Hazards of Farming

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SUMMARY

Farming is the most dangerous occupation in the industrialized world. Children, in particular, are at high risk for injury and disability. There is ample scope to improve this situation. Parents are the most important group to be educated. Emergency response services in rural areas are sometimes unable to provide optimum care for victims. Better surveillance methods need to be in place, both to gather information and to evaluate strategies aimed at prevention. Farm safety needs to be higher on the agenda for farmers, farm organizations, government, and health care professionals.

RÉSUMÉ

Dans le monde de l'industrie, c'est l'agriculture qui constitue le travail le plus dangereux. Les enfants en particulier sont à haut risque de blessures et d'incapacités. Il existe suffisamment de données pour forcer l'amélioration de la situation. L'éducation doit d'abord viser le groupe le plus important qui sont les parents. Les services d'urgence des régions rurales sont parfois incapables d'assurer des soins optimaux aux victimes. Il faut mettre en place de meilleures méthodes de surveillance, autant pour recueillir des renseignements que pour évaluer les stratégies préventives. La sécurité à la ferme doit se voir accorder une plus grande priorité auprès des fermiers, des organismes d'exploitation agricole, du gouvernement et des professionnels de la santé.

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"How blest beyond all blessings are farmers, if they but knew their happiness! Far from the clash of arms, the most just earth brings forth from the soil an easy living for them."

Virgil, The Georgics, 70-19 BC

FARMING IS ONE OF THE OLDEST occupations.[1] For the last 5000 years, it was the most common way of making a living; indeed, until the 1970s more than half of the world's labor force worked the land.[2] In the past 25 years, agriculture has changed drastically. New technologies have increased production, but they have been accompanied by new health and safety problems. Economic pressures, chemicals, pesticides, and machinery have transformed life on the farm. The image of a tranquil bucolic existence is belied by the fact that agricultural workers suffer the most extensive occupational exposure to disease and injury.[3]

Mortality studies

One way to define the health risks of farmers is to establish when and why they die. This is the kind of reverse logic beloved of epidemiologists, who in recent years have produced several studies of mortality in farm populations.[4] Most of these studies in the United States have used death certificate data. Despite the shortcomings of this type of study, it reveals some trends. There is good news and bad news.

Compared with the general population, farmers have a lower chance of dying from coronary artery disease, chronic obstructive lung disease, and carcinoma of the lung. But there are striking increases in death rates from tuberculosis, pneumonia, and some specific malignancies. The salient finding is the increased number of deaths due to "external causes." Most prominent among these external causes are traumatic deaths and suicide. National Safety Council data suggest that agriculture has a mortality rate of 55/100 000 workers each year and a morbidity rate of 58/100 000 each year.[5] This fatality rate is higher than that for such dangerous occupations as mining and quarrying (50/100 000), or for construction, manufacturing, and all other industrial groups (*Table 1*[6]).

The number of fatal accidents on Canadian farms has been declining steadily (*Figure 1*[7]). In 1976, 190 Canadians died in farm-related accidents; in 1986, there were 104 such deaths.[7] The greatest proportion of these deaths occurred in Ontario (30%), followed by Saskatchewan (21%), Alberta (20%), and Quebec (11%). According to the Canadian Safety Council, more than 60% of all fatalities involved farm machinery.[8]

Studies done in other countries echo these findings, but data from Ireland indicate

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Table 1. **FATAL WORK ACCIDENTS IN THE UNITED STATES, BY INDUSTRY, 1985**

INDUSTRY	WORKERS (IN MILLIONS)	DEATHS	DEATH RATES[a]	INJURY RATES[a]	DISABLING INJURIES
All industries	106.4	11 600	11	1887	2 000 000
Agriculture	3.2	1600	49	5312	170 000
Mining, quarrying	1.0	500	50	4000	40 000
Construction	6.0	2200	37	3666	220 000
Manufacturing	19.5	1200	6	1795	350 000
Transportation and public utilities	5.6	1600	29	2857	160 000
Trade	25.1	1300	5	1594	400 000
Service	30.0	1900	6	1400	420 000
Government	16.0	1300	8	1500	240 000

[a]*Per 100 000 workers.* *Data from Layde.*[6]

that the true rate of mortality has not decreased significantly in recent years.[9,10] These studies might not accurately reflect overall mortality related to farming, as there is some evidence that stress-related deaths (ie, suicides) attributable to farming are not included in the mortality figures.[1,9]

Disabling farm injuries

Statistics on disabling injuries are more difficult to find. It is estimated that farmers suffered more than 100 000 injuries in the United States during 1986.[11] But some researchers believe that the rate of injury is underestimated by up to 50%. This is the case particularly in Canada where most farmers are self-employed and therefore are not covered by disability insurance that is available to other employees through the Workers' Compensation Board (WCB). Data on injuries at work are gathered from claims made to the WCB and are analyzed to give information about disabilities in other occupations. For economic reasons most farmers do not carry private disability insurance.

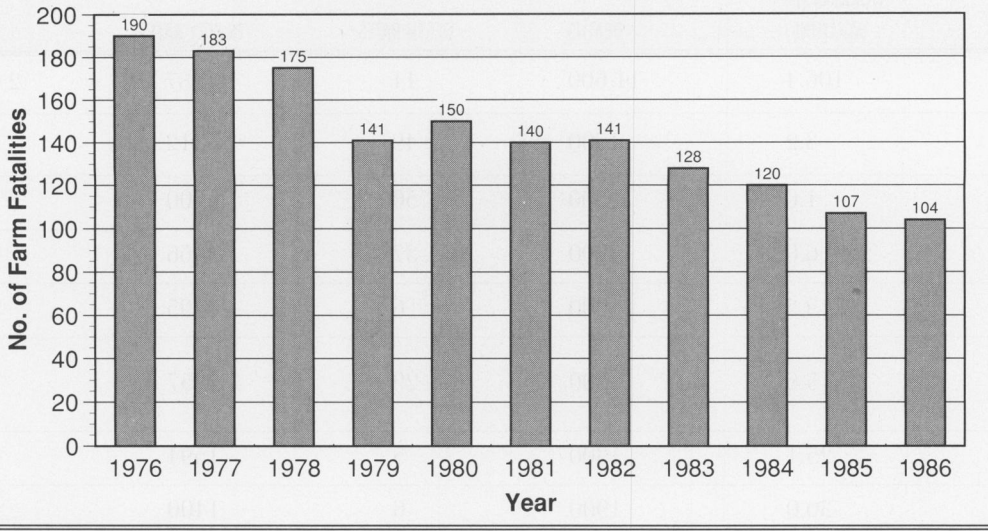
Thus accurate statistics are difficult to obtain because of insufficient reporting and confusion about the definition of farm accidents.[12] Nonetheless the National Electronic Injury Surveillance System (NEISS) of the Consumer Product Safety Commission was set up in the United States in 1972 as a surveillance system of consumer product-related injuries treated in hospital emergency rooms. One study comparing the NEISS database and National Center for Health Statistics register of Cause of Death showed that, for every fatality in children (from birth to 19 years) on farms, 129 children were treated in emergency rooms for farm injuries.[9]

Health hazards of farming

The image of a slow, safe, and secure existence enjoyed by rural folks is the stuff of popular imagination and the works of authors from Hardy to Thoreau. The reality of life on modern farms in industrialized countries is very different. Such farms have become factories for the food that increasing populations need. Machines are necessary to increase productivity; chemicals are necessary to force the land to grow plants that are becoming less resistant to natural enemies. Economic policies dictate a shrinking profit margin for individual farmers, which forces some farmers to use methods and equipment that put their health at risk.[3] The following list gives an overview of the hazards involved in farming[13-17]:

- accidents: machinery, falls, crushing, animals, electrocution, fires, drowning;
- poisonings: pesticides, herbicides, fungicides, toxic manure gases;

Figure 1. **FATAL ACCIDENTS ON CANADIAN FARMS 1976 - 1986**



Reprinted with permission from White and Cessna.[7]

- respiratory disease: dusts, gases, fungal spores, bacterial endotoxins;
- infections;
- ergonomics: strains to muscles and joints;
- deafness;
- skin ailments;
- cancer; and
- psychological stresses.

Accidents. The greatest hazard in farming is accidents. From 1985 to 1988 there were 88 farm fatalities in Saskatchewan; 48% of these involved tractors.[18] The causes of all farm accidents vary according to location and the type of agriculture practised, but there are trends that are worth noting.[3,9,13,14,19-21] Tractors are involved in more than 30% of all farm accidents. They are a ubiquitous tool on farms, extremely powerful, and used to operate a variety of tools. Tractor roll-over (either sideways or backward) is particularly lethal.[19] Tractors run over an inordinate number of smaller children.[22] The power take-off, which is a metal shaft that transmits power from the tractor's transmission to attached implements, is another common source of injury. The victim's clothing becomes entangled with the rotating shaft and the person is flailed around it. The result is death due to severe injuries to head, limbs, thorax, and abdomen.

Farm trucks are involved in about 10% of fatalities, combines in 8%, swathers and mowers in 5%. Other farm machinery, such as grain augers, round balers, and grain wagons, are also the cause of accidental death. A surprisingly frequent cause of fatalities is asphyxiation, often in dugouts, in holding tanks for liquid manure, and occasionally in grain and by moving parts of machinery. Children are over-represented in this kind of death.[10,15,16,22] Similar statistics have been reported in other provinces and in other countries.[2,9,23-25]

The United States is noteworthy in that accidental death due to use of firearms accounted in one study for one in 10 deaths to children on farms; among 10- to 14-year-olds, 15% died from gunshot wounds.[15] This is likely due to ready availability of firearms in the United States as a result of liberal gun-control laws.

Animals are involved in an increasingly smaller number of fatalities, reflecting the fact that many farms no longer use animals for work or play and that most animals are kept in very controlled situations.

Injuries. Farm machinery is again implicated in serious injury. Studies document injuries to the spinal cord, amputations, blunt trauma to the chest and abdomen, crush injuries, and compound fractures.[10,13,15,17,25] An Alberta survey of 1703 non-fatal farm injuries indicated that in 59% of cases the injury was classified as

severe (48%) or permanent (11%). Amputations accounted for 64% of the permanent injuries.[26]

New technologies bring with them new patterns of injury that are unique to farming. Round balers can now make bales that weigh 400 to 800 kg, which are moved around with front-end loaders. Serious spinal cord injuries result when these bales slip backward onto the tractor operator.[20] Grain augers or silo-loaders create a specific type of injury. These implements consist of a large metal screw encased within a metal cylinder of up to 120 cm in diameter. The screw revolves 500 to 600 times each minute, powered by either a gas engine or a tractor power take-off. The intake area is shielded with a metal cage to prevent inadvertent insertion of a limb. These shields are often removed to increase grain-handling efficiency, with catastrophic results, as these machines are not easily stalled, even when a limb is trapped.

Children are at greater risk because their limbs are smaller and are able to fit between some shields. A review of cases of traumatic amputation at the Child Amputee Clinic in Winnipeg revealed that auger injuries were responsible for nearly 50% of such amputations in Manitoba. Up to 30% of these accidents happened to Hutterite children.[10] The authors of one paper point out, rather ruefully, that the frequency and magnitude of this type of trauma are much greater than the well-known thalidomide congenital limb amputations, though public awareness of this threat is almost negligible.[10]

High-pressure injection injuries have occurred with the use of field sprayers, engine fuel injectors, and other hydraulic equipment. Forty percent of such injuries result in the amputation of at least one finger.[27]

Biologic hazards. Biologic hazards constitute a large group of injurious agents. The most troublesome is that of airborne pollution. Green pastures and unlimited fresh air is a fiction when we look at what actually exists on the farm. Agriculture is the third largest polluter of particulate matter in the United States, producing more than 15 million tonnes a year, mostly from grain dust. The ill effects of grain dusts have been known for centuries, and the earliest record of observation in the literature was in 1555. The following is a quotation from a Swedish "epidemiologist" of the 16th century.

When sifting the chaff from the wheat one must carefully choose a time when a suitable wind is available to sweep away the harmful dust. This fine grained material readily enters the mouth, congests the throat and threatens the vital organs of the threshing men. If one does not seek instant relief by drinking beer one may never more, or only for a short time, enjoy what one has threshed.

Olavs Magnus 1555.[17]

Farmers often work in an atmosphere of dusts and gases that would not be allowed in any other industry.[17] After shaking out a bale of hay, a farmer can inhale up to 1.5 billion spores. In animal confinement barns, the gases emanating from the manure storage pits have been shown to surpass allowable levels, especially in hog barns.[17,28,29] When the manure pit is agitated before emptying, huge quantities of hydrogen sulfide are released, resulting in deaths in farmers and livestock. Silo-filler's disease is caused by exposure to silo gases, a mixture of nitrogen oxide, nitric oxide, and carbon dioxide. These gases can cause pulmonary edema.[12] The farmer inhales many dusts that consist of a complex mixture of soil silica, rodent excreta and dander, plant and fungal allergens, insect allergens, and chemical residues. Many of these particles are less than 3 μm, and so readily penetrate the alveoli. This inhalation can cause farmer's lung and organic toxic dust syndrome.

Farmer's lung. This is a hypersensitivity pneumonitis due to inhaled spores of thermophilic actinomycetes released from musty hay. In Manitoba, 40% of farmers show antibodies that indicate exposure. The incidence is 2/1000 with a prevalence of 6/1000 on the Prairies.[17] It has been reported to be as high as 10% in the United Kingdom, where the weather is wetter.[4,15]

Organic toxic dust syndrome. This is thought to be caused by bacterial endotoxins from moldy grain or hay. It is associated with cough, fever, myalgias, and dyspnea that is usually short-lived (less than 24 hours). Asthma can be a result of an allergy to molds. Chronic obstructive pulmonary disease (COPD) is increased in elevator workers, especially if they smoke.[7]

Infections. Zoonoses, or animal-transmitted diseases, are another occupational hazard on the farm. More than 150 of these have been documented worldwide.[30] Rabies, brucellosis, toxoplasmosis, leptospirosis, viral encephalitis, psittacosis, and tuberculosis are among the more common ailments that affect farmers in a variety of ways. Lyme disease is endemic in the upper midwest and in the northeastern United States, representing a new threat to farmers.[31]

Skin diseases. The organ system that is most commonly affected in a farm injury is the skin. Farmers are susceptible to allergy, and this can give rise to a contact dermatitis.[4] Contact dermatitis can also be a direct result of contact with:

- plant and animal products, such as poison oak, poison ivy, weeds, flowers, and leathers;
- agricultural chemicals; and
- food products that are ingested.

In Saskatchewan during 1979, skin problems in agriculture accounted for 13% of all occupational skin disease. Fungal skin lesions were the most common form of infection in the farming population.[31]

Chronic injury. The most widely researched chronic injury in farmers is noise-induced hearing loss. This is a classic pattern of loss of hearing at frequencies above 1500 Hz and has been shown to occur in farmers of all ages.[32,33] The high noise levels of many farm activities are not well known. Machinery and mechanical tools are obvious sources, but surprisingly high levels of noise pollution occur in pig barns and auction marts.[34] It is estimated that 75% of the tractors in use during the 1970s still exceeded the recommended exposure level of 90 dB for an 8-hour period. Exposure to noise in excess of 85 dB can result in permanent hearing loss; many farm situations exceed this level.

A growing body of literature documents the prevalence of hearing deficits in farmers.[4] Hearing protection can reduce levels by 20 to 30 dB but has been shown instead to put farmers at risk of being unable to hear or localize warning cries, which can increase their risk of other injury.[4]

Vibration is another potential source for chronic injury. It can either be localized (ie, to the hand) or applied to the whole body. When the body is vibrated at a frequency of about 5 Hz, there is amplification of the energy being delivered.[35] In farmers this vibration is usually delivered to the buttocks and spine. This can give rise to chronic back pain. A cohort of German farmers was followed for 10 years and analyzed for the prevalence of back pain and abnormal results from physical and radiologic examination of the spine. Back pain and positive findings increased with the amount of time spent on a tractor. Other studies implicate whole body vibration in the genesis of chronic back pain.[4] Although modern tractors often use suspension seats that have appropriate natural frequency and damping characteristics to reduce vertical vibration, most farm workers are likely to continue to receive relatively low-frequency, high-amplitude, whole-body vibration because few of them will be using modern tractors.[4]

Cancer risk. Most available information points to a lower risk to farmers for most cancers, compared with the general population. Farmers have fewer deaths from lung cancer and other cancers related to smoking.[36] Certain groups of farmers have a higher risk than average for certain types of cancer. Poultry and dairy farmers have a higher incidence of leukemia and stomach cancer. Exposure to agricultural chemicals has been associated with lymphomas. Excessive exposure to sunlight causes basal and squamous carcinoma of the skin, especially on the face.[4,36] It is difficult to determine the exact etiologic factors in the excess risk for certain types of cancer, but there is strong evidence that skin cancer, stomach cancer, and some leukemias are linked to the occupation of farming.[36] Skin cancer is a huge problem; in some surveys 55% of the farm population screened have skin disease, and up to 10% of these respondents have malignant lesions.[31]

Farm chemicals. Chemical use is an integral part of modern farming.[7] In 1986, 5000 pesticide formulations composed of more than 500 active ingredients were registered for use in Canada.[16] The use of pesticides puts the farmer at risk for:

- acute and chronic toxic effects of formulated pesticides;
- corrosive properties of formulated pesticides; and

- sensitization to the active ingredients; to the various solvents, emulsifiers, etc, used in the formulation; and to sprayer tank adjuvants.[7]

These risks are real. Dermal absorption of certain organophosphate compounds has produced severe neurologic symptoms or death.[37] Recent epidemiologic studies on exposure to phenoxy-herbicides suggest an increased incidence of cancer and unfavorable outcomes in pregnancy.[38] In Saskatchewan from 1983 to 1987, there were 34 accidental pesticide poisonings on farms that required hospitalization.[7] Chemicals can be absorbed in many ways; oral, ocular, dermal, and by inhalation are the common routes.

Eyes are vulnerable to the corrosive nature of chemicals, especially when pH is less than 5 or greater than 8. Splashes and dusts are common, and soft or gas-permeable contact lenses can concentrate chemicals next to the cornea.[7]

Oral exposure to chemicals can result from inhalation.[39] Poor personal hygiene practices, such as blowing on nozzles of spray tips or eating, drinking, or smoking with contaminated hands, can lead to inadvertent exposure. Most studies show that skin is the most important route of exposure to pesticides.[37-41] Rates of absorption vary between areas of the body and between individuals. Studies show that dermal absorption is relatively slow.[39] It has been estimated that the absorbed dose of 2, 4-D amine salt measures in urine excreted in 24-hour postexposure voids was in the order of 2% of the total body exposure of farmers who did not wear gloves.[42] In addition to wearing protective clothing, those who use pesticides should shower as soon as possible after exposure to minimize dermal absorption.[7]

Inhalation exposure is much less than dermal and has generally been in the order of 1% of total body exposure.[37-41] It is important to note that pesticides are more rapidly absorbed by inhalation and can lead to significant toxicity in the event of accidents.

Psychosocial stresses. Farming is among the top 10 of 130 high-stress occupations in North America.[4,7,15] A number of factors influence work performance. These include work organization and biologic, psychologic, and social factors. These factors can be as diverse as weather, financial pressure, international grain markets, and government policies and are often compounded by long work hours, fatigue, and relative isolation. In addition, farmers experience the stress of spousal, family, and neighbor relations, much like their urban counterparts.[16] This stress takes its toll. Some evidence indicates that suicide is more common in older farmers; other markers, such as spousal and child abuse, marriage breakdown, and alcoholism, are difficult to measure, and so the scope of the problem has not yet been clearly defined.[16]

Who are the victims?

Mortality data are easy to access from death certificates, but it is much more difficult to get accurate information about injuries on the farm. Nonetheless, several trends can be identified. Males are four times more likely to be victims than are females. Children are over-represented; in one study 27% of injuries occurred in children aged 0 to 18 years.[13] The group with the highest incidence of injuries is men 26 to 45 years.[10,15] This is not surprising, as they have the largest exposure to the risks of farming. The incidence of suicide is highest in men 65 years and older.

Strategies for prevention

The high rate of injury and death in children is unique to farming. Children are excluded from the workplace by law in all other occupations in industrialized countries. Yet on farms they represent an important part of the work force, and it is unlikely that this will change. Economic pressures force farmers to use children instead of hired adult help. Children are also living and playing in the farmyard, which is fraught with hazards.[10,15] Therefore the exposure to risk is part of rural living. Most accidents occur during summer and harvest, because the times that children are at home from school coincide with the busiest times of the farming cycle.[21] As mentioned earlier, a study of auger injuries in Manitoba indicated that 30% of children who suffered amputation were from Hutterite colonies.[10]

Some of these statistics suggest ways of prevention. Studies have shown that many of these accidents are preventable.[16] High-risk groups, such as Hutterites, could be

targeted for accident prevention programs as they become identified. Certain types of accidents, particularly tractors running over children, occur with a perplexing frequency and need to be researched further to identify etiologic factors.[11] Steps that could be taken to prevent accidents include:

- education of farm families about accident prevention: 1) close observation of young children; 2) instructing children to avoid dangerous areas, ie, open ponds or pits; livestock; and the operation of farm equipment unless supervised; 3) observing safety procedures with farm equipment; and 4) proper storage of farm chemicals;
- formal instruction of older children on how to operate machinery safely; and
- modification of machinery to prevent inadvertent injury to children, eg, most shields on grain augers allow little hands and legs to slip through.[10] Grain box gates should be fitted with a safety catch to prevent entrapment of children's heads.[22]

Young children could be removed from the workplace at the high-risk times (harvest and seeding) by having appropriate day-care available.[15,23] This day-care would need to be very flexible because of parents' erratic work hours due to weather and other factors. Primary prevention is key in childhood, as these children can have a life of significant disability. Adults pose a different set of challenges when it comes to prevention. There is evidence that farmers are in general concerned about farm safety.[15] In particular, they are concerned about the safety of family members, especially young children, but there are marked inconsistencies between attitudes and practices.[23,15,16] Many farmers know what safety measures to implement but often neglect to do so in practice.

A variety of reasons for this phenomenon have been offered. The "macho" image of rugged and tough farmers makes worrying about precautions seem effeminate for male farmers.[15] Precautions take more time, and they often require special equipment. Some machinery shields decrease the efficiency of equipment, such as augers.[17] Protective clothing and gloves can be uncomfortable. Older equipment may not have up-to-date safety devices and can be costly to retrofit. Some homemade retrofits (tractor cabs) can amplify noise pollution if they are not properly designed. Hearing protectors can provide their own hazard because when worn they can interfere with the tractor operator's ability to hear a warning shout.[1] Some risks are too costly to avoid because safer alternatives reduce (or eliminate) profit. For example, Sweden makes hay dryers available to farmers who have lung problems.[18] This approach is costly but allows farmers to reduce risk to lungs from improperly cured hay; however, it is dependent on obtaining government aid.

The main approaches to prevention are education and attempting to make certain safety features standard on machinery that is involved in 40% to 60% of accidents. Part of this education should be aimed at urban, as well as rural, populations because a number of accidents occur to urban visitors helping on farms.[20,13] Farmers need to be trained by more formal methods to use equipment and machinery.[15] Most other careers require a formal apprenticeship and objective evaluation of proficiency in handling equipment safely; some of these methods could be applied to farming.

Rural health care services

The issue of access to medical care and emergency services must be addressed. Rural communities have seen a dramatic decrease in the number of facilities that can provide emergency care. In 1987 in the United States, 40 rural hospitals closed.[31] This has a critical impact on the management of injuries on farms. In one study it was noted that more than half (52.5%) of children younger than 18 years of age who suffered a fatal injury died without having seen a physician. An additional 19.1% die in transit, and only 7.4% live long enough to receive inpatient care.[15]

This finding reflects the lethal nature of farm injuries, but further study needs to be done to examine whether emergency services in rural areas are adequate. Emergency medical systems with trained paramedics and regionalized trauma centers have been shown to improve the outcomes of severely injured patients.[48-50] West and colleagues[48] suggest that up to 73% of non-CNS trauma deaths and 28% of CNS trauma deaths could have been prevented with better initial trauma care.

The most common causes of death are head injury and multiple trauma, which indicates that sophisticated emergency care will be necessary to decrease the resultant deaths and disability.[15]

Injury surveillance

Information on agricultural trauma is limited and difficult to find when it is needed.[11] Planning for effective prevention strategies and evaluation is compromised by the lack of a good surveillance system. Several agencies and organizations have provided some data, but they are, at best, an approximation of the real situation. We still have a rather superficial understanding of the entire injury picture. A new approach to surveillance is necessary to overcome past deficiencies. A combined approach has been suggested. This combination would include on-site surveys, mail surveys, telephone interviewing, and medical record verification.[11] Trial applications of such systems are occurring in Minnesota in the US.

Future directions

A study from Sweden suggests that parents with young children are the most likely to respond to education on safety and accident prevention.[23] They seem to be the best motivated to learn and adopt new strategies. Most children are seen by either public health personnel or physicians periodically for immunizations or for routine well-baby examinations. Programs for accident prevention could be aimed at the parents of this group. Antenatal classes could also be used to teach about prevention, as the male partner in the family is more likely to be present.

Health care professionals need more education on the magnitude of this problem. More research on mechanisms of injury and its prevention are needed. Legislation to enforce proven safety devices, ie, roll-over bars on tractors, needs to be in place. Safety standards for machinery need to be more rigorous and applied nationally and internationally. Gun control laws in the United States need to be examined as a means of preventing accidents to children.[15] Government policy determines profitability of farming in many countries[23]; therefore, government health agencies need to be active in promoting accident prevention. Furthermore, lack of money or time should be removed as barriers for farmers who would improve the safety of their workplace.

These measures must be adopted simultaneously by the farmer, farming organizations, and government. Good epidemiologic field work is necessary to define the problem further and to evaluate strategies that are aimed at prevention.[51]

Agriculture is a critical activity in our world. It is ironic that it is so hazardous. We all have a vested interest in minimizing the hazards to the health of those who grow our food. ■

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