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Promoting and Protecting Worker Health and Safety in the Republic of Korea Agricultural Sector

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SPECIAL FEATURES

Promoting and Protecting Worker Health and Safety in the Republic of Korea Agricultural Sector

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ABSTRACT. With the exception of agriculture, all other Republic of Korea industrial sectors have comprehensive systems in place for workplace surveillance (i.e., disease, injury, and exposure), research, and targeted interventions. However, because few statistics are available on the occupational health and safety conditions in the Republic of Korea agricultural sector, there is little information to guide interventions to prevent hazardous agricultural exposures. The scant information that is currently available suggests that agriculture ranks among the most hazardous industries in the Republic of Korea. Building on information obtained at the *International Symposium on Development of Prevention Strategies for Agricultural Health and Safety* held in Suwon, Republic of Korea, in 2005, and embellished with examples of surveillance, research, and intervention activities conducted in the United States and elsewhere, this article provides guidance to promote and protect the health of Korean agricultural workers. This information can also guide other countries to reduce agricultural hazards.

KEYWORDS. Agriculture, injury, Korea, musculoskeletal diseases, pesticides, surveillance

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INTRODUCTION

Agriculture is a hazardous industry. In many countries it has the highest occupational injury mortality rate.[1,2] Farmers also have an elevated risk for many diseases, including Hodgkin's disease, leukemia, multiple myeloma, non-Hodgkin's lymphoma, and cancers of the lip, stomach, prostate, skin (melanotic, and nonmelanotic), brain, and connective tissue.[3] Agricultural exposures are also associated with nonmalignant diseases of the lung,[4,5] nervous system,[6] and reproductive system.[7] Some hazardous exposures that may be responsible for these elevated cancer and chronic disease risks include excessive direct sun exposure, poor diet, contaminated drinking water, and occupational exposure to a variety of potentially hazardous chemicals and biological agents including pesticides, animal viruses, mycotoxins, dust, fuels, oils, engine exhaust, and fertilizers.[8]

This report describes approaches to assess and address agricultural health and safety problems in the Republic of Korea, a country commonly referred to as South Korea. (In the remainder of this article, this country will be referred to as Korea.) This effort began with participation in the *International Symposium on Development of Prevention Strategies for Agricultural Health and Safety*, which was sponsored by the Korean Rural Development Administration (RDA) and held in Suwon, Korea, on August 17–18, 2005. In addition, we identified surveillance, research, and intervention activities in the United States and elsewhere that could serve as models for improving working conditions on Korean farms. These models could also be used by other developing and recently developed countries to reduce the hazards found on their farms and ranches.

The current situation in Korea in reminiscent of the one in the United States before 1990, when there had never been a national focus on agricultural health and safety, and few resources were directed toward identifying and preventing hazardous agricultural exposures.[9] In 1990, the U.S. Congress responded to this problem by passing a national initiative (Public Law 101-517) to address the disproportionately higher rates of occupational injury and illness among agricultural workers.[9] The legislation led to a comprehensive national program consisting of surveillance, research, and intervention activities to promote safe and healthy agricultural workplaces. These activities are on-going and include establishing and maintaining university-based agricultural research centers, supporting the surveillance of agricultural injuries and illnesses, conducting research on agricultural hazards and their prevention, and guiding interventions to prevent agricultural injuries and illnesses.

OCCUPATIONAL HEALTH AND SAFETY IN KOREA—CURRENT STATUS

Korea has a population of approximately 48.9 million. The labor force is approximately 25 million, 7% of which are employed in agriculture.[10] Twenty percent of the Korean land area is arable, and the principal agricultural products are rice, root crops (e.g., sweet potatoes), barley, vegetables, fruit, cattle, pigs, chickens, milk, eggs, and fish.

All industrial sectors in Korea, except for agriculture, have comprehensive schemes in place for surveillance, research, and targeted interventions. With respect to nonagricultural workers and workplaces, these schemes have been instrumental in making Korea one of the world leaders in the prevention of occupational injury and illness and in the protection of worker health and safety. A partial list of schemes and activities are provided in the next sections. Unfortunately, in many of these schemes, agricultural workers are overlooked.

Insurance Programs Whose Data Are Used for Surveillance and Research

Korea has three major insurance programs that are vital sources of data for research and surveillance. It is important to understand how these programs operate in order to understand their strengths and limitations as they pertain to Korean agricultural workers.

Workers' Compensation Insurance Program

The Korea Workers' Compensation and Welfare Service (KCOMWEL) is the quasi-governmental organization that provides workers' compensation insurance. The insurance program is called the Workers' Compensation Insurance Fund (WCIF). Insurance premiums are paid by employers. This insurance program pays the medical and indemnity (e.g., disability) costs of any work-related injury and illness experienced by a worker who is covered by the program. In Korea, because WCIF is the only workers' compensation insurance program for nonagricultural workers,[11] it provides the most comprehensive source of data on occupational illnesses and injuries. WCIF also covers workers employed at large agricultural establishments (i.e., those with five or more workers). Those not covered by this insurance include government officials, soldiers, educational staff at private schools, the self-employed, and contingent (temporary) workers. In 2008, of the 24 million economically active Korean workers, 13.5 million (56%) were covered under the WCIF.[12] Although not covered by WCIF, government officials, soldiers, and education staff at private schools receive similar benefits from their own scheme funded by the Korean government or schools and school staff. The self-employed workers (e.g., most farmers) and contingent workers (e.g., temporary agricultural workers) generally are not covered by WCIF. These workers could pay the WCIF premiums themselves, but few do because these workers are generally low-paid. A Korean government document reported that self-employed and contingent workers with occupational injuries and illnesses often use their savings, government welfare if eligible, or aid from family and friends to cover any associated indemnity.[13]

Safety Aid System

This is a supplemental insurance system for agricultural workers. This insurance system is subsidized by the Korean national government and operated by the National Agricultural Cooperative Federation.[14] This system subsidizes the costs of medical care of work-related illnesses and injuries not covered by the national single-payer health insurance company. However, despite the government subsidization, most agricultural workers cannot afford this insurance. As such, only about 690,000 agricultural workers (41% of 1.7 million agricultural workers) participate in the Safety Aid System.

Single-Payer Medical Insurance Program

Korea has a national single-payer medical insurance program created by the Medical Insurance Act of 1977. This program covers all documented Korean residents, including agricultural workers. In addition, supplemental medical insurance can be purchased from private insurance companies. Unfortunately, the national medical insurance program does not systematically capture information on industry and occupation. However, data from the single-payer government insurer and private insurance companies have been utilized for occupational surveillance and research. Using their Resident Registration Number (RRN), which is also referred to as the Personal Identification Number, cohorts of industrial workers can be linked to this database to identify illnesses and injuries among the cohort members.[15] Injury and illness incidence among these workers can then be compared to that of all other Korean workers, allowing identification of health conditions for which cohort members are at increased risk. The Korean Occupational Safety and Health Agency (KOSHA) uses these data to study injuries and illnesses among nonagricultural workers.

Public Health Surveillance

Korea has established mechanisms to conduct national health and hazard surveillance. However, of these two activities, only the national heath surveillance activity systematically captures information on agricultural workers.

National Health Surveillance

The Korean National Health and Nutrition Examination Survey (KNHANES) is conducted every 3 to 4 years by the Korean Ministry of Health and Welfare. The target population is the Korean civilian, noninstitutionalized population, and interviews are conducted face-to-face in the participants' homes. A representative sample of households, including agricultural workers, is selected using a stratified multistage probability sampling design. The occupation of the participant is captured by the survey, and these data have been used to examine the prevalence of selected diseases among agricultural workers, as described later in this article.

Hazard Surveillance System

Hazard surveillance is an assessment of the magnitude and trends in exposure to toxic substances and unsafe activities. Ideally, this surveillance can identify geographic areas, work settings, industries, and occupations with elevated exposures to hazardous agents and hazardous activities. Workers with elevated exposures may be at risk for occupational injury and disease. Instituting early interventions to decrease these hazardous exposures can reduce the burden of occupational injury and disease.

All workplaces insured under the WCIF are inspected at least once per year. Workplaces with hazardous processes or exposures (e.g., workplaces that use lead or mercury) are required under the Occupational Safety and Health Act to be inspected twice per year. These inspections are conducted by consultants employed by universities or private consulting firms. The cost of the inspection is paid by the workplace being inspected. The consultant provides the inspection findings to the employer, and the employer is required to provide the findings to the Korean Ministry of Employment and Labor, who makes them available to KOSHA. Problems identified in the inspections must be addressed by the employer.

These inspection data are aggregated by the Korean Ministry of Employment and Labor to create a national database of workplace exposures. These data are electronically transferred to KOSHA for filing and analyzing. The inspection findings provide extensive knowledge about the magnitude and frequency of hazardous exposures in Korean workplaces. These data also identify all workers who are exposed to specific hazards, and these workers are targeted for appropriate safety training and provided with timely and pertinent screening medical examinations (e.g., special health examinations).

Every 5 years, KOSHA sends a self-administered survey to workplaces that report using or producing hazardous chemicals. It is called the "Survey on Work Environmental Status in the Manufacturing Industry" and was initiated in 1993. The data from these surveys are used for monitoring the work environment. The survey findings are published and provide details on the quantity and location of chemical and physical hazards in Korea.[16]

Required Worker Health Examinations

General Health Examinations and Special Health Examinations

Workers in Korea are required to have a periodic physical examination every 1 to 2 years. For most workers these are called the *General Health Examination*, and for workers exposed to hazardous agents these are called the *Special Health Examination*. The findings from these examinations are used to monitor the health status of workers and allow early recognition of work-related health problems. Early recognition increases the chances of successful resolution of the health problem before it becomes permanent. In addition, workplace factors that precipitated the health problem can be targeted for correction, thereby preventing similar injuries and illnesses among coworkers.

The Special Health Examinations are funded by the worker's employer. The General Health Examinations are funded by the Korean national, single-payer medical insurance program. Self-employed workers (including most agricultural workers) and contingent (i.e., temporary) workers are also required to receive General Health Examinations every 2 years, but efforts to ensure compliance with this requirement among these workers are inadequate.

CURRENT STATUS OF AGRICULTURAL HEALTH AND SAFETY IN KOREA

The Korean agricultural sector is largely excluded from industrial accident compensation insurance, workplace inspections, and worker health examinations. As such, little is known about occupational health and safety conditions in the Korean agricultural sector.[17]

A few surveys have been conducted that provide hints to the magnitude of illness and injury among farmers and rural residents. A survey conducted in 2008 of a representative sample of 4809 rural households (consisting of 9630 household members) found that the annual rate of work-related injuries involving at least 4 hours away from work was 5.6%.[18] This estimate included injured workers who did not seek medical care. In contrast, based on insurance claims made to the Safety Aid System, the average annual physician-diagnosed work-related injury rate among agricultural workers between 2004 and 2006 was 1.8%.[19] Based on a 2006 survey of 1233 subjects from 18 villages distributed across the eight Korean provinces, the lifetime rate of self-reported medically treated pesticide poisoning was 7.2%.[20] The rate was highest among apple orchard farmers (8.9%) and lower among rice farmers (3.8%). In contrast, the 2008 representative survey described above found an annual chemical poisoning rate of 1.6%.[18] The vast majority of these chemical poisonings are thought to involve pesticides.

An analysis using 1998, 2001, and 2005 KNHANES data was conducted and included 3639 farmers.[17,21] Farmers were found to have a higher prevalence of arthritis, intervertebral disc disorders, and gastritis compared to other workers and the total Korean population. Farmers had a lower prevalence of hypertension, asthma, cancer, diabetes, chronic hepatitis, and chronic obstructive pulmonary disease, and a similar prevalence of cerebrovascular disease, ischemic heart disease, tuberculosis, and cataracts/glaucoma compared to the total Korean population. KNHANES has a relatively low sample size of agricultural workers (e.g., 1732 in 2005, which also includes forestry and fishing workers) that does not permit stable estimates.

It is encouraging that a project titled "the Safe Farm Zone of Korea" was initiated 1 year after the 2005 Suwon symposium. It is a 9-year intervention project whose goal is to improve farm health and safety and prevent agriculture-related diseases and injuries in Korea. Details on this project are available elsewhere[22,23] and are very similar to the Certified Safe Farm (CSF) program developed by investigators at the University of Iowa and the University of Nebraska.[24]. The Safe Farm Zone of Korea is being conducted in 55 Korean villages, with at least one participating village in each of the eight Korean provinces. The project consists of three parts. The first part includes interviewing and examining participants from each village. The examination includes collection of blood and urine for biomonitoring. The second part includes a hazard survey of farms in each village. The third part consists of implementing interventions to prevent farm-related injuries and illnesses. The investigators plan to conduct pre- and post-intervention comparisons of health and safety outcomes. The project was endorsed by the farming leaders in the relevant provinces, and a project manager was appointed in each province. Having strong local leadership and project coordination should help maintain local interest and participation. Because farmers have strong disincentives for participation (eg, limited financial resources and limited leisure time) the countervailing incentives for farmer participation need to be powerful and convincing. Incentives that are being used to promote participation include offering discounts on agricultural materials and supplies, discounts on safety equipment, and reductions in medical insurance premiums.

POSSIBLE FUTURE DEVELOPMENTS IN KOREAN AGRICULTURE

The Korean agricultural sector is evolving quickly. Sociodemographic changes and bilateral trade agreements are influencing this evolution. Agricultural sector workers (who are

typically farmers in Korea) are becoming older (in 2009, 56% of farmers were 60 years of age or older), and there are few youth who are choosing farming as an occupation.[25] This trend has led to fewer family farms and an increase in larger farms.[25] In addition, the dietary preferences of Koreans are changing. It has been observed that rice consumption is decreasing as Koreans are eating more meat and wheat.[26] These trends may play a role in the future reshaping of the Korean agricultural sector.

In 2007, the United States and Korea signed a free trade agreement (FTA) that is intended to remove tariffs and quotas on a broad range of products. The agreement was approved by the U.S. Congress and the National Assembly of Korea in 2011, and it went into effect on March 15, 2012. Under the agreement, roughly $1.91 billion (64%) of U.S. agricultural exports to Korea are duty-free.[27] Critics are concerned that this substantial opening of Korea's agricultural market to U.S.-grown products may lead to a significant decrease in domestic agricultural production and a subsequent loss of farming jobs. In addition, the Korean government provides price supports for agricultural commodities that allow Korean farmers to compete against low-cost imports. However, there is speculation that these price supports may soon be reduced or eliminated due to the restrictions imposed by the United States and Korea FTA.[28] As such, the effects of the agreement could lead to social, cultural, and environmental deterioration of Korean agricultural communities.[29]

In many developed countries, many family farms have been consolidated into large corporate farms. With increased mechanization, these larger farms employ fewer workers. Currently, there are laws against Korean chaebol (i.e., large Korean business conglomerates) from owning farmland. However, given the course of agricultural evolution in developed countries, it is possible that in the future Korean laws may change to permit large corporate farms. The FTA between the United States and Korea may accelerate such a phenomenon in Korea. In the United Kingdom, the appearance of large corporate farms was accompanied by increases in the number of part-time, niche-market farmers. These small farms, which have few resources for promoting occupational health and safety, have the highest risks of work-related injuries, illnesses, and fatalities.[30]

SPECIFIC RECOMMENDATIONS TO PREVENT AGRICULTURAL INJURIES AND ILLNESSES IN KOREA

Agricultural health and safety problems in Korea are very challenging for a number of reasons: many farms are small and have few resources to implement health and safety interventions; the small farms are spread out over a wide geographical area, making it difficult to provide on-site education and consultation; farms are exempt from complying with many health and safety rules and regulations; and baseline surveillance data are often lacking, making it difficult to identify the most pressing health and safety problems that should be targeted for intervention. With these barriers in mind, we developed a list of recommendations to improve health and safety in Korean agriculture (Table 1).

Coordinating and Stimulating Innovative Research and Improved Workplace Practices

Korea might consider adopting a partnership model. Representatives from diverse organizations and factions could be assembled

TABLE 1. Recommendations to Prevent Agricultural Injuries and Illnesses in Korea

- Establish a task force consisting of agricultural health and safety stakeholder representatives
- Establish various surveillance systems
  - Fatal injury surveillance
  - Nonfatal illness and injury surveillance
  - Agricultural hazard surveillance
- Conduct agricultural health and safety interventions
  - Safe Farm Zone of Korea
  - Model health and safety inspections
  - Establish poison control centers
- Conduct agricultural health and safety research
  - Prospective and retrospective cohort study
  - Ergonomic research studies
  - Establish university-based agricultural research centers
- Disseminate surveillance and research findings
- Evaluate surveillance, research, intervention and dissemination activities

to identify the most critical agricultural safety and health issues. If a such a council or task force were established in Korea, members could include the RDA, whose mission includes protecting the health and safety of agricultural workers, KOSHA, which plays a substantial role in promoting and protecting the health and safety of all Korean workers, the Ministry of Employment and Labor, the Ministry of Agriculture and Forestry, the Ministry of Health and Welfare, academia, farmer cooperatives or other organized groups that represent farmers, farm implement and chemical manufacturers and suppliers, KCOMWEL, and the Korean medical insurance program.

Establishing Surveillance Programs for Agricultural Safety and Health

Surveillance is needed to identify the most pressing agricultural health and safety problems. As intervention activities are undertaken to address these problems, surveillance data will be important to determine whether the interventions are effective and that they are having their intended impact.

Fatal Injury Surveillance

Establishing a surveillance system to identify all fatal injuries among Korean agricultural workers could document the magnitude of the fatalities and common causes of fatalities, and could serve as a driver to implement effective interventions and prevention activities. Currently, the occupational injury and illness statistics produced by KOSHA are not capable of providing comprehensive fatality data, since only approximately 5% of Korean agricultural sector workers are included in KCOMWEL.[11] A system similar to the surveillance system used in the United States (i.e., Census of Fatal Occupational Injuries [CFOI]) could be considered. CFOI obtains fatality reports from a multitude of federal, state, and local administrative sources, including death certificates, workers' compensation reports, reports to various regulatory agencies (e.g., the Occupational Safety and Health Administration [OSHA]), medical examiner reports, police reports, state farm bureau data, news reports, and other nongovernmental reports. These various sources are used because no single source is a comprehensive repository of all fatal injuries. Because one of the major priorities of the Korean Rural Resources Development Institute (RRDI), which is one of the RDA institutes, is to reduce agricultural injuries and illnesses, this may be an appropriate activity for RRDI.

Nonfatal Illness and Injury Surveillance

In Korea, the potential sources of surveillance data on nonfatal occupational illnesses and injuries include the WCIF, data from the General Health Examinations and Special Health Examinations,[31] and the Safety Aid System. The first two sources provide very incomplete data for nonfatal agricultural illnesses and injuries, because only a small proportion of agricultural sector workers participate in WCIF and the General and Special Health Examinations.[12] The Safety Aid System, which includes only agricultural workers, currently is the best source of estimates on the pattern and characteristics of injuries in farmers; however, it is limited by low coverage and restricted to physician-diagnosed cases, in contrast to the comprehensive WCIF for nonagricultural workers. Additional potential sources of surveillance data are the national single-payer medical insurance program, and data from the Ministry of Governmental Administration and Local Autonomy that has data on ambulance calls made to rural areas.

Data from the national single-payer medical insurance program could be a good source of surveillance data for agricultural sector workers. Unfortunately, the national medical insurance program currently does not systematically capture information on the enrollee's industry (i.e., type of business of the enrollee's employer) and occupation (enrollee's type of work). As such, to use this medical insurance program data for surveillance purposes, one would need to link it to an agricultural worker cohort. Another limitation of this insurance data is the difficulty assessing whether the illness or injury is work related, since this information is often not included in medical records and is not captured by medical insurance programs. However, there are many conditions that can be assumed to be work related, including pesticide poisoning,

amputations, and many other injuries. In addition, it might be possible to require physicians to indicate whether an illness or injury is work related, and to make this information available to those conducting occupational illness and injury surveillance. The medical insurance data are comprehensive and would capture most of the cases found in the Ministry of Governmental Administration and Local Autonomy ambulance call data. As such, the ambulance call data may not be a cost effective source of data. The only ambulance calls not included in the medical insurance data are those where the patient was not taken to a health care facility, either because the patient refused or was not ill enough to be taken. Other sources of data are the Korea Hospital Discharge Survey and the Korean National Emergency Department Information System, but these suffer from the same limitations as the national single-payer medical insurance program.

Agricultural Hazard Surveillance Database

Currently, there is no systematic hazard surveillance being conducted in the Korean agricultural industry. An electronic agricultural hazard surveillance database could be useful and could be created by entering the data from the Safe Farm Zone of Korea, and Model Health and Safety Inspections (described below) into an electronic database. By assessing the magnitude and trends of hazardous exposures by geographic area and type of farm, this hazard surveillance data could be used to target interventions that would reduce the prevalence of hazardous agents and activities.

Agricultural Health and Safety Interventions

Hazard control is the goal of intervention activities. This is done through eliminating the hazard to the greatest extent possible. Classically, effective hazard control involves following an ordered hierarchy. First, it is best to adopt engineering controls, material substitution, or isolation to prevent or control release of a hazard (e.g., rollover protection on farm vehicles). If these types of controls are unavailable or impractical, then administrative or work practice controls should be considered (e.g., using a sorting table to grade strawberries). Finally, use of personal protective equipment is the least preferable means of hazard control and should be implemented only when other control measures are not feasible.

Education alone is insufficient to reduce agricultural injuries and illnesses.[24,32] Farmers often are aware of farm hazards, but are reluctant to correct them for a variety of reasons, including financial limitations, lack of time, and the belief that they will not get hurt.[24]

Model Health and Safety Inspections

Given the large number of small farms in Korea, it is unrealistic to inspect each of these yearly. One alternative is to consider a program similar to the Model Health and Safety Inspections in the United Kingdom. This program would involve asking a family farmer to invite several farming neighbors to an "inspection" of his/her farm by the RDA or a similar Korean government agency. After the inspection, the government agency could lead a discussion on the findings and recommendations that were made by the inspectors. To ensure that all farmers would have the opportunity to attend a sample inspection, three to four inspections, one in each season, could be held annually in each of the eight Korean provinces. The inspection and question-and-answer session would require 3 to 4 hours. Concluding it with a complementary lunch might serve as a powerful incentive. Other incentives to consider are a reduction in the farmer's medical insurance premium or discounts on agricultural equipment and supplies. Combining educational interventions with financial benefits appears to increase their effectiveness in reducing injury and illness.[32]

Safe Farm Zone of Korea

This intervention project was initiated a year after the 2005 Suwon symposium and was described in detail earlier in this article.

Poison Control Centers

Poison control centers (PCCs) are call centers staffed by highly trained professionals who respond to phone calls from the public, health care professionals, police and fire officials, and homeland security staff. They provide information on how to manage health effects arising from toxic exposures, including pesticides. Korea currently does not have any poison control centers. One or more poison control centers in Korea could have many benefits: reduction in total health care costs by handling minor toxic exposures over the phone by PCC staff, instead of making a visit to a physician; serving as a real-time toxic surveillance system; and serving as a useful source of cases for pesticide poisoning surveillance systems.[33,34]

Agricultural Health and Safety Research

Research on agricultural hazards has been conducted in many industrialized countries; however, the characteristics and culture of the Korean agriculture industry may differ from other countries. As such, research is needed in Korea to further explore surveillance findings, to identify the etiology of chronic disease, to assess the acute and chronic hazards of toxic exposures, and to identify effective and cost-efficient interventions.

Prospective and Retrospective Cohort Study

Although Korean farmers may be exposed to many of the same hazards as farmers in more developed countries, the frequency and intensity of these exposures may differ. In addition, cultural attitudes, values, customs, beliefs, and behaviors are known to influence disease risk,[35] and these factors, alone or through interaction with agricultural exposures, may influence disease risks among Koreans. As such, a large prospective cohort study of Korean farmers, similar to the U.S. Agricultural Health Study, could be informative.[36] Similarly, a large retrospective cohort study of Korean farmers could provide information on the disease and injury risks of earlier agricultural exposures.

Ergonomic Research Studies

Surveillance data are necessary to identify the incidence and prevalence rates of various work-related musculoskeletal disorders (MSDs) among agricultural workers. Those MSDs with the greatest prevalence and severity should be targeted for additional research and intervention. Research can identify the associated risk factors, including physical, biomechanical, psychological, and psychosocial factors.[37] Any initial ergonomic research strategy should concentrate on physical or biomechanical factors rather than psychological or psychosocial factors, because these biomechanical factors are the most amenable for development of effective interventions. In addition, ergonomic research studies should consider the variability found in farm exposures. It is well known that farming is very seasonal, with different levels and types of stressors throughout the year. To account for this variance, an optimal study design would involve repeated measures that quantify the level of risk at different times of the year (e.g., measure exposure during peak periods such as planting and harvesting, and during minimal stress periods such as the growing periods). This design would permit using both cumulative and point estimates when assessing the relationship between the exposure and MSD.

University-Based Agricultural Research Centers

Institutes similar to the National Institute for Occupational Safety and Health (NIOSH) Agricultural Research Centers could be established in Korea to conduct research, education, and prevention projects that address the nation's pressing agricultural health and safety problems. They could be geographically distributed across Korea so that the agricultural health and safety issues unique to the different regions could be addressed. More information on the NIOSH Agricultural Research Centers can be found at: http://www.cdc.gov/niosh/agctrhom.html#objectives.

Dissemination of Findings

The importance of dissemination of findings cannot be over emphasized. Surveillance and research findings need to be shared with stakeholders (i.e., farmers, academicians, policy makers, government researchers, and extension service agents), so that the stakeholders understand the magnitude and nature of agricultural health and safety problems and the consequences of ignoring them. An understanding of these problems will build support for adopting intervention activities. In addition, it is important for stakeholders to have access to information about effective, efficient, and practical interventions. Hopefully, recognition and knowledge about agricultural health and safety problems and knowledge about effective ways to address them will lead to actions to solve these problems.

There is no one size-fits-all approach for dissemination of findings. Each stakeholder often requires a separate approach. Farmers may need their information in a simple, straightforward manner, with practical solutions and advice. Information can be disseminated at many different encounters. These include their annual health examination (pamphlets could be made available in the clinic waiting room); at model health and safety inspections; by radio broadcast; by mail; or by the Internet. Information to academicians, government researchers, and extension service agents could be disseminated through publication of research in peer-reviewed and trade journals, presentation of findings at scientific meetings, posting information on the Internet, and reports distributed by Korean government agencies. Finally, information for policy makers could be made available in similar fashion, and through brief reports, and brief presentations delivered in-person.

Some of the agricultural health and safety statistics cited in this article are available only in Korean government reports or reports from nongovernmental organizations, which are written in Korean. The valuable information in these reports could be more readily accessed and cited by international scientists if published in peer-reviewed English language journals.[31]

Internet and Assessment Tools

The Internet is a powerful tool for dissemination of all types of information including educational materials. NIOSH in the United States and the Health and Safety Executive in the United Kingdome place useful agriculture-related educational materials on their Web sites. The RDA has also made tremendous strides in getting this type of information on the Web.

Evaluation

The Plan-Do-Check-Act cycle is vital for continuous improvement of any project or activity. The process is begun by setting goals and planning how to achieve them; next is the implementation or doing what was planned. During and after the do stage, information is gathered to check or evaluate what happened to assess whether the intended impacts and efficiencies were realized. At this stage, an inventory of strengths and weaknesses can also be taken. Finally, by using the evaluation findings, one must act to improve the process. This involves eliminating the weaknesses, and may involve expanding the program into new geographic areas. It will be difficult to argue for ongoing resources if impacts and benefits cannot be demonstrated. By establishing and maintaining surveillance systems and evaluation methodology, the appropriate governmental authorities would have the tools to identify performance targets, measure health and safety baselines, and determine whether targets have been met. As an example, the NIOSH agriculture research program was recently evaluated by the National Academies.[38]

CONCLUSION

Globally, agriculture ranks among the most hazardous industries. Korea is a world leader in conducting research and interventions to protect its workers from health and safety hazards, but the Korean efforts in the agricultural sector have not kept pace with their efforts in other industrial sectors. Little reliable information is currently available on the health status of Korean agricultural workers, although it is

reassuring to see that this situation is beginning to change in Korea. The 2005 Suwon *International Symposium on Development of Prevention Strategies for Agricultural Health and Safety* represented an excellent initial effort to address the occupational health and safety problems in Korean agriculture. Since that symposium, efforts to address the knowledge gap in agricultural health and safety have accelerated, but much additional work is needed. This report embellishes the knowledge and lessons that were shared at the 2005 Suwon symposium, with the intent to provide guidance to promote and protect the health of Korean farmers.

REFERENCES

1. U.S. Department of Labor, Bureau of Labor Statistics. *Revisions to the 2008 Census of Fatal Occupational Injuries (CFOI) Counts.* Washington, DC: U.S. Department of Labor; 2010. Available at: http://www.bls.gov/iif/oshwc/cfoi/cfoi_revised08.pdf. Accessed May 28, 2012.

2. Health and Safety Executive. *Fatal Injury Statistics.* Merseyside, UK: Health and Safety Executive; 2011. Available at: http://www.hse.gov.uk/statistics/fatals.htm. Accessed May 28, 2012.

3. Blair A, Freeman LB. Epidemiologic studies in agricultural populations: observations and future directions. *J Agromedicine*. 2009;14:125–131.

4. Hoppin JA, Umbach DM, Kullman GJ, et al. Pesticides and other agricultural factors associated with self-reported farmer's lung among farm residents in the Agricultural Health Study. *Occup Environ Med*. 2007;64:334–341.

5. Hoppin JA, Umbach DM, London SJ, et al. Pesticide use and adult-onset asthma among male farmers in the Agricultural Health Study. *Eur Respir J*. 2009;34:1296–1303.

6. Alavanja MC, Hoppin JA, Kamel F. Health effects of chronic pesticide exposure: cancer and neurotoxicity. *Annu Rev Public Health*. 2004;25:155–197.

7. Calvert GM, Alarcon WA, Chelminski A, et al. Case report: three farmworkers who gave birth to infants with birth defects closely grouped in time and place—Florida and North Carolina, 2004–2005. *Environ Health Perspect*. 2007;115:787–791.

8. Blair A, Hoar Zahm S, Pearce NE, Heineman EF, Fraumeni JF Jr. Clues to cancer etiology from studies of farmers. *Scand J Work Environ Health*. 1992;18:209–215.

9. National Institute for Occupational Safety and Health. *Papers and Proceedings of the Surgeon General's Conference on Agricultural Safety and Health, Public Law 101-517, Des Moines, Iowa, April 30–May 3, 1991*. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health; 1993. DHHS (NIOSH) Publication No. 92–105.

10. Central Intelligence Agency. *The World Fact Book: Korea*. Washington, DC: Central Intelligence Agency; 2012. Available at: https://www.cia.gov/library/publications/the-world-factbook/geos/ks.html. Accessed Accessed May 28, 2012.

11. Ahn Y, Bena JF, Bailer AJ. Comparison of unintentional fatal occupational injuries in the Republic of Korea and the United States. *Inj Prev*. 2004;10:199–205.

12. Labor Insurance Research Institute. *Industrial Accident Compensation Insurance and Employment Insurance Collection Data and Analysis (Year 2008)* [in Korean]. Seoul, Korea: Labor Insurance Research Institute; 2009.

13. Occupational Safety and Health Research Institute (OSHRI). *Analysis of Workers Who Are Vulnerable to Industrial Accident* [in Korean]. Incheon, Korea: OSHRI; 2006. Publication No. 2006-85-785.

14. Rural Development Administration (RDA). *Safety Aid System for Korean Farm Workers* [in Korean]. Suwon, Korea: Korean Rural Development Administration; 2010. Available at: http://farmer.rda.go.kr/. Accessed May 28, 2012.

15. Ahn YS, Park RM, Stayner L, Kang SK, Jang JK. Cancer morbidity in iron and steel workers in Korea. *Am J Ind Med*. 2006;49:647–657.

16. Korea Occupational Safety and Health Agency (KOSHA). *Prevention Using the Results From the Survey of Work Environmental Status in 2009* [press release]. Seoul, Korea: Ministry of Labor; 2010.

17. Cha ES, Kong KA, Moon EK, Lee WJ. Prevalence and changes in chronic diseases among South Koran farmers: 1998 to 2005. *BMC Public Health*. 2009;9:268.

18. Kim SB. *Statistics for Agricultural Work-Related Injury in Korea* [in Korean]. Seoul, Korea: Wonjin Institute for Occupational and Environmental Health; 2010.

19. Lee SJ, Kwon YJ, Kim IA, Lim HJ, Lee KS, Kim KR. *A Study on Patterns and Characteristics of Agriculture-Related Injury by Analysis of Safety Aid System of Farm Workers* [in Korean]. Ansan, Korea: Rural Research Institute; 2007.

20. Rural Resources Development Institute (RRDI). *The Status of Farmer's Health and Farmwork Management* [in Korean]. Suwon, Korea: Korean Rural Development Administration; 2008.

21. Lee WJ, Cha ES, Moon EK. Disease prevalence and mortality among agricultural workers in Korea. *J Korean Med Sci*. 2010;25(Suppl):S112–S118.

22. Rural Development Administration (RDA). *Internal Report of the Safe Farm Zone of Korea* [in Korean]. Suwon, Korea: Rural Development Administration; 2010.

23. Heo Y. Community-based Safe Farm Zone intervention program for healthy and safe agricultural work environments. In: *Proceedings of the International Symposium on Development of Prevention Strategies for Agricultural Health and Safety*. Suwon, Korea: Korean Rural Development Administration; 2005.

24. Thu KM, Pies B, Roy N, Von Essen S, Donham K. A qualitative assessment of farmer responses to the Certified Safe Farm concept in Iowa and Nebraska. *J Agric Saf Health.* 1998;4:161–171.

25. Korean Statistical Information Service. *Economically Active Population by Occupation* [in Korean]. Daejeon, Korea: Statistics Korea; 2009. Available at: http://kosis.kr/ups/ups_02List01.jsp?kor_id=&pubcode=WA&type=F. Accessed May 28, 2012.

26. Korean Statistical Information Service. *The Trend of Korean Grain Consumption* [in Korean]. Daejeon, Korea: Korea Ministry of Strategy and Finance; 2010. Available at: http://kosis.kr/abroad/abroad_01List.jsp. Accessed May 28, 2012.

27. United Stated Trade Representative, Executive Office of the President. United States and the Republic of Korea Sign Landmark Free Trade Agreement. 2007. Available at: http://www.ustr.gov/trade-agreements/free-trade-agreements/korus-fta. Accessed May 24, 2011.

28. Kim TG, Chong HG. *Evaluation of Direct Payment Scheme on Less Favored Farming Area in Korea* [in Korean]. Seoul, Korea: Korea Rural Economic Institute; 2009. Report No. P120.

29. Korea Rural Economic Institute (KREI). *Strategies for Agricultural Sector to Cope With Free Trade Agreements*. Seoul, Korea; 2005.

30. Nourish RA. Vision for agriculture: the UK strategy for progressively improving health and safety outcomes in the agricultural industry. In: *Proceedings of the International Symposium on Development of Prevention Strategies for Agricultural Health and Safety*, pp. 225–273. Suwon, Korea: Korean Rural Development Administration; August 17–18, 2005.

31. Kang SK, Ahn YS, Kim KJ. Recent advances in occupational health research in Korea. *Ind Health*. 2004;42:91–98.

32. Rautiainen R, Lehtola MM, Day LM, et al. Interventions for preventing injuries in the agricultural industry. *Cochrane Database Syst Rev*. 2008;(1): CD006398.

33. Bronstein AC, Spyker DA, Cantilena LR, Green JL, Rumack BH, Giffin SL. 2009 annual report of the American Association of Poison Control Centers' National Poison Data System (NPDS): 27th Annual Report. *Clin Toxicol (Phila.). 2010*;48:979–1178.

34. Calvert GM, Mehler LN, Alsop J, De Vries AL, Besbelli N. Surveillance of pesticide-related illness and injury in humans. In: Kireger R, ed. *Hayes' Handbook of Pesticide Toxicology*. 3rd ed. San Diego, CA: Elsevier; 2010:1313–1369.

35. Singh GK, Hiatt RA. Trends and disparities in socioeconomic and behavioural characteristics, life expectancy, and cause-specific mortality of native-born and foreign-born populations in the United States, 1979–2003. *Int J Epidemiol*. 2006;35:903–919.

36. Alavanja MC, Sandler DP, McMaster SB, et al. The Agricultural Health Study. *Environ Health Perspect*. 1996;104:362–369.

37. da Costa BR, Vieira ER. Risk factors for work-related musculoskeletal disorders: a systematic review of recent longitudinal studies. *Am J Ind Med*. 2010;53:285–323.

38. National Research Council and Institute of Medicine. Agriculture, Forestry, and Fishing Research at NIOSH. Committee to Review the NIOSH Agriculture, Forestry, and Fishing Research Program. *Report. No. 3, Reviews of Research Programs of the National Institute for Occupational Safety and Health*. Washington, DC: The National Academies Press; 2008.