitarian approach to his mission earned him the Ramon Magsaysay Award (the Asian equivalent of the Nobel Peace Prize) in 1976 (5). In Europe, the Institute for Rural Occupational Health was initiated (in 1951) at Lublin, Poland, and was the first research institute to focus on the occupational health of farmers. The institute at Lublin became known as the Institute of Agricultural Medicine in 1984. This institute houses a multidisciplinary team of some 150 scientists researching the occupational and environmental health of Poland’s rural and farming community (16). It also founded a new journal in 1994 titled *Annals of Agricultural and Environmental Medicine*, which publishes peer-reviewed scientific articles on a wide variety of occupational and environmental health problems among agricultural workers (16).

The first use of the term “agricultural medicine” in the United States can be traced to 1955 with the founding of the Institute of Agricultural Medicine (IAM) at the University of Iowa within the College of Medicine. This institute was organized with a multi-professional faculty (after the philosophy of the one-health approach) that included a physician, an industrial hygienist, a veterinarian, a microbiologist, an anthropologist, an agricultural engineer, and a toxicologist (17, 18). The IAM was renamed the Institute for Rural and Environmental Health, and in 1999 became a program within the newly formed College of Public Health.

Franklin Top, first director of IAM (19) set out the didactic basis of agricultural medicine, which included the importance of understanding the processes and work environment of agriculture, including acute injuries, sanitation, allergies, farm chemicals, zoonoses, and social and mental health. Rasmussen and Cole (7) expanded on Top’s comments and further established the didactic content of agricultural medicine. Berry (17, 20) produced the first published articles regarding the peculiarities of agricultural medicine. Elliott (8) published the first attempt at a definition of agricultural medicine, which used a variation of the definition of industrial hygiene. In 1982, Donham expanded on Elliott’s definition, to incorporate concepts of clinical medicine and public health: Agricultural medicine is “… the anticipation, recognition, diagnosis, treatment, prevention, and community health aspects of health problems peculiar to agricultural populations” (9). Agricultural medicine is an academic discipline, a specialty area of occupational and environmental medicine and public health. Multidisciplinary in its approach, it involves professionals from all the clinical and basic health and safety sciences and veterinary medicine. Agricultural medicine has a research base and a core of didactic information. This didactic core of information serves as the basis for training programs for health or safety professionals who work in the area. Early development of academic training in agricultural medicine can be traced back to the University of Iowa program (IAM). Existing in the beginning as a research institute, in 1974 a training program in agricultural medicine was initiated for healthcare professional students and
graduate students (21). Two international professional organizations further the professional field of agricultural medicine. The International Association of Agricultural Medicine and Rural Health, founded in 1961 at Tours, France (8, 22), is a multi-professional group of healthcare practitioners, health and safety scientists, and agriculturalists who aim to identify and control health and environmental problems in rural and agricultural communities. The International Commission of Occupational Health, Scientific Committee on Agriculture, Pesticides and Organic Dusts has furthered the international concept of agricultural medicine (23).

Furthering the scientific basis for the field of agricultural medicine, two scientific journals have agricultural medicine in their title: *Journal of the International Association of Agricultural Medicine and Rural Health* and *Annals of Agricultural and Environmental Medicine*.

A variant on the term agricultural medicine was used with the founding of the National Farm Medicine Center in 1981 at Marshfield, Wisconsin. This medical research and outreach group to the farm community was developed within a private multi-specialty physician group, but it has evolved into a multi-professional group focusing on occupational illnesses and injuries in the farming community (24). The University of Saskatchewan in Canada has been involved in agricultural medicine since the mid-1990s, and in 2006 developed the Canadian Centre for Health and Safety in Agriculture (25).

Another variant on agricultural medicine, agromedicine, was first used in 1976 and defined in more detail in 1978 by John Davies (6). He expressed his concern over the public and agricultural producers’ fears regarding the health and environmental effects of pesticides. He perceived a need for the medical and agricultural health communities to work together on this issue and called for an “agromedicine approach.” Davies asserted that although pesticides were clearly a boon for agricultural production, the occupational, environmental, and public’s concerns and regulations were driven by fear, rather than science, creating a barrier to their rational use. Stanley Schumann at the Medical University of South Carolina expanded on the agromedicine concept. He observed that the Cooperative Extension Service of land grant colleges had agricultural specialists in every county of the state to disseminate information from the research campuses to the farmers in the countryside. Extension agents are located in rural areas to assist with problem solving that might arise regarding production issues. Schumann thought that medical and health information and problem solving could and should be disseminated in a similar manner, but in full collaboration and in context with scientific agricultural production information (26). The South Carolina Agromedicine Program was initiated in 1984 as a joint collaboration between the Division of Family Medicine at the Medical University of South Carolina and the Agricultural Extension Service of Clemson University. The program grew, gaining first regional then national interest, and in 1988 the North American Agromedicine Consortium (NAAC) was established. This organization held annual professional conferences through 2006 and founded the scientific, peer-reviewed *Journal of Agromedicine*. However, due to decreased funding at the state level and the evolution of other related organizations, NAAC is no longer active. The *Journal of Agromedicine* still persists, and operates out of the Farm Medicine Center, Marshfield WI.

The differences between the history and concepts of agricultural medicine and agromedicine in their beginnings were clear. However, their basic goal to improve health and safety in the agricultural community was common. Both are fields of agricultural health and safety, with the objective of controlling or preventing agricultural occupational and environmental illnesses and injuries. Both are multidisciplinary in their approach. Both promote the importance and understanding of agriculture and the culture of its people. The basic difference is that agricultural medicine is a public health/medical discipline (a subspecialty of occupational and environmental health) and agromedicine is a process, an inter-professional link between the medical faculty
(usually family medicine) and the agricultural college (extension).

Agricultural safety compared to agricultural medicine has had a longer history, starting in the United States in the 1940s. The first individuals involved included extension agents, insurance loss control personnel, and farm bureau representatives. Professionals who became involved in this effort brought an orientation from the field of industrial safety. The methods focused on promoting awareness of safety hazards resulting in acute injuries in the farm community. The National Institute for Farm Safety was the primary professional organization for this group of professionals. In 2012, the name of this organization was changed to the International Society for Agricultural Safety and Health (ISASH; 27) to reflect greater international participation and greater involvement of health professionals. The principal scientific journal of this group is the Journal of Agricultural Safety and Health.

Although the three terms described above have different histories, professional make-up, and culture, they are tied together by the common goal of reducing illnesses and injuries among agricultural populations. Furthermore, the related professional journals and societies (mentioned above) provide a common chronicle for practitioners and students interested in agricultural health and safety. Government agencies for occupational health also bring various professionals together to address agriculture. For example, the National Institute of Occupational Safety and Health (NIOSH) funds agricultural health research and education activities both internally and through its lead extramural activity, the Agricultural Health Centers Program. The latter consists of 10 multi-professional center programs in the United States (28). Demonstration of functional multi-professional collaborative solidarity within the field of agricultural safety and health was evident in 2004 and 2005 when combined national meetings were cohosted by ISASH, the NIOSH Agricultural Health Centers Group, and NAAC.

A new organization (the Agricultural Safety and Health Council of America (ASHCA), http://ashca.org/) was established in the United States in 2007. Formed as a coalition of agricultural businesses, farm organizations, federal agencies, and health and safety professionals, this organization furthered the multi-professional collaborative approach. A primary goal of ASCHA is to seek active collaborative involvement and leadership of agricultural businesses (e.g., farm supply and services, insurance, machinery manufacturers) in the formation of agricultural health and safety policy, regulations, research, and prevention interventions.

1.3 What is an Agricultural Health and Safety Professional?

The evolution of the profession of agricultural health and safety was recently reviewed (29). The following paragraphs summarize the progress in this field. Many individuals of varying backgrounds can make a difference in the health and safety of our agricultural communities, including healthcare practitioners who as a part of their practice may serve agricultural patients. There are also professionals who deal with agricultural health and safety on a full-time basis. Figure 1.2 describes the roles and relevant background education needed to fill these different niches.

1.3.1 The Primary Care Physician, Nurse, Allied Health Professionals, and Veterinary Practitioners

Healthcare professionals and veterinarians in rural communities have an excellent opportunity to address the issues of agricultural health and safety with their patients and/or clients. They have frequent contact with farmers and their families, and they are in a position of respect and credibility within their community. The agricultural health and safety training program at the University of Iowa (30) has included health
professionals from a variety of backgrounds, including (1) primary care physicians, (2) nurses, (3) nurse practitioners, (4) physician assistants, (5) veterinarians, (6) respiratory therapists, (7) emergency medicine technicians and paramedics, (8) occupational therapists, (9) physical therapists, and (10) public health practitioners. The point is that professionals from many backgrounds can become agricultural health and safety professionals. They all can play important roles in addressing agricultural health and safety issues in their communities if equipped with some specific agricultural medicine training. The authors’ goal for this text is to arm health and safety professionals with knowledge and skills that facilitate better practice of fundamental agricultural medicine, including anticipation, recognition, evaluation, diagnosis, treatment, and prevention of occupational and environmental illnesses.

Mutel and Donham (31) have proposed an expanded role for the rural practitioner incorporating agricultural medicine within their clinical work, community service, health education, and research. Simmons (32) suggests there is a need for a special residency program in rural health and agricultural medicine. Physicians in rural communities often serve as the health leader, and therefore their actions may have a profound effect on their community’s health activities. Nurses also have a vital role in delivery of agricultural health services (33–36), for example the AgriSafe network (37) is a nurse-based model for delivery of occupational health services in farming communities. Veterinarians have an excellent opportunity to play a role in the health and safety of their farm clients. They frequently visit their clients’ farms, they know their clients’ exposures, and they have the medical background to recognize farm exposures and possible health risks. Furthermore, veterinarians are one of the most trusted professionals for the farm population in regard to human health and medical issues as well as animal health (38).
1.3.2 The Full-time Agricultural Health and Safety Specialist

Relatively small cadres of professionals (an estimated 500 world-wide) reside primarily in North America, the EU, Australasia, and South East Asia. These professionals devote the majority of their professional lives to activities dealing with the health and safety of agricultural populations. They are associated with extension services, university or hospital research programs, insurance companies, governmental occupational health regulators, public health agencies, or non-governmental for profit or non-profit occupational health programs for the farming community. These programs provide the research basis, evidence, and training for health professionals to practice in their field. They make up the professional organizations, write and publish scientific manuscripts in the field, and advocate public policy to address farmers’ health issues.

1.4 Training of Agricultural Health Practitioners and Agriculture Health and Safety Specialists

1.4.1 Training for Healthcare Practitioners

Very few formal agricultural medicine training programs exist in the world. Most health professionals who practice in rural areas have to learn about these issues through on-the-job experience or informal continuing education. Although several medical schools train rural physicians, few teach agricultural medicine as a component of that training. There are exceptions that include agricultural medicine training for medical students aiming at rural practice. These programs include the University of Alabama (39), the University of Nebraska, and the University of Iowa (40, 41). These programs have initiated the 40-hour Agricultural Medicine Core Course for their Rural Medical Scholars students (39, 41). Furthermore, the University of Iowa's Building Capacity Program in Agricultural Medicine (40, 42, 43) has facilitated new training programs in nine states in the United States, Australia, and Turkey. In Australia, the Agricultural Health and Medicine course commenced in 2010 and is offered through the School of Medicine at Deakin University. It is based on the University of Iowa's course and combines a 1-week intensive in-class course with farm visits and online learning (44).

Several graduate programs and continuing education programs provide training for nurses (30, 45, 46). The University of Iowa provides a certificate program in agricultural occupational health for healthcare practitioners. The non-profit organization AgriSafe Network in the United States also provides continuing education training either by web-based presentations or as a component of other ongoing continuing education programs. Landbruksradgivning HMS (NLR-HMS) in Norway has developed a combined classroom and online interactive educational program in agricultural health and safety for farmers, farm school students, local farm advisers, and researchers and teachers at universities.

1.4.2 Training Full-time Agriculture Health and Safety Specialists

There are few formal academic training programs to prepare full-time agricultural health and safety specialists. Some organizations have workshops; some universities have a course or two in agricultural health and safety, plus research experience that can enhance training in this area. Only a few universities have a formalized didactic training specialty in agricultural medicine or agricultural safety and health that leads to a specific degree or certificate. Table 1.2 provides information about several training programs in agricultural health and safety.

As agricultural health and safety is a multi-professional field, there is a place for entry into the field of formalized agricultural health and safety training for people with backgrounds that may include but are not limited to any of the health sciences, occupational medicine and
Table 1.2 Universities with academic training programs in ASH and organizations with general ASH resources, outreach training and prevention, and professional development

<table>
<thead>
<tr>
<th>Academic program</th>
<th>Audience</th>
<th>Program name or courses available</th>
<th>Comments</th>
<th>Contact information/URL</th>
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<tr>
<td><strong>North America</strong></td>
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<tr>
<td><strong>University of Saskatchewan, Canada</strong></td>
<td>Graduate students</td>
<td>Public Health and the Agricultural Rural Ecosystem (PHARE)</td>
<td>Collaboration with 10 other universities Course in public health and rural ecosystems; monthly web seminars, annual conference Degrees offered in various departments at collaborating institutions (<a href="http://www.cchsa-ccssma.usask.ca/trainingprograms/phare.php">http://www.cchsa-ccssma.usask.ca/trainingprograms/phare.php</a>)</td>
<td>Shelly Kirychuck, PhD Canadian Centre for Health and Safety in Agriculture P.O. Box 23 RUH 103 Clinic Place Saskatoon SK S7N 5ES 306-966-6649 <a href="mailto:Shelley-kirychuck@usask.ca">Shelley-kirychuck@usask.ca</a> <a href="http://www.cchsa-ccssma.usask.ca/">http://www.cchsa-ccssma.usask.ca/</a></td>
</tr>
<tr>
<td><strong>University of Iowa</strong></td>
<td>Graduate students in public health, health and safety science, education, and agriculture</td>
<td>ASH Training Program</td>
<td>MS, PhD, and Certificate in ASH Four specific courses totaling 12 graduate credits in agricultural health and safety courses This is the only known graduate degree program (listed on the diploma) in ASH</td>
<td>Diane Rohlman, PhD Department of Occupational and Environmental Health College of Public Health S161 CPHB 145 N Riverside Dr. 52242 319-335-384-4007 <a href="mailto:Diane-Rohlman@uiowa.edu">Diane-Rohlman@uiowa.edu</a> <a href="http://cph.uiowa.edu/icash/">http://cph.uiowa.edu/icash/</a></td>
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<tr>
<td><strong>University of Kentucky</strong></td>
<td>Graduate students in various fields of public health, available for MPH, MS, or PhD students from various departments in public health</td>
<td>Certificate program in ASH for MS or PhD students MPH ASH offered through the NIOSH-funded education center</td>
<td>Training in ASH is primarily researched focused</td>
<td>D.M. Mannio, MD Southeast Center for Agricultural Health and Injury Prevention University of Kentucky College of Public Health 111 Washington Avenue Suite 220 Lexington KY 40536. 859-323-6836 Fax: 859-254-3760 <a href="mailto:Dmannino@uky.edu">Dmannino@uky.edu</a> <a href="http://www.mc.uky.edu/scahip/">http://www.mc.uky.edu/scahip/</a> <a href="http://www.mc.uky.edu/erc/trainingPrograms/">http://www.mc.uky.edu/erc/trainingPrograms/</a></td>
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<tr>
<th>Institution</th>
<th>Program Details</th>
<th>Contact Information</th>
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<tr>
<td>North Carolina State University</td>
<td>Undergraduate students with biological and agricultural engineering, technology or related field; Undergraduate industrial engineering students</td>
<td>No recognized ASH degree or program; BAE 432: Agricultural and Environmental Safety and Health, three credits; IE 544: Occupational Biomechanics is a related, but not exclusively an agriculture course; Undergraduate minor in agricultural and environmental technology; includes some ASH content</td>
</tr>
<tr>
<td>East Carolina University Agromedicine Center</td>
<td>Continuing education and MPH students</td>
<td>A developing full academic program in ASH</td>
</tr>
<tr>
<td>Pennsylvania State University</td>
<td>Undergraduate students in agricultural and industrial health and safety; Seniors/beginning graduate</td>
<td>No recognized ASH degree program; ASM 326: Hazard Identification and Control in Production Agriculture and Related Business; ASM 426: Management of Safety and Health Issues in Production Agriculture and Related Business</td>
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<tr>
<td>University</td>
<td>Undergraduate students</td>
<td>Undergraduate courses</td>
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| **The Ohio State University**    | Primarily agricultural students (agricultural systems management (ASM) majors) or construction systems management (CSM) majors Other students include ASM minors, landscape construction, agricultural business, animal science, agricultural education, horticulture, turfgrass management, and agronomy | No recognized ASH degree program  
*ASM 600: Agricultural Health and Safety, three credits*  
*CSM 600: Construction Health and Safety, three credits* | Mostly undergraduate students Courses do count as graduate credit | Dee Jepsen, PhD  
Agricultural Safety and Health  
Food, Agricultural, and Biosystems Engineering  
College of Food, Ag, and Environmental Science  
The Ohio State University  
590 Woody Hayes Dr.  
Columbus  
OH 43210  
614-292-6008  
jepsen.4@osu.edu, orosuagsafety@gmail.com |
| **Purdue University**            | Undergraduates and graduates in the Colleges of Agriculture and Agricultural and Biosystems Engineering | *ASM 510: Emergency Management for Agricultural Production Operations*  
*ASM 350: Agricultural Safety* | This program provides research opportunities in farming disabilities, injury surveillance and other fields of agricultural safety research | William Field, PhD  
Purdue University  
Department of Agricultural and Biological Engineering  
225 South University Street  
West Lafayette  
IN 47907-2093  
+1 765 49-41191  
field@purdue.edu  
https://engineering.purdue.edu/ABE/Engagement |
| **University of Illinois**       | Undergraduate and graduate students | All programs award both undergraduate and graduate credit  
*TSM 422: Ag Health and Illness Prevention, three credits*  
*TSM 423: Ag Safety and Injury Prevention, three credits*  
*TSM 425: Ag Safety and Health Interventions, three credits*  
*ASH traineeships: three or four credits*  
*Minor in ASH: within the College of Agriculture, Consumer and Environmental Sciences* | The program’s primary aim is to provide students from a variety of backgrounds with a program in ASH (e.g. industrial hygiene, secondary agriculture education, extension, public health, etc.) | Robert (Chip) Petrea, PhD  
Agricultural Engineering Department  
University of Illinois  
1304 W. Pennsylvania  
Urbana  
IL 61801  
(217) 333-5035  
rcp@sugar.age.uiuc.edu |

(Continued)
### Beyond North America

**Australian National Centre for Farmer Health, in cooperation with Deakin University, Hamilton, Australia**

- Course: Graduate Certificate of Agricultural Health and Medicine
- Courses: HMF701: Agricultural Health and Medicine, HMF702: Healthy and Sustainable Agricultural Communities
- Affiliates: Susan Brumby, PhD, RN, RM, Dip, M’Ment
  - Address: Australian National Centre for Farmer Health
  - Contact: PO Box 283, Hamilton, Victoria, 3300
  - Email: susan.brumby@wdhs.net
  - Website: http://www.farmerhealth.org.au/page/education-centre

**Harran University**

- Courses: Medical students and graduate students, Health and safety practitioners, healthcare practitioners
- Conference: Growing interest in ASH, managed out of the Public Health Department in the College of Medicine
- Affiliates: Zeynep Simsek, MD
  - Address: College of Medicine, Harran University, Sanliurfa, Turkey
  - Email: zsimsek@harran.edu.tr

### North America

**International Society for Agricultural Safety and Health (ISASH)**

- Extensive specialty: Extension safety specialists, Insurance risk managers, Machinery manufacturer product safety specialists, Academic health and safety specialists
- Events: Annual meeting offers ASH continuing education sessions, A three-day agricultural safety and health certificate core course offered annually
- Affiliates: Chair of the NIFS Professional Improvement Committee
  - Contact: http://www.ag.ohio-state.edu/%7Eagsafety/NIFS/officers.htm#Standing

### Organizations with general ASH resources, research, outreach training and prevention, and professional development

- Programs: North America, Beyond North America
- Services: Conferences, Training, Research, Advocacy, Member Education, Prevention, Professional Development

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Table 1.2 (Continued)
<table>
<thead>
<tr>
<th>Organization / University</th>
<th>Field of Study</th>
<th>Focus Areas</th>
<th>Specializations</th>
<th>Websites / Resources</th>
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<tbody>
<tr>
<td>Pesticide Action Network</td>
<td>Farm workers</td>
<td>Advocacy, education, research</td>
<td></td>
<td>Network of over 600 participating non-governmental organizations, institutions, and individuals in over 90 countries</td>
</tr>
<tr>
<td>International Social Security Association, Section for Agriculture (ISSA)</td>
<td>Farmers, farm workers, farm managers, health and safety professionals</td>
<td>Advocacy, member education, research</td>
<td></td>
<td>Works within the framework of the existing ISSA international sections for prevention of illnesses and injuries in agriculture and forestry</td>
</tr>
<tr>
<td>Farm Worker Health and Safety Institute</td>
<td>Farm populations</td>
<td>Advocacy, professional training</td>
<td>Functions as a training arm for migrant and seasonal farm workers</td>
<td>Formed in 1992 to protect the health and safety of migrant and seasonal farm worker organizations in the United States, Mexico, Central America, and the Caribbean</td>
</tr>
</tbody>
</table>

**Agricultural health and safety centers: North America**

**National Institutes for Occupational Safety and Health supported agricultural health and safety centers in the United States**

**NIOSH Centers**
- Colorado [http://csu-cvmbs.colostate.edu/academics/erhs/agricultural-health-and-safety/Pages/default.aspx](http://csu-cvmbs.colostate.edu/academics/erhs/agricultural-health-and-safety/Pages/default.aspx)
- Iowa [http://cph.uiowa.edu/icash/](http://cph.uiowa.edu/icash/)
- Kentucky [http://www.mc.uky.edu/scahip/](http://www.mc.uky.edu/scahip/)
- Nebraska [http://www.unmc.edu/publichealth/cscash/](http://www.unmc.edu/publichealth/cscash/)
- Wisconsin [https://www3.marshfieldclinic.org/nccrahs/](https://www3.marshfieldclinic.org/nccrahs/)

(Continued)
<p>| Vermont Farm Health Task Force | Health and safety professionals, farm workers | 48-hour core course in agricultural medicine | One of nine building capacity sites facilitated by the University of Iowa | Champlain Valley Area Health Education Center 92 Fairfield Street St. Albans VT 05478 (802) 527-1474 <a href="http://www.uvm.edu/extension/agriculture/health-safety/taskforce/">http://www.uvm.edu/extension/agriculture/health-safety/taskforce/</a> |
| Agriwellness, Inc. | Professional training, behavioral health services | Training for mental health professionals in agricultural issues | Promotes accessible mental health services for the farm population | (712) 236-6100 <a href="http://www.agriwellness.org/">http://www.agriwellness.org/</a> |
| Farm Safety 4 Just Kids | Farm children, youths and parents | Promotes a safe farm environment | Prevention of health hazards, injuries, and fatalities among farm youth | (800) 423-5437 <a href="http://www.fs4jk.org/">http://www.fs4jk.org/</a> |
| Iowa’s Center for Agricultural Safety and Health (I-CASH) | Farmers, farm workers, agricultural medicine students | Professional agricultural medicine training, and training of farmers | Combines College of Public Health, Iowa Department of Public Health, Department of Agriculture, and Agricultural Extension | Brandi Janssen, PhD (319) 335-4438 <a href="http://www.public-health.uiowa.edu/ICASH/">http://www.public-health.uiowa.edu/ICASH/</a> |
| National AgrAbility Project | Health and rehabilitation of professionals | Professional training Direct services to disabled farmers | Technical consultation to accommodate disabilities in farmers | <a href="http://www.agrabilityproject.org/">http://www.agrabilityproject.org/</a> |
| National Center for Farmworker Health, Inc. | migrant and seasonal farm worker families | Information services and products | Improving the health status of migrant and seasonal farm worker families, center service sites in the United States and other organizations and individuals serving migrant and seasonal farm worker | <a href="http://www.ncfh.org/">http://www.ncfh.org/</a> |
| National Children’s Center for Rural and Agricultural Health and Safety | Children and parents exposed to ASH hazards | Advocacy, training of professionals, youths, and parents | Strives to enhance the health and safety of rural and agricultural youths | <a href="http://research.marshfieldclinic.org/children/">http://research.marshfieldclinic.org/children/</a> |</p>
<table>
<thead>
<tr>
<th>Organization</th>
<th>Focus Areas</th>
<th>Services</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Education Center for Agricultural Safety (NECAS)</td>
<td>Health professionals, emergency medical technicians/first responders, producers and agri-businesses</td>
<td>Grain and manure pit safety and rescue training, farm machinery training</td>
<td>Conducts education and outreach addressing ASH</td>
</tr>
<tr>
<td>National Farm Medicine Center</td>
<td>Health professionals, producers, and farm worker training</td>
<td>Dairy worker health, agricultural medicine training</td>
<td>Conducts research addressing human health and safety associated with rural and agricultural work</td>
</tr>
<tr>
<td>National Rural Health Association</td>
<td>Rural healthcare providers and healthcare facility managers</td>
<td>Annual conference, professional peer review journal, Journal of the National Rural Health Association</td>
<td>Advocacy, information forum</td>
</tr>
<tr>
<td><strong>Agricultural health and safety centers: European Union</strong></td>
<td><strong>Health &amp; Safety Executive: Agricultural and Food Sector (UK)</strong></td>
<td>Farm population education, professional training, health, education, and employment, safety, and forestry, strategy and evaluation</td>
<td>Protect people's health and safety by ensuring risk in the changing workplace is properly controlled</td>
</tr>
<tr>
<td>Norwegian Farmers’ Association for Occupational Health and Safety (Norsk Landbruksradgiving)</td>
<td>Farm population education, some ASH professional training</td>
<td>On-farm technical services and occupational health services, preventive health services</td>
<td>Norwegian occupational health service for farmers, cooperates with local occupational health services and farm organizations</td>
</tr>
<tr>
<td>Finnish Agricultural Health and Safety Centers</td>
<td>Farm population education</td>
<td>Preventive health services</td>
<td>Connected to regional health centers, provides comprehensive occupational health services to farm families</td>
</tr>
<tr>
<td><strong>Agricultural health and safety centers: Australia</strong></td>
<td><strong>Australian Centre for Agricultural Health and Safety</strong></td>
<td>Farmers, farm families</td>
<td>Research, farm injury data collection, reports</td>
</tr>
<tr>
<td>Farmsafe Australia, Inc.</td>
<td>Farm population education, professional training</td>
<td>Lead and coordinate national efforts to enhance the ASH of Australian farmers</td>
<td>Aims to improve health and safety awareness and practices</td>
</tr>
</tbody>
</table>

(Continued)
Table 1.2 (Continued)

<table>
<thead>
<tr>
<th>National Center for Farmer Health</th>
<th><a href="http://www.farmerhealth.org.au">http://www.farmerhealth.org.au</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>National Rural Health Alliance, Inc.</td>
<td>Rural healthcare providers, rural healthcare facility managers, researchers, and non-government agencies</td>
</tr>
</tbody>
</table>

Agricultural health and safety centers: South America

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina: Cooperative Federated Farmers Argentinos (AFA SCL)</td>
<td>Farmers, farm families, farm workers</td>
</tr>
</tbody>
</table>

ASH, agricultural safety and health.

Note: This is not intended to be a comprehensive list of all organizations or individuals who practice agricultural safety and health.
health, veterinary medicine, public health, agricultural engineering, education, social sciences, or agriculture. The key is to have a combination of agricultural training, or at least a background and cultural familiarity of the people, along with one of the related fields above. Also essential to the training of an agricultural health and safety specialist is core knowledge in occupational exposures, resulting illnesses and injuries, and prevention. Core topics, objectives, and competencies have been developed by a consensus process of 38 agricultural health and safety professionals as the national core course in the field of agricultural health and safety (47). Figure 1.2 provides a diagram of this author’s (KJD) concept of a recommended background and training to make up an agricultural health and safety specialist.

1.5 Demographics of the Agricultural Workforce

Worldwide, agriculture employs the largest number of workers compared to all other industries. Over 40% (450 million) of the world’s workers are employed in agriculture (48). Over half of these workers are women. In developing countries, 40% of the total population is engaged in agriculture, compared to 20% in transitioning economies, and 3% of the workers in developed industrialized countries (49). However, even in industrialized countries the agricultural sector is a significant portion of the total workforce. The 27 countries of the European Union (EU27) has about 12 million farms (2013) with a mean size of 14.2 Ha, and 95% are family farms (50, 51). Mexico has about 4 million farms (2007), the United States has about 2.2 million farms (2007), and Canada has about 229,000 farms (2006) (52–54). Australia has 135,000 farms (2011) (55), and New Zealand had 78,549 farms in 2012 (56).

In order to comprehend the demographics of the agricultural workforce, it is important to understand the evolving structure and terminology used within the agricultural industry. The agricultural workforce includes principal operators (also called owner-operators), unpaid family members, and wage-earning employees or farm workers (indigenous and foreign-born nationals). Additionally, large and corporate-style farms employ farm managers. The vast majority of the agricultural workforce across industrialized countries is involved in family-style operations. These operations include a principal operator, who is also the owner-operator, and unpaid family members (although some larger family farms may have a few part-time or full-time employees). Another growing style of agricultural enterprise is alternative or niche farming, which is a growing variant of the traditional family farm operation. These operations produce and market products locally (e.g., fresh fruit and vegetables, organic foods, exotic food crops, eggs, milk and meat), markets not met by the traditional large family or corporate family operations (57).

The decline in the number of farms began in the early 1900s as the industrial revolution enabled powered farm machinery to be incorporated into agriculture, reducing the amount of manual labor needed to farm and increasing the amount of land a farmer could manage. Beginning in the 1970s agricultural economic policies in the United States began a shift from a supply management policy (to bolster farm commodity prices) to an emphasis on a market-driven, supply-side economic policy. This meant that the lowest cost producer had the advantage. This resulted in increased global competition and demand for increasing productivity (more products with less labor), narrowing profit margins, and a force to get bigger to be able to stay in business. The 1990s was a period of increased globalization of economies, exacerbating the forces previously mentioned. International trade agreements also further enhanced these forces, which created economic stress on traditional family farm operations, increasing the decline in their numbers that has continued into the current millennium. However, some of the traditional small family farms have grown to become family corporations in order to compete, adopting
the management systems of large corporate-style operations (58). These types of operations separate labor and management, as well as the farm and residence. Some large corporate-style vertically integrated food companies may produce the raw products, process them, as well as retail the finished food products. Some individual private farms are connected to these large farms as contract growers (59, 60). The corporate-style farms employ the majority of hired farm workers. These workers may come from the local area or foreign countries, and they travel for employment purposes (migrant seasonal workers).

Figure 1.3 (61) illustrates the breakdown of these types of operations for the United States. This pattern is similar in all the developed countries discussed in this book. However, large corporate-style agriculture has developed more rapidly in the United States compared to other industrialized countries. These large farms make up less than 5% of the total farms, but they contribute about 50% to the total US commodity production (57). Additional details of the evolving structure of production agriculture are discussed in the Persistent and Emerging Megatrends section of this chapter.

1.6 The Evolution of Production 
Agricultural, Workforce, and Types of Farms

1.6.1 Family Farms

Family farming in Western industrialized countries developed as Northern Europe evolved from a feudal system to democratic nation states in the late 1700s and early 1800s. Opportunities for land ownership, farming, and religious freedom in the 1800s drew many Northern Europeans to North America, Australia, New Zealand, and South America, where they developed family farming mixed with plantation farming. Some came with facilitation from early colonial regimes and later new indigenous governments with the aim to “settle the land”; some came into direct conflict with the indigenous peoples. Millions of emigrants came to these countries and found the “New World dream.” Later in this period in Western Europe, greater democratization, reformed social and land tenure allowed family farming to develop in those countries. History, political and social change, and perhaps genetics resulted in a similar culture among family farmers. Rosmann (62) has written on the factors...
of common culture of family farms, with an emphasis on the probable heritability of an agrarian type of psychosocial make-up. Family farms remain the dominant type of farm today worldwide, and comprise 95% of the total farm operations in developed countries. However, the trend in industrialized countries is that the number of small family farms has been decreasing by approximately 10% each decade with a corresponding decrease in the number of farm residents and relative increase in farm size.

There is an important culturally relevant point as to the terms that should be used in reference to a member of a family farm or ranch unit. Farm family members consider themselves to be owner-operators, managers, and self-employed businessmen/women (not farm workers). A farm worker, to them, is an employee, a person with less socioeconomic status. Family farm members are proud and may find being referred to as a farm worker an indication that you do not understand their role and work. They may think you are disrespectful or naïve of their culture and the structure of agriculture. This is important for practitioners to understand to enable meaningful communication. Acceptable terms for adult farm family members include farmer, producer (with a prefix of specific commodity such as pork, wheat, etc.), rancher, grower, owner-operator, or principal operator. As gender equality has evolved in the past two decades, women also want to be recognized in a similar fashion. “Farm wife” may not always be an acceptable term, as women also are principal operators or joint principal operators. Children under teenage years may be referred to as “farm children,” but adolescents who are actively involved in the operation would be proud to be referred to as a farmer, rancher, etc., just as an adult would.

1.6.2 Principal Operator

Approximately 70% of the principal operators of family farms in developed countries are male. However, the percentage of women principal operators has been growing over the past two decades. In most operations, the principal operator puts in the majority of hours of work on the farm and they typically are older than the general mean of the workforce in their country. For example, the average age in 2007 of male principal operators in the United States was 57 years (similar in other industrialized countries), and the trend is toward an increasing age (51, 53, 63). This compares to a mean of about 45 years in the general workforce (57). A total of 28% of the farmers in the EU are over 65 years old and only 9% are under 35 (51). Similar demographics are seen in Australia, where the median age is 55 years (55).

The vast majority (over 95%) of the US family farm workforce is Caucasian, primarily of Northern European descent. In the United States about 2.4% of principal farm operators are of Hispanic origin, 1.2% are black, and about an additional 0.5% include Native American Indians and Asian or Pacific Islanders. Over 70% of the principal operators live on their farm (57).

1.6.3 Farm Family Members

Women have long been a vital component in the family farming enterprise. Worldwide, the Food and Agriculture Organization has reported that over 60% of economically active women in developing countries work in agriculture (64). Although the percentage is less in industrialized countries, that figure is growing. In industrialized countries, women’s roles include part-time laborer, management assistant, bookkeeper, homemaker, full partner in the operation, co-principal operator, and principal operator. Women principal operators have been increasing in both North America and Europe. Although only 5% of principal farm operators in Canada are women, 27.8% of farms are jointly operated by a man and a woman (54). In the 30% of farms in the United States where multiple operators are reported, 30% of the operators are women (64). On those farms where just a principle operator is reported, 14% are women. In Finland, a high percentage of women consider themselves to be full-time farmers. In Poland, over 60% of the farms are operated by women (51) as they tend to stay on the farm if their husband dies or takes a job off the farm.
A high percentage of both men (30–50%) and women (45–60%) on family farms in North America have additional employment off the farm (57). Fifty-six per cent of those working off farms have either management or professional positions, much higher than the average for the workforce as a whole (65, 66). This has been an increasing trend over the past three decades in all industrialized countries, as profit margins have decreased, making it a necessity to have additional off-farm income for the family. In the United States, taking an off-farm job is also motivated by the possibility of obtaining health insurance from the employer, as insurance may otherwise cost a family up to $12,000 per year (64). This additional employment has increased the total workload and stress on modern family farm members, and it increases risk for adverse mental and physical health outcomes (66–68), as is discussed in Chapters 10 and 11.

Children typically begin more independent work on farms at about the age of 10 years. Boys are usually more involved in the heavier farm work than girls, and their farm injury rates bear that out as they are about twice as high compared to those for farm girls (68). In Sweden, girls of 14–16 have the same high injury rate as boys in the same age group. However, the source of injury for girls is primarily from contact with horses.

### 1.6.4 Farm Workers

Farm workers are employees and receive wages for work. Of the estimated 1.3 billion persons employed in agriculture worldwide, nearly half are farm workers, 38% are migrant/seasonal farm workers, and 50% are women (69). Farm workers make up an important part of the agricultural labor force in all industrialized countries. Of these workers, about 50% come from the local area (indigenous) and about 50% are migrant or seasonal workers, some who are foreign-born but citizens living in the country where they work and some who are citizens from neighboring or distant countries.

### 1.6.5 Indigenous Farm Workers

Indigenous farm workers may have the same culture and socioeconomic status as the owner/operator. They may be farm youths who work seasonally or part-time on another person’s farm. These workers may be exposed to the same hazards as other workers but do not have the same inherent lower socioeconomic status as migrant or seasonal or foreign-born workers. Generally speaking in the United States, indigenous farm workers are similar in number to foreign-born migrant or seasonal workers.

### 1.6.6 Migrant and Seasonal Farm Workers

The International Labour Organization (69, 70) published a detailed global report on migrant workers. The following review provides additional focus on the situation in the EU and North America.

Developed countries depend highly on migrant and seasonal workers to conduct farm work. Migrant and seasonal workers are defined by their movement from farm to farm as seasons change and labor demands change with production cycles. They often return to their home place in the “off season.” The EU employs 4.5 million migrant and seasonal workers; about 500,000 of these are from outside the EU. Farm operators in the United States hire (at some time during a year) about 317,750 (2012 data) foreign-born migrant and seasonal workers (69, 71). In North America, migrant and seasonal workers make up nearly a quarter of the agricultural workforce. Many of these workers have found more permanent employment in larger industrial-style farms and have or are in the process of “settling out” in the community. For Europe and Australasia, the percentage of migrant and seasonal workers in the agricultural workforce is somewhat lower than in the United States (69). In North America, migrant and seasonal workers are largely Hispanics from Mexico. However, Central and South America contribute workers
as well as Bosnia, Asia, Africa, and the Caribbean Islands. The US Department of Agriculture (71) indicates that only 22% of US farmers hire one or more employees, and just over 8% of the farms hire more than 10 employees. The latter figure is significant in the United States because federal Department of Labor worker protection laws can be enforced only on those farms with more than 10 employees (or which have a temporary labor camp). Australian orchardists often depend on student labor (backpackers) from the EU or North America who work part-time to help pay for their vacation travel expenses.

### 1.6.7 Large Farms and Industrial-style Farms

As mentioned above, large farms have been increasing in number relative to small family farms. Some large farms have taken on the general management structure and work organization of private industry or a factory. The emphasis is on high productivity based on specialization, routine and tightly managed work processes, and replacement of much of the labor with mechanization and technology. Labor and management are separated, as are the residence and the farm business. The operation may be a link in a vertically integrated food company or it may be a large family corporation (see below). These farms are often more specialized than small family farms, and are sometimes referred to as “factory farms” by those who prefer traditional family farms. There may be stockholders or other investors involved in these corporations as the farm may rely on outside funds to expand its operations.

### 1.6.8 Family Corporations

Family corporations are usually enterprises that have grown from family farms over the years to involve multiple generations and extended family members. Their management scheme differs little from private corporate farms.

### 1.7 Other Occupations Exposed to the Agricultural Environment

Although this book is primarily about the occupational health and safety of those who work producing food, fiber, and bio-fuels, many other workers in agricultural support businesses have similar exposures to those of farmers and ranchers (72). Agricultural support businesses include services, sales, and processing of agricultural commodities. These occupations and potential exposures are included in, but are not limited to, those listed in Table 1.3.

### 1.8 General Health Status of the Agricultural Population

Several studies from different countries suggest that the rural and agricultural populations have better general health status compared to urban populations, rural non-farm populations, and other occupational groups based on the major causes of death and morbidity. The farm population has lower cancer rates and cardiovascular disease rates, including ischemic heart disease and stroke (73, 74). Details of lower overall cancer risks are seen in Chapter 5. In Sweden, Stiernstrom and colleagues (75) have found lower morbidity in the farm population due to lower rates of cancer, alcohol-related diseases, psychological conditions, cardiovascular conditions, and urinary conditions. The “farmer health effect” for these health benefits ranges from 20% to 50% lower relative risk, depending on the study and the country (76).

The reasons for these health benefits are thought to be lifestyle factors, including (1) decreased smoking, (2) less alcohol consumption, (3) more exercise, and (4) healthier diet (75). It is clear that farmers smoke significantly less (approximately 50% less) compared to the general population (77, 78). They also appear to consume less alcohol (79). Increased exercise might also be a benefit for farmers, primarily from their work, as they expend as much as 30% more calories per day...
than the general population (75). However, their leisure time is less likely to include vigorous aerobic cardiovascular exercise (75). Farmers’ body mass indexes are similar to those of the general rural population (79). Although there are no large-scale definitive dietary studies relative to health outcomes in the farming population, there is slight evidence that farmers’ diets may be a health benefit (73).

Contrary to the positive health benefits associated with farming, studies in Australia have revealed a different picture, as farmers there appear to have greater obesity (with larger girths) and higher risk for diabetes and metabolic syndrome, binge drinking (80–82), and suicide (83).

### 1.9 Occupational Health Status of the Agricultural Workforce

Although the general health status of farmers (owner/operators) appears to be better than comparison populations (Table 1.4), their occupational health appears to be one of the worst.
Among all occupations (84–86). Since the writings of Olaus Magnus (87) of Sweden in the mid-1500s and Ramazinni in the 1700s (4) on occupational diseases, there have been numerous reports, review articles, books, and book chapters documenting the low occupational health status of the agricultural workforce (3, 11, 15, 68, 88, 89). Agriculture in every industrialized country is one of the most hazardous occupations, based on occupational fatality rates, non-fatal occupational injury rates, and occupational illness rates.

### Table 1.4 Overall health status (morbidity and mortality) of the farm population relative to comparison populations

<table>
<thead>
<tr>
<th>Comparison population</th>
<th>Location</th>
<th>Findings</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural compared to urban populations</td>
<td>New York</td>
<td>Lower overall mortality</td>
<td>70, 71</td>
</tr>
<tr>
<td></td>
<td>Kentucky</td>
<td>Lower cancer mortality</td>
<td>86, 87</td>
</tr>
<tr>
<td></td>
<td>United States</td>
<td>Lower cardiac mortality and risk factors</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>Poland</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Costa Rica</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>United States</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agriculture compared to the general</td>
<td>Scandinavia</td>
<td>Lower mortality by 10%</td>
<td>89</td>
</tr>
<tr>
<td>population</td>
<td>New York</td>
<td>Lower mortality</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>Iowa and North</td>
<td>(40%)</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Carolina</td>
<td>Lower mortality</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>Australia</td>
<td>(50%)</td>
<td>78, 79</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Higher risk for cardiovascular disease, diabetes, and binge drinking</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Male farmers higher for all causes of death (33%), especially circulatory</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>and neoplasms</td>
<td></td>
</tr>
<tr>
<td>Agriculture compared to the rural</td>
<td>New York</td>
<td>Lower overall mortality</td>
<td>85</td>
</tr>
<tr>
<td>population</td>
<td>Sweden</td>
<td>Lower morbidity</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>Iowa</td>
<td>Lower mortality overall and cardiovascular (20%)</td>
<td>73, 74</td>
</tr>
<tr>
<td>Agriculture compared to other</td>
<td>Italy</td>
<td>Lower mortality:</td>
<td>91</td>
</tr>
<tr>
<td>occupations</td>
<td></td>
<td>cardiovascular (50%), cancer (28%), overall (46%)</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>Sweden</td>
<td>Lower mortality</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lower morbidity (15–70%)</td>
<td></td>
</tr>
</tbody>
</table>

1.10 Occupational Injury and Illness Statistics

There were 479 occupational fatalities in 2013 in the US agricultural industry, resulting in a fatality rate of 22.2/100,000 (90). This compares to 3.2/100,000 (2013) for all US occupations, making the US farm fatality rate over seven times higher. Fatality rates for youths under 20 years of age are about 8/100,000, over twice the fatality rate for all occupations. Fatal injuries in most other developed countries are lower than the United States, for example, fatality rates among farmers in Canada are 11.6/100,000 (92) and in Finland are 6.5/100,000 (91).

Accurate reporting of non-fatal injuries and illness is more challenging than for fatal injuries. There are large variations in reporting regarding rates of non-fatal injuries. For the United States, rates vary from about 5/1000 to 170/1000 (90, 93–95). Studies that had an active injury surveillance process recorded 420/1000 (91, 94). Most studies fall somewhere in the middle of this range, around 100/1000. In other words, one out of 10 farmers suffers a disabling injury every year.
Comparing non-fatal injury rates in the United States to other countries, the United States rate is comparatively high. For example, Canadian farmers report 03.9/1000, compared to 3.2/1000 for all occupations (53, 92).

Occupational illness rates are even more difficult to quantify than non-fatal injuries because such illness in self-employed people would rarely be identified as occupation related (there is no mechanism to create a need to report). Therefore, objective data is mainly based only on employed workers, where the employers are required to report. Other data are based on self-reported surveys, which have inherent sensitivity and specificity problems. Given these caveats, the US Bureau of Labor Statistics (90) indicates an illness rate of 3.1/1000. The top three conditions causing these illnesses were skin conditions (56%), cumulative trauma (14%), and respiratory diseases (13%). Data from the Finnish insurance company Mela indicate that occupational illnesses in agriculture occur at a rate of 6.4/1000. Respiratory illnesses make up nearly 40% of these conditions, followed by skin (21%) and joint illnesses (31%) (96, 97).

Not only is there an important loss of human resources from agricultural injuries and illnesses, there is also an enormous economic consequence. Leigh (98) found that each agricultural fatality creates an expense for the family on average of $29,904 direct and $555,770 indirect costs (in 2013). When multiplied by all the fatalities that occur annually in the United States, this adds up to $306 million. Adding the estimated costs for disabling injuries brings the annual total to nearly $4 billion.

### 1.11 Persistent and Emerging Megatrends in Agriculture: Health—Safety Implications

Domestic and international economic, technological, and policy changes have caused major changes in the agricultural industry over the years. Some of the economic policies were reviewed earlier in this chapter. These changes have not only had an effect on the structure of agriculture, but also have affected the socioeconomic status, health, and safety of the agricultural workforce (58, 60, 99). The authors of this chapter have chosen 11 persistent or emerging megatrends, which are discussed below. Along with describing the megatrends, the authors will discuss how these megatrends have or may affect the health, safety, and general wellbeing of producers and the agricultural workforce.

#### Persisting Demographic Trends in Farm Type, Size, and Human Capital

Decreasin Number of Traditional Family Farms

Small traditional family farms are sometimes referred to as “the farms in the middle,” as large industrial-style farms increase at one end of the scale and small alternative niche farms increase at the other end. Factors that influence this trend include increased production costs (replacing labor with powered machines and a vast array of technologies and production inputs) and increased costs for compliance with stricter environmental and worker health standards. With the increase in employed farm workers that accompanies large farms, the general make-up of the rural population remaining in agriculture is moving from a relatively high socioeconomic self-employed, owner-manager occupation to a wage-earning farm worker base and a shift to an overall lower socioeconomic status of the farm workforce (100).

These factors combined have resulted in not only economic stress, but also social stressors within communities who struggle to meet the social needs of the new workforce, with dwindling economic resources and infrastructure. Furthermore, these issues have increased the risk for mental as well as physical health issues for the remaining farmers. Additionally, as there is less economic incentive for new farmers to come into the industry, the family farm sector continues to consist of older producers. Geriatric health issues have become complexed with occupational health issues in the owner/operator agricultural workforce.
As these challenges to traditional family farms persist, it is very important to note that this group still comprises the majority of people involved in production agriculture, over 80% in most industrialized countries.

Increase in Large Industrial-style Farms

With increasing farm size and transition to more industrial-style operations there also comes a separation of management and labor, and increased numbers of farm employees. A second trend accompanying agricultural industrialization has been increasing economic and political control of the agricultural industry based on a greater economic base through consolidation and vertical integration. Domestic and international economic and trade policies have facilitated the rise of international vertically integrated food corporations (101, 102). These food companies have political power and can affect the policies and international trade agreements that facilitate their style of operations (103, 104). This is in sharp contrast to smaller family operations that have little control over their situations. Such lack of self-determination exacerbates their personal stress.

Farm Government Policy Issues

Government Subsidization of Agriculture

Subsidization of agriculture in industrialized countries has affected both domestic and foreign markets. Many countries are conflicted about the direction that policies are pushing agriculture (103, 105). For historical, social, political, and domestic food security purposes, many nations would like to maintain a family farm structure (106, 107). However, this requires a large farm subsidy, which is a significant economic cost (108, 109). These subsidies create difficulties for developing countries, as they often are challenged to compete on the world markets with subsidized products from the industrialized countries, thus challenging their domestic food security efforts. The international lenders (e.g., the World Bank) to developing countries often require that their loans support potentially exportable commodities, which have the potential to create cash flow, and help service their loans. However, these exportable commodities may differ from those products that are important to their domestic food supply, thereby adding additional barriers to the development of the domestic food security system.

In some countries (e.g., the United States), conservative and liberal political voices disagree on domestic farm policy. The liberal side argues for food policies to feed the less privileged. The conservative side favors policies supporting strong production, larger commodity producers, and enhanced export markets (102). This division has created uncertainty in the markets and additional stress on farmers. In recent years, US farm policy has included subsidized crop insurance, replacing gradually diminishing direct support payments. The government pays a major portion of the premiums for crop insurance for those who sign up for it. This policy significantly reduces the risk of economic loss with crop failure (and therefore reduces excess psychological stress) from adverse weather or other acts of God. This policy will become more important as climate change promises the probability of increased adverse and severe weather conditions. The negative aspect of this policy is that it encourages farmers to produce crops on marginal lands, which may lead to increased environmental stress.

International Trade Agreements

International trade agreements have been in existence since the early 1900s. These agreements have been growing and involving agriculture since 1948, beginning with the General Agreement on Tariffs and Trade (GATT). This agreement gave rise to World Trade Organization (WTO) (110) in 1994. The WTO is composed of 154 member nations who negotiate general rules to keep trade flowing between nations while guarding against undesirable economic, social, and environmental side effects. Individual nations promulgate numerous separate trade agreements with neighboring countries or individual distant partners to form economic blocks. For example, the European Community (EU) has agreements
in place or pending with well over 200 nations (111). As of 2015, the United States has current agreements with 17 countries, with 12 additional agreements in process (112). All these separate agreements are to be based on the general principles of the WTO, which helps promote oversight and discipline in the agreements. Although these agreements have generally facilitated economic advancement of the agricultural industry, critics claim they are too highly influenced by and give favorable treatment to large multinational corporations at the expense of family farm producers and farm workers (103). In addition, these agreements distort markets for certain commodities and drive up food prices in other instances. However, international trade agreements are a growing trend that in all likelihood will continue well into the future. If so designed, these agreements could help promote the health and safety of farmers and farm workers. For example, the agreements could include standards for the health and safety of farmers and farm workers, and environmental protection standards among the member states. However, this has not been a component of these agreements in the past. Perhaps with influence from relevant nations’ health and safety governmental organizations and NGOs, these agreements could be a component of future agreements. The trans-Pacific partnership being negotiated (as of December 2015) between the United States and 12 Asian nations includes statements on enhanced labor and environmental protection. This agreement might be a model for future agreements that could counteract some of the negative aspects of trade agreements on the human capital in production agriculture.

**Occupational Health and Safety Standards**

Occupational health and safety standards are varied among nation states. Developed countries generally pay more attention to occupational health and safety than less developed countries. Industrialized countries generally have some standards, but they often do not pertain to small family farms. However, as farms become larger and have more employees, and social and democratic systems become stronger, occupational health and safety standards and enforcement will likely become more prominent. (This issue is discussed in more detail in Chapter 15.)

**The Rising Voice of the Consumer, the General Public, and Powerful Food Retailers**

Since the 1990s there has been an increasingly powerful consumer voice calling for “unadulterated” food and food produced in a sustainable and humane way (e.g., public demand for products free of antibiotics, infectious organisms, antibiotic-resistant organisms, pesticides, growth promotants, genetically modified organisms (GMOs), and for food animals to be raised under humane conditions; 113). Demand for more “naturally produced products” has created new niche markets for a variety of producers (114). Organic products are increasingly in demand by consumers (115). Food animals grown under more “natural conditions” are increasingly in demand by consumers. This helps provide more market opportunities for many new and transitioned traditional small family farms. These types of operations in this growing sector of agriculture are called “alternative farms.” Unfortunately, from the producer health aspect, the equipment and methods for these alternative farms are similar to those used in farming several generations ago. The equipment may be old and lack modern safety features, for example old tractors without roll over protection (ROPS) and with unguarded drive lines (power take-off shafts). Also, the nature of the work is largely heavy manual labor, often conducted with poor ergonomic standards and leading to a high risk for musculoskeletal conditions such as low back pain. Furthermore, some of these operations may be worked by persons new to agriculture. They may have come from the city to seek a new lifestyle and may not be familiar with agricultural machines and the necessary safety devices and precautions. This group of new alternative farmers is potentially at higher risk for occupational injuries compared to
other workers. However, there is little surveillance or research to provide guidance as to their risks and prevention. These generalizations are based on this author’s (KJD) experience and observations. As an evidence basis is currently lacking for these generalizations, this is an important area for new research, surveillance, and intervention.

Many food retailers and restaurants have responded to consumers concerns and are finding a market advantage by demanding from their suppliers products grown free of “contaminants” (hormones, antibiotics, pesticides, GMOs, i.e. organic). An example in Australia is the Coles supermarket chain, which has moved to only stocking hormone-free meats. Some restaurants are seeking sources of meat from animal raised humanely, for example McDonald’s has dropped a supplier because of allegations of animal cruelty (116). Some farmers are also responding to this demand, for example Niman Ranch markets pork and beef “certified” to be grown organically and with high humane standards (117). A number of terms are being used by marketers to attract those interested in what they perceive as more healthy foods. However, few of these terms have an official definition or value of assurance. The states/countries governmental departments of agriculture are a good source to determine the meaning and value of various labels and claims.

In addition to individual consumer concerns, there is increasing public scrutiny of agricultural operations regarding environmental contamination, consumer and public health, and occupational health. The general public in most industrialized countries is no longer willing to give agriculture special “exempt” status for polluting the environment. Many people feel that agriculture should be held to the same standards as any other industry. The popular press features many authors who advocate for sustainable food systems, for example Michael Pollan’s Omnivores Dilemma (118) and McFague’s Blessed are the Consumers (119). Furthermore, the burgeoning field of information and communications technology, the internet, and social media have enabled the breadth and strength of the public’s concern and voice to be heard. Although much of the public’s concern is driven by emotion rather than science, they maintain a strong effect on how and what the farmer produces and how it is done. Consequently, new regulations have/are being developed, such as required minimal requirements for the size and dimensions of animal pens, stocking densities, humane kill processes at slaughter, and labeling requirements for the source and content of foods. These requirements are creating the need for farms to expend resources to meet these regulations. Although the regulations will focus more on large operations, they may have a greater economic impact on small farms. They will increases economic stress and may force some out of farming. A new way forward will be to see how these interests can work together with farmers. An important positive result of this trend could be a new direction for increased sustainability of agricultural production.

The Rise of Niche Markets and Local Food Production

The consumer demand for alternative agricultural products and more ecologically sustainable production has linked the alternative agricultural producer to new-found niche markets for organic crops, exotic crops, and locally produced food. One example of these local markets are community groups who share in sponsoring a local farm and consuming its produce (community sponsored agriculture). The 2011 US Census of Agriculture revealed 45,640 new farms were initiated since 2002; most of these were in the category of alternative agriculture (63). A higher percentage of these farms are owned and operated by women compared to traditional farms. This movement is related to the growing public concern and interest in more sustainable agriculture and "local food" with fewer “food miles.” Additional to the demand for organic products, there are also new markets for products such as ginseng, meat from ostriches, emus, deer, and buffalo, and many other exotic products. Furthermore, there is a new demand for a closer
connection between the grower and the consumer (120, 121). Farmers’ markets and local farms are linking with local urban dwellers, increasing opportunities for small farms to provide fresh farm products to their local community. Energy production is also a developing sector. Wood chips and oats are being used for fuel in Europe. Farmers in many areas of North America, Australasia, and Europe are growing grains for biofuels, producing methane from animal wastes for fuel, and installing wind generators and solar panels to power their own farms and to sell power commercially.

Food costs for the consumer from alternative farms are usually higher than traditional sources. However, as long as the consumer economy can afford this extra cost and the social values of the consumer hold, this type of farming will continue. This style of production has even spread to abandoned available urban spaces, with urban agriculture emerging in some of our large cities (122).

Efforts toward investigating the issues and developing appropriate interventions to promote the health and safety of these new-style producers is an important evolving issue in the field of agricultural health and safety.

**Consumer Dietary Habits**

International dietary habits include a continually rising consumption of fast food. Consequently, the fast-food industry continues to expand internationally. This industry demands very strict uniform standards of product, delivery times, and amounts. These attributes are most effectively supplied by industrial-style agriculture. Individual family farms find it difficult to reliably supply under these strict specifications. This trend therefore favors the large compared to the small family or alternative farms.

The rapidly developing economies (e.g., China, India) have created more wealth in these countries, and thus an increased demand for animal protein compared to plant and fish protein (105). While these countries may export grains (e.g., rice), their improved economies have increased their appetite for and ability to purchase red meat and poultry (123, 124). This in turn has increased the markets for livestock producers in industrialized countries, where livestock production has expanded to fill new market demands (125). As this trend continues, there will be a greater demand on grain production to feed the animals, as it takes approximately 2.5 times the amount of grain to produce the same nutritional output compared to eating a plant-based diet (126).

Increased health consciousness and diet fads of industrialized countries (e.g., low-fat diets in the 1970s, and low-carbohydrate, high-protein, and gluten-free diets in the 2000s) have also created new product demands. The agricultural industry has responded by dramatically increasing the amount of chicken produced and selecting for genetics of leaner pork and beef. These trends favor larger and more industrialized farms, which can respond more rapidly to consumer product demands.

**The Rise of New Players in the World Market of Agricultural Commodity Producers**

Brazil, Argentina, India, and China have emerged as major agricultural exporting nations (127). As these countries are lower-cost producers, and the industrialized countries have depended heavily on export markets, this emerging and expanding competition continually demands higher productivity of the traditional agricultural exporting countries. Globally, this results in lower prices for commodities and decreasing profit margins, which adversely affects small farms in more developed countries.

**The Advancing Technological Tools for Production Agriculture**

Advance technology tools (precision technologies) are evolving largely as a means to increase productivity by decreasing labor and increasing crop input (128). Genetically modified crops, new plant protection products, global positioning technology creating near robotic planting and harvesting machines, robotic dairies, drone
airplanes for surveillance of crops and livestock, and biofuel production are all current realities. Mechanization of agriculture has been ongoing since the mid-1800s, but this new phase of machines replacing human labor is occurring at a much higher rate in industrialized countries. This may diminish the opportunities for work in agriculture for many populations, particularly the lower socioeconomic contingent of the labor force. However, these interventions may reduce health and safety issues by distancing the worker from hazardous work places or exposures. There is currently no research to identify the benefits, or unknown unintended consequences, relative to the health of farm operators or workers of these new technologies. There are certain potential environmental benefits of precision agriculture, such as more efficient and safe use of fertilizers and crop protection products.

**Climate Change**

There is little doubt among the scientific community that global climate change is real. The following facts relative to agriculture are within the realm of high probability (129):

1. The oceans are warming and the polar ice fields are melting.
2. There is an increasing frequency of severe weather incidents, including heavy rain, flooding, droughts, tornados, typhoons, temperature elevations and cyclones.

The effects on production agriculture will vary geographically and temporally. There may be a benefit in some areas as warm-weather cereals such as corn (maize) will be able to be grown further north. However, in other areas, current crops will not be able to be grown, and new varieties or species will have to be investigated as possible substitutes for previous crops. Models and predictions for this change are not precise, leading to uncertain growing seasons. These circumstances lead to additional economic and thus psychological stress through possible and actual decreased yields. For example, the psychosocial health of the farm population has been challenged in Australia as a result of the persistent 10-year drought (now referred to as the millennium drought). Over 60% of the nation was declared in exceptional drought in 2007. Certain sectors of the farm population have suffered extreme stress, including increased suicides (80, 81). However, in general the adverse effects of climate change will be unevenly distributed toward developing countries, as they have fewer resources to counteract the issues, such as advanced harvest equipment, crop storage, and technology such as genetically adapted seeds and crops. The greater effects of climate change challenge global food security in the short and long term as the world grapples with adequate food production for the expanding world population.

**Challenges of Producing Food for Nine Billion People by 2050**

The scientific and public health communities share concern about population growth and the ability of our agricultural enterprises to be able to provide sufficient nutrition in the future. With the 2015 world of six billion projected to grow to nine billion by 2050 (123) the agricultural industry is at the forefront of this challenge to produce sufficient food, fiber, and fuel to sustain the projected 50% increase in population. According to the WHO World Food Program (130) nearly 18% of the people currently on the planet are malnourished. The current industrial agriculturalists are building on native Iowan’s Norman Borlaug’s “Green Revolution” of the late 1960s with new biological and mechanical technologies. This assumes, however, that our world’s agricultural industries are sustainable. This assumption is not a given, as there are many challenges to creating a sustainable world food system. Grain production has declined in many developing countries (and less developed countries; LDCs), with slowing growth in production in the United States, Australia, and Canada, and uncertain performance in the former Soviet bloc countries. However, production is increasing in Brazil, Argentina, and China (127). Tillman (126) suggests that the global agricultural industry has
the potential capacity to produce enough for eight to ten billion people. However, there is little consensus on how to sustainably produce food at these high demands. Challenges include food safety, degradation of the environment and depletion of biodiversity (131), climate change, depleting water resources, and lack of transportation and storage infrastructure. However, an extremely significant factor seldom mentioned in sustainability and growth in agricultural productivity is sustaining the health and safety of the people who do the work—the human capital in the agricultural industry.

Emerging and Re-emerging Zoonotic and Livestock Infectious Diseases, and Food Safety

Infectious diseases re-emerged in the early 1980s as an important public health issue in developed countries, coincident with the emergence of the human immunodeficiency virus (HIV) (132). Like HIV, over 60% of the new and emerging infections are of zoonotic origin (diseases originating in animals and/or in common with humans) (132). The emergence of these infections is in some cases associated with ecologic changes and human activity (133), including agriculture. Some of these agents affect only livestock but can cause extreme economic and psychological stress to the farmer. The following list includes some of the emerging and persistent infections of interest for agricultural populations.

- **NIPAH and Hendra virus infections** in animals and people have created animal and human illnesses in Malaysia, Australia, and other South-East Asian countries.
- **Bovine spongiform encephalopathy** or mad cow disease in the UK, other EU countries, Japan, and North America among other countries has created an economic burden as well as a public health concern (currently under control by virtue of a stringent surveillance and eradication program).
- **Foot and mouth disease** is endemic in many developing countries and emerges sporadically in developed countries. Although not infectious for humans, it causes severe economic and emotional burden to cattle, sheep, and swine producers.
- **Food-borne infections** of animal origin include *Escherichia coli* (strain O157:H7), *Salmonella*, *Listeria*, and *Campylobacter*. These agents are often carried from the farm to the fork, creating public health, economic, and producer public-image concerns for both livestock and crop producers.
- **Avian and swine influenza** remain on the global public health radar as potential agricultural sources of an infectious epidemic.

These infections are examples of persistent and emerging zoonotic agents that have significant physical and psychological occupational health concerns for farmers, their families, and the general public. They also have significant implications for markets. For example, Canada’s and England’s beef export markets (among other countries) were closed because of mad cow disease (bovine spongiform encephalopathy) for several years in the early 2000s, creating a critical economic burden on the beef producers as they had no markets for their cattle. The 2001 response to the outbreak of foot and mouth disease in the UK resulted in the destruction of thousands of cattle and sheep herds. The associated economic and mental stress among the farming population was severe, leading to increases in suicide (134).

Human Capital (Farmer and Farm Worker Health and Safety): The Missing Component of Sustainability Discussions

The discourse on the health of agricultural people has long been lacking among production agricultural scientists and policy makers. This issue was first written about in publications in the 1990s (58). However, the term “sustainability” is now reaching common discourse and there is new promise that the issue of farmer health can be included in the context of sustainable practices. Andrew Savitz (135) condenses sustainability of industries to sustaining three essential components: (1) profit, (2) planet, and (3) people. Profit, of course, is self-explanatory. If a profit is
not made, a business will close very quickly. Savitz posits that a business must not make a profit at the expense of the environment or public health. The third of Savitz’s three Ps is people, referring to the health and maintenance of those who do the work. Particularly within the agricultural industry, agricultural health and safety (the people, the human capital) is highly underrepresented in investments and policy around discussions of sustainability of the industry. Susan Brumby, the director of the Australian National Center for Farmer Health, recognizes this issue. The flagship program of that center is Sustainable Farm FamiliesTM (136–138). This program recognizes the fact that if farmers do not have their health, they do not have a sustainable operation. However, the sustainable health of farmer and worker is slow work, as globally agriculture remains one of the world’s most hazardous industries. Although some strides have been made in this arena in the past decades, agriculture health and safety still lags far behind that of other industries. The way forward is to raise awareness of this situation and prepare a broad, multidisciplinary group of professionals to challenge the issue in their daily work. That is the essence of the remainder of this book.

The following section is a brief overview of the major health and safety issues in production agriculture. This section leads to a detailed treatment of each of these health and safety areas in the following chapters.

1.12 A Preview of Specific Occupational Health and Safety Risks and Conditions

The section provides an overview of the specific conditions that will be covered in the following chapters of this book. The objectives are to assist the reader to understand the exposures and risks, and, most importantly, prevent these conditions. The topics were chosen by consensus of our 38 member advisory group (47) to this text, along with an extensive literature review (over 1300 references searched). Additional input comes from the over 80 years of combined direct practical farm experience of the two principal authors of this book (KJD and AT), as well as research, teaching, clinical, and preventive aspects in the field of agricultural medicine. The following paragraphs provide a brief overview of each of the conditions and injuries and the referent chapter where they are discussed in depth. Other references for this overview are found in the several reviews and books (12, 15, 68, 139, 140).

1.12.1 Special Risk Populations in Agriculture (Chapter 2)

Children, women, the elderly, migrant and seasonal farm workers, and Anabaptist religious groups are populations at increased risk for illness or injury from exposure to the farm environment. Children are at risk because they live, play, and may work in the same hazardous work environment as their parents (141). Children may not have the physical or mental developmental capacity to play or work safely in this environment without close informed parental supervision. Pregnant women exposed to certain zoonotic infectious agents or veterinary pharmaceuticals (oxytocin or prostaglandins), carbon monoxide, and certain insecticides or herbicides may risk damage to an unborn fetus. Elderly farmers are at increased risk because as they age their physical and cognitive faculties might be diminished, increasing their risk of injury in a hazardous working environment. Also, they may have co-morbidities such as poor eyesight, hearing loss, arthritis, and diabetes that may increase their risk of injury. Furthermore, the elderly often use the older equipment they are used to, which is often less safe than newer equipment. Migrant and seasonal workers are at risk because they are generally of a poorer economic and social circumstance (one of the most common links to general health status is socioeconomic status), have language barriers, lack education, and have physically hard jobs in hot environments. Anabaptist groups are at increased risk because the equipment they use is often old or homemade.
and without safety features. Furthermore, their cultural and spiritual beliefs include minimal use of mainstream health care, which decreases their probability of having up-to-date immunizations, prenatal care, and early diagnosis of chronic disease.

1.12.2 Agricultural Respiratory Conditions (Chapter 3)

Based on research and surveillance data, and the authors’ experience, respiratory illnesses are the most important occupational illness of agricultural workers. Available data reveal that 10–30% of agricultural workers experience one or more occupational respiratory conditions (142). The most frequent causative agent of respiratory illness is organic (agricultural) dust from livestock production and handling grain, silage, or hay. There is a syndrome of respiratory conditions caused by agricultural dust that includes bronchitis, asthma-like condition, and irritation of the upper airways mucosa and eyes (mucous membrane irritation, MMI), organic dust toxic syndrome (ODTS), and farmer’s lung (hypersensitivity pneumonitis). The former two conditions are usually chronic, and the latter two are usually acute influenza-like conditions lasting one to several days. However, these conditions may also have chronic components.

Less common hazards that add to the library of risks for respiratory conditions include (1) silo gas from non-airtight silos, (2) hydrogen sulfide and ammonia from decomposing livestock manure, (3) fumigant pesticides or biocides, (4) zoonotic infectious agents, and (5) the herbicide paraquat.

1.12.3 Agricultural Skin Diseases (Chapter 4)

Several reports indicate that skin conditions are the most frequently reported type of agricultural illness (143, 144). The most common skin condition is contact dermatitis, which may occur as an irritant or allergic contact dermatitis. The latter can occur within minutes or over the course of days or months. Contact dermatitis may also occur concurrently with sun exposure causing a chemical change to the offending substance on the skin, which then becomes an irritant or allergen (e.g., furucumars in the sap of plants of the Umbelliferae family). Some irritant or allergic substances may be contracted from airborne exposures (airborne contact dermatitis), such as cape weed in South Australia and ragweed in North America. Several plants cause delayed allergic contact dermatitis, including those that contain the allergen erushiol (poison ivy, poison oak, poison sumac).

Sun and heat exposure are the second most common causes of skin conditions. Sunburn and miliarial rubra (prickly heat) are the two most common acute skin conditions caused by sun and heat. Chronic sun exposure causes wrinkling and thickening of the skin, precancerous lesions called actinic keratoses, and the skin cancers squamous cell carcinoma and basal cell carcinoma. Melanoma is thought to be caused by multiple sunburns at an earlier age in life, but may also be related to total impact of sunshine.

Ringworm (dermatophytosis) contracted from cattle is the most common zoonotic fungal infectious skin problem among farmers handling animals, especially dairy farmers. There are numerous arachnids and insects (including mites, ticks, spiders, and stinging or biting insects, i.e. wasps, ants, and mosquitoes) that may cause minor to very severe irritation of the skin.

1.12.4 Cancer in Agricultural Populations (Chapter 5)

The farming population (primarily because they smoke less) benefits from lowered overall cancer because they have less lung cancer (one of the most common cancer fatalities) and other smoking-related cancers (e.g., bladder, esophageal, kidney). Overall colon and rectal cancer seems to be lower (except in Australia), and farm women have less overall breast cancer. Besides not smoking, there may be other cancer protective factors in farming, but they have not been clearly identified. However, there are several cancers for which the farming population may be at increased
risk, including lymphoma, leukemia, multiple myeloma, prostate, skin, and brain. Of various speculative risk factors for these cancers, only excessive sun (skin cancers), methyl bromide, fonophos and family history (prostate cancer), and acetic acid herbicides (non-Hodgkin’s lymphoma and soft-tissue sarcoma) exposures are relatively proven risk hazards.

1.12.5 Toxicology of Pesticides (Chapter 6)

Although the issue of pesticide exposure is often a dominant concern among the farming population, acute poisonings and fatalities are far less common than acute traumatic injuries or respiratory illnesses. Whilst some of the pesticides (especially the cholinesterase-inhibiting chemicals) used are very toxic, they are largely being replaced by less toxic insecticides (e.g., pyrethroids, and neonicotinoids). The most common health hazard of the latter two insecticides classes and herbicides (chemicals that kill weeds) is contact dermatitis. Herbicides are used in far larger quantities than insecticides.

1.12.6 General Environmental Health Hazards in Agriculture (Chapter 7)

Adverse water quality from nitrate contamination is the most important general environmental health hazard for agricultural workers and those living in a rural environment. Consumed nitrates are converted to nitrites in the gastrointestinal tract, which can lead to methemoglobinemia, which limits the red blood cells’ ability to carry oxygen. The condition is most critical in infants (causing the condition “blue baby”). Nitrates may also be a carcinogenic risk, as nitrates in the presence of amino acids or the herbicide atrazine may form nitrosamines, which are known carcinogens.

There are other water, air, and solid waste problems in agriculture, but these are more directly related to environmental quality degradation and ecologic change, rather than direct individual worker health hazards.

1.12.7 Musculoskeletal Diseases in Agriculture (Chapter 8)

Low back pain and degenerative osteoarthritis of the hip and knee are common among the agricultural workforce problems along with a number of other musculoskeletal disorders. Related to physical work these conditions are worsened by poor ergonomic working conditions, long working days, and heavy workloads. Furthermore, carpal tunnel syndrome is common among those working in meat and poultry processing. Musculoskeletal diseases (MSD) is one of the most common reasons for farmers to contact a healthcare professional. Managing these conditions includes modifying work practices with sound ergonomic practices.

1.12.8 Physical Factors Affecting Health (Chapter 9)

The work environment in production agriculture can be a hot or cold, vibrating and noisy place. All of these physical elements bring the risk of injury to the farm worker.

Heat Exposure Risks

Agricultural work is often undertaken in hot environments and/or in direct sunlight. As agricultural work requires a great deal of energy consumption, the risk for heat-induced illnesses is common. Heat exhaustion may be a minor problem prevented by protection from the sun, periodic rest from a hot environment, and increasing fluid intake. Untreated heat exhaustion may lead to the more serious condition of heatstroke, which physiologically includes incapacitation of the body temperature regulatory mechanism. The body temperature may rise high enough to cause brain damage, and combined with dehydration and electrolyte imbalance may result in death if not treated as an emergency condition.

Cold Exposure Risks

Work outdoors in extremely cold environments is often a requirement in the agricultural industry. Frostbite, which is the freezing of skin and
subcutaneous tissues, is a risk. Furthermore, cold environments exacerbate a condition called “white finger” or Raynaud’s phenomenon, which may be a result of chronic high-frequency vibration damage (from operating powered hand tools or chainsaws) to the nerves and blood vessels in the hand (today often referred to as hand-arm vibration syndrome, HAVS). When the hands become cold, the vessels of the affected hands “shut down” circulation, leading to painful symptoms and loss of refined hand movements.

Vibration-related Injuries

Additional to Raynaud’s injury to the hands, vibration-associated symptoms may also be seen in the arm and shoulder. Low-frequency vibration can lead to subtle internal whole-body vibration symptoms that might include back pain, nausea, and fatigue.

Noise-induced Hearing Loss

The agricultural work environment is noisy, leading to the very common problem among farmers of noise-induced hearing loss. Excessive noise and exposure over time causes direct damage to the hair cells of the middle ear, which transmit sound energy to the brain. Once damaged, the cells will not repair themselves and the loss is permanent. Loss of hearing increases the risk of injury to farmers, and communications problems in the home and social settings, leading to social isolation.

1.12.9 Mental, Social, and Behavioral Health in Agriculture (Chapter 10)

Farming is an occupation that is increasingly filled with stress, mainly due to the unpredictability of the climate and diminishing profit margins. The culture of the agriculturalist is to persevere, rather than to seek help. Mental health issues carry more of a stigma in farming communities than in urban communities. The social structure of the rural community is changing, as the population becomes sparser and the social structures and customs that enhance “neighboring” change. As old social support structures are declining (e.g. church, neighbors) and formal mental health services are rare, many farmers and family members suffer as chronic stress builds to depression. The most severe outcome of this situation is suicide, as chronicled in the true account of a stressed farmer in a Midwestern community in the United States (145). Gunderson documented higher rates of suicide compared to the general population in the north central states of the United States (146).

1.12.10 Acute Agricultural Injuries (Chapter 11)

Acute physical injuries are the primary occupational health concern in agriculture, causing more fatalities and disabilities than any other category. Tractor-related events account for the majority of fatalities in the United States and quad bikes cause most in Australia. Regarding non-fatal injuries, the primary sources include farm machinery and animal-related contact, each accounting for about equal numbers of injuries. However, machinery injuries are usually more serious and account for more disabling injuries than animal-related injuries.

In northern European countries farming is commonly combined with forestry. The risk of injuries is very high for farmers active in forestry.

Medical treatment of agricultural injuries is complicated by the extreme severity of tissue damage and even amputation. Severe trauma often combined with extensive contamination with soil and animal fecal material increases the risk for wound infections with anaerobic organisms and antibiotic-resistant organisms. Delayed location, rescue, and emergency transport of victims to appropriate medical facilities further complicate the prospects for good outcomes of these cases. Finally, rehabilitation of these victims often falls upon the rural primary care physician. Almost all injured farmers want to resume their farming activities, and it is up to the primary care provider in conjunction with public and private rehabilitation organizations to help injured farmers return to farming.
1.12.11 Human Health Hazards of Veterinary Pharmaceuticals (Chapter 12)

Many products used for animal health or growth promotion may cause illness in humans who come in contact with these products. Accidental needle sticks are common among veterinarians and animal handlers, and they carry the consequence of unintended trauma, infections, and toxicity or inflammation. Antibiotics, immunization products, and hormones used in obstetrical procedures are common substances that may result in unintended illness in veterinarians or animal handlers. The largest concern with antibiotic use is the enhancement of resistant organisms and resulting resistant infections. Other concerns include severe toxic reactions (such as the antibiotic tilmicosin, which is cardiotoxic to humans) and allergies. Accidental inoculation with immunization products may result in an infection of the product itself (live products), inflammation, or allergic response. The hormones oxytocin and prostaglandin are two products that may cause abortion in pregnant women if they are accidentally inoculated.

1.12.12 Agricultural and Rural Zoonotic and Emerging Infectious Diseases (Chapter 13)

Over 25 different infectious diseases can be transmitted from animals or the environment that may produce occupational illnesses in agricultural workers. At least 24 different zoonotic diseases are occupational hazards in agriculture. These diseases are often difficult to diagnose as they have few characteristic symptoms. A basic knowledge of the general epidemiologic characteristics of these diseases and work that results in exposure will be reviewed in this text.

1.12.13 Prevention of Illness and Injury in Agricultural Populations (Chapter 15)

Farming (especially small family farms) is relatively unregulated compared to other industries in regard to occupational health and safety. The reasons for this are multifaceted, including the fact there are thousands of self-employed operations with few employees, scattered across the countryside, creating logistical difficulty for inspection. Furthermore, governments recognize the independent culture of farmers, and thus are sensitive of regulations impacting on farm family work and the right of parents and families to make their own decisions. The most common regulation (internationally in developed countries, but not in the United States) is the requirement of rollover protective structures on farm tractors.

Most countries have regulations that apply to children’s work and hired agricultural workers. However, some countries have a minimum number of workers per operation before the regulations take effect. For example, in the United States there must be at least 11 employees in an operation before federal funds can be used to inspect and enforce occupational safety and health regulations. The International Labor Organization has produced model guidelines for member countries to adopt for the protection of agricultural workers and children. Details of regulations applicable to agricultural health and safety are given in Chapter 15.

1.12.14 Agricultural Health and Safety Organizations

The past two decades have witnessed extensive growth in agricultural health and safety activities in industrialized countries, in both governmental and non-governmental organizations. The sum effort of these organizations has advanced the field significantly, creating a new discipline and changing the field to include a public health approach from a previously low-profile interest of farm safety in agricultural colleges. Chapter 15 discusses in detail these organizations and how they have advanced the field of occupational safety and health.

1.13 Summary

This chapter provides a broad overview of agricultural health and safety. Aided by this overview, the reader can approach the subsequent chapters
with a background that provides broad connections to the field of agriculture and a perspective that enhances greater comprehension of the material.

The following key points are made to help summarize the essential information in this chapter.

**Key Points**

1. The history and evolution of field of agricultural safety and health/ agricultural medicine includes the following terms and concepts:
   a. *Agricultural safety* emerged in the mid-1940s with extension, insurance professionals, and farm groups.
   b. The term *agricultural medicine* arose internationally in the mid-1950s, mainly led by healthcare professionals.
   c. The term *agromedicine* arose in the mid-1980s as a collaboration between primary care medicine and agricultural extension to provide outreach information to the farm community. Several such programs formed the non-profit organization the North American Agromedicine Consortium (NAAC; terminated in 2014). The *Journal of Agromedicine* originated as the organ of NAAC.
   d. These different terms and professionals associated with these organizations are joining in a common goal of prevention, and the generic term agricultural safety and health pulls these segments together, for example the International Society of Agricultural Safety and Health (ISASH; formerly the National Institute for Farm Safety).

2. Agricultural health and safety is an evolving profession and includes at its core a knowledge and understanding of production agricultural processes, the culture of farmers, their families and workers, core knowledge of the specific occupational exposures, risks, and prevention, along with professional education that may be from a variety of areas including health sciences, safety, education, engineering, veterinary medicine, and social sciences.

3. Worldwide, 1.3 billion people are employed as wage earners in agriculture. They are diverse culturally and socioeconomically. Thirty-eight per cent are migrant workers, and 50% of these are women. In the United States there are 775,000 farm workers and 59% of them are local non-migrants.

4. In most developed countries, farm owner/operators have lower fatality rates from cardiovascular disease (heart attacks and stroke) and lower overall cancer compared to the general population. The reasons for these lower rates appear to be due to lower prevalence of smoking and alcohol consumption, better diets, and more exercise.

5. In most developed countries occupational fatalities in agriculture are higher (two to seven times higher) than for all occupations (fatality rates for all occupations generally are in the range of three to six fatalities per 100,000).

6. Persistent and emerging mega trends that are shaping agriculture include the following:
   a. International trade agreements in agriculture.
   b. Government programs/regulations, including farm support programs, occupational safety regulations, and environmental regulations.
   c. Consumer power and the general public’s concern are important forces in how agriculture may be done in the future (e.g., humane livestock husbandry methods, food safety concerns, food “contaminants” and the negative view of GMOs, pesticides, hormones, and the positive perception of “organic” production).
   d. Climate change prediction means more volatile weather patterns and extreme scenarios. Some areas may benefit from a warmer or drier climate, as others
References


50. Matthews A. Family farming and the role of policy in the EU. CAP Reform.eu; 2013 (accessed


67. Spengler SE, Browning SR, Reed DB. Sleep deprivation and injuries in part‐time Kentucky farmers: impact of self reported sleep habits and sleep problems on injury risk. AAOHN J. 2004;52(9):373–82.


86. Reed DB. Caring for the families that feed the world. AAOHN J. 2004;52(9):361–2.


