

Assessment of Personal Protective Equipment Use Among Midwestern Farmers

W. Scott Carpenter, MD,* Barbara C. Lee, PhD, Paul D. Gunderson, PhD,
and Dean T. Stueland, MD

Background *Personal protective equipment (PPE) is readily available and widely recommended, yet usage among agricultural workers is largely unknown.*

Methods *A mail survey of 2,483 farmers in six Midwestern states with telephone follow-up addressed PPE usage related to sun exposure, noise abatement, chain saw usage, welding and metal work, handling of large animals in and out of confinement facilities, feed handling, manure storage facilities, and mixing and applying chemicals. Summary statistics of survey responses were compiled.*

Results *With the exception of welding masks, PPE usage was low. Farmers were satisfied with availability of PPE through local hardware and farm cooperatives, but the decision to use PPE was personal and influenced little by outside parties.*

Conclusion *PPE usage rates by farmers on Midwestern farms need to be increased. The desire of the individual farmer to reduce risk of personal injury or exposure should be targeted. The most effective venue will be local agricultural extension services.* Am. J. Ind. Med. 42:236–247, 2002. © 2002 Wiley-Liss, Inc.

KEY WORDS: *farmers; agricultural workers; agricultural safety and health; safety training; safety attitudes; prevention personal protective equipment*

INTRODUCTION

The 1999 National Census of Fatal Occupational Injuries ranked farm occupations second in number of fatalities (557) [Bureau of Labor Statistics, 2000a]. Tractor-related events accounted for most of these. Only truck driving had a larger number of fatalities (898), where highway crashes and jackknifings were the primary causes. Two-fifths of all fatally injured workers under 18 years of age were killed while doing

farm work. This census provides the most complete count of fatal work incidents available, and includes fatalities on both small and large farms.

In Bureau of Labor Statistics surveys, trends for nonfatal illness and injury are slightly different. According to the 1999 Survey of Occupational Injuries and Illnesses, the agriculture, forestry, and fisheries industry injury and illness rate ranked third behind that of the manufacturing and construction industries [Bureau of Labor Statistics, 2000b]. This injury/illness rate is now equal to that occurring in transportation and public utilities. The agricultural services sector reported 7.1 injuries and illnesses per 100 full-time workers, while the crop production sector reported 7.0 and the livestock production sector reported 10.0. This compares with 6.1 in the forestry and 6.9 in the fishing, hunting, and trapping sectors.

Across all industries, the injury and illness rates for 1999 were the lowest since the Bureau began reporting this information in the early 1970s. Overall in the agriculture, forestry, and fishing industry, there has been a steady decline

National Farm Medicine Center, Marshfield Medical Research Foundation, Division of Marshfield Clinic, Marshfield, Wisconsin

Dean T. Stueland has deceased.

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*Correspondence to: Dr. W. Scott Carpenter, Emergency Medicine Department, Marshfield Clinic, 1000 North Oak Avenue, Marshfield, WI 54449. E-mail: carpentw@mfdclin.edu

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in nonfatal occupational injuries and illness from 8.7 per 100 full-time workers in 1996 to 7.3 in 1999.

This most recent injury and illness data look encouraging, however, the survey data are derived from the Occupational Safety and Health Administration (OSHA) 200 logs and exclude farms with fewer than 11 employees, approximately 97% of US farms. Also, some conditions (e.g., long-term latent illnesses caused by exposure to carcinogens) are often difficult to relate to the workplace and are not adequately recognized and reported. Therefore, the Bureau of Labor Statistics cautions that long-term latent illnesses are understated in the survey's illness measures.

Personal protective equipment (PPE) designed to substantially reduce the risks associated with many hazardous farm activities is widely available. Currently the Worker Protection Standard (WPS) mandates the use of specific PPE when mixing, handling, or applying specifically labeled chemicals. In addition, farmers employing eleven or more workers are required to provide PPE, decontamination stations, and training to help reduce the risk of worker pesticide exposure [USEPA, 1993]. The labor statistics cited above may be interpreted to indicate that among larger farm operations, where safety measures are more likely to be enforced by farm managers and outside regulators, recommended protective practices may be having a positive effect.

On small farms, where safety measures must be practiced on a much more personally motivated level, data are unavailable. For most situations, the decision to use PPE is based upon knowledge, attitudes, and beliefs about health protection rather than "company policy."

We sought to implement a survey to determine PPE usage in a variety of farm activities in a large sample of farms in five Midwestern states. The Minnesota Agricultural Statistics Service (MASS) office in St. Paul, on behalf of other state statistical offices in Federal Health Region V, collaborated with the National Farm Medicine Center (NFMC) in Marshfield, Wisconsin, on this survey. The states in Federal Health Region V are Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin.

Specific farm activities whose associated risks would be reduced by usage of a variety of widely recommended and readily available PPE were targeted. These activities included working under the sun, working with or around noisy equipment, working with chain saws, welding, metal work, handling large animals, working in animal confinement housing, working with hay, grain, feed, and/or silage, entering or repairing enclosed manure storage facilities, and mixing and/or applying agricultural chemicals. In addition, we sought to determine how farmers use and store PPE, where they buy or prefer to buy PPE, where they go or prefer to go for education, training, and fitting of PPE, and what factors influence the personal decision to use PPE.

The purpose of the present report is to present summary statistics of the survey responses. This provides an overview

of general safety behavior on a cross-section of Midwestern farms.

METHODS

Recruitment

The MASS maintains updated list sampling frames of farm operations in the Midwest region. For the current study, the sample was selected from those who had responded to the annual end-of-season acreage and production survey. Each state conducts a similar survey at the end of the growing season.

To increase the probability that only active farming operations were considered, the sample was selected from these annual acreage and production survey respondents. Inactive farming operations were also removed by only selecting operations reporting at least one of 11 commodities: corn, soybeans, winter wheat, spring wheat, dry beans, alfalfa hay, other hay, cattle, hogs, milk cows, or chickens. To reduce operator inconvenience, the sample excluded operations that had been previously selected in the National Institute for Occupational Safety and Health (NIOSH) health survey, agricultural statistics quarterly surveys, and farm cost and return surveys.

The sample for each state was selected independently of other states from the remaining eligible farms, after listing them in order from large to small on an "all land" basis. A systematic random sample was selected by sampling farms from largest to smallest at an interval computed to give the target number of farms with representation of all sizes of farming operations. The planned sample of 2,500 farms was distributed across the six participating states in proportion to the estimated total numbers of farms in the respective states.

Each state office reviewed the sample for their state and had the opportunity to remove samples based on prior knowledge of the respondents in order to reduce respondent burden. The final sample included 2,483 farms (Tables I and II).

Mailing

A modified Dillman mail survey technique was used [Salant and Dillman, 1994]. The first mailing included a personalized cover letter from the principal investigator cosigned by the state statistician for the respective state, a questionnaire, and a business reply envelope to the MASS office. A second mailing was made to operators not responding to the first mailing. The mailing included a second cover letter, a questionnaire, and a business reply envelope. As an enticement, the name of each respondent completing a questionnaire was entered into a drawing for a \$100 gift certificate (one per state). Those receiving the gift certificates were selected at random from the survey respondents and

TABLE I. Sample Distribution and Eligibility for Data Collection by State

State	Total number of 1994 farms	Percent distribution	Proposed sample ^a	Eligible for data collection ^b
Illinois	77,000	18.0	450	450
Indiana	63,000	15.0	375	368
Michigan	52,000	12.0	300	297
Minnesota	85,000	20.0	500	500
Ohio	75,000	17.0	425	419
Wisconsin	78,000	18.0	450	449
Total	430,000	100.0	2,500	2,483

^aAfter MASS exclusions due to participation in other recent studies, listing on an all land basis, and weighting and determination of sampling intervals according to percent distributions by state.

^bAfter state-determined exclusions on the basis of prior knowledge of the respondent to reduce respondent burden.

contacted for permission to publish their name as a gift certificate winner.

Telephone Follow-Up

All non-respondents were selected for telephone follow-up. MASS in St. Paul conducted all telephone calling for this survey. Telephone interviews began after training by the study director. Interviewers completed training sessions with each other prior to beginning interviews with non-respondents from the sample. Each respondent selected for the phone follow-up sample was attempted five times on different days before being designated as an inaccessible respondent.

Data Entry

MASS converted data from paper questionnaires to machine-readable media. Summary response data were

provided to NFMCC on 3.5" diskettes. Names and addresses are confidential and were removed from the data.

RESULTS

Response Rates

Of the 2,483 farms sampled, a total of 1,493 (60.1%) respondents completed the survey (Fig. 1), by mail (1,168) or by phone (325). The first mailing resulted in a 24.3% response rate. Of those receiving a second mailing, the response rate was 34.2%. Of those not responding to the mailings, but successfully contacted by phone, the response rate was 38.0%.

For the six states total there were 376 non-respondents that could not be reached by phone (75% not available/not at home/no answer; 18% wrong phone number/no number available; 7% phone not in service/phone disconnected). This represents 15.1% of the total sample of 2,483 farm operators.

Of the farm owner/operators who were no longer farming or refused to participate in the survey ($n = 535$), a variety of reasons were given. Many associated PPE with pesticide handling only, and because chemicals on their farms are custom applied, they felt that questions of PPE usage were inapplicable. Several felt that they were careful enough in their practices, used "common sense," felt no need to do anything to improve their safety behavior or education, and were therefore not interested in participating in the survey. Some operators reported that they worked long hours and had no time to participate in surveys. Several cited the inconvenience and discomfort of using some PPE, especially, in hot conditions. A number felt those inquiries about and/or regulations requiring PPE usage represented unreasonable interference by the government and wanted no part of the survey.

TABLE II. Response Rates by State

State	Sample	Refused, not farming, not reachable by phone, or missing data	Completed	Response (%)
Illinois	450	206	244	54.2
Indiana	368	133	235	63.9
Michigan	297	157	140	47.1
Minnesota	500	183	317	63.4
Ohio	419	153	266	63.5
Wisconsin	449	158	291	64.8
Total	2,483	990	1,493	60.1

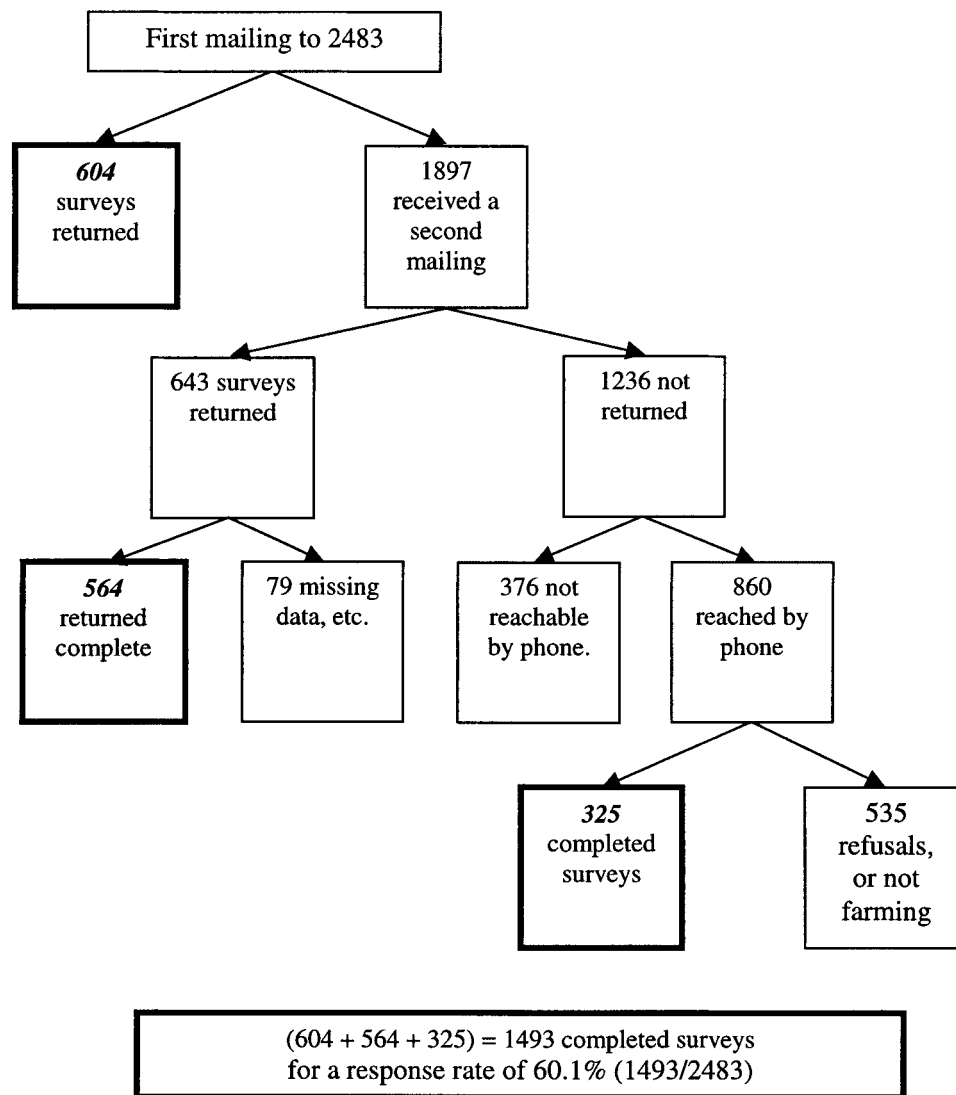


FIGURE 1. Flow chart showing questionnaire response; 1,493 (604 + 564 + 325) subjects completed the questionnaire.

Farm Demographics

A total of 1,493 farms were represented in this survey. Table III presents some characteristics of these farms. Most farms were cash grain farms (35.5%), followed by dairy (20.4%), beef (17.5%), and hog (4.2%) operations.

Roughly 77% of the respondents were sole owners of their farms. Another 11% were in partnerships, while others rented (6%), or had other arrangements (6%) with the owners.

Hours worked per week on the farm were spread quite evenly from 1 to 80 hr. Ninety percent of the respondents were between 35 and 65 years of age; 97% were male and 88% were married.

The owner/operators were asked, in addition to themselves, how many workers (including family members) they

assumed safety responsibility for on the farm. A large number of farmers (42%) felt responsible only for themselves. Another 48% assumed responsibility for one to three additional laborers. Only 11% of the sample reported hiring four or more workers for whom they assumed safety responsibility.

When asked whether they wore any type of PPE for farm work currently as compared to 5 years ago, 56% responded that their usage was about the same, and 40% reported more frequent usage. A few (4%) actually reported that their usage had gone down over the last 5 years.

Farmer Health and Grooming

Certain grooming and health habits can affect the use or fit of PPE. For instance, wearing a beard and/or mustache will

TABLE III. Farmer and Farm Demographics of Survey Respondents

	Number	Percent
Relationship to farm		
Sole owner	1,122	76.6
Partner	168	11.5
Rent	88	6.0
Other	86	5.9
Age (years)		
< 18	1	0.1
18–24	10	0.7
25–34	114	7.9
35–44	345	23.9
45–54	348	24.1
55–64	320	22.1
65–69	157	10.9
> 70	150	10.4
Gender		
Male	1,417	96.7
Female	49	3.3
Marital status		
Married	1,281	87.7
Never married	98	6.7
Divorced	42	2.9
Separated	1	0.1
Widowed	35	2.4
Hours of farm work/week		
1–10	149	11.3
11–20	177	13.5
21–30	162	12.3
31–40	183	13.9
41–50	159	12.1
51–60	192	14.6
61–70	147	11.2
71–80	145	11.0
Additional workers on farm		
None	601	41.8
1–3	679	47.2
4–10	152	10.6
≥ 11	5	0.3
Primary Ag enterprise		
Cash grain	515	35.5
Dairy	296	20.4
Other	284	19.6
Beef	254	17.5
Swine	61	4.2
Vegetable	24	1.7
Fruit	12	0.8
Poultry	5	0.3
Use of PPE now vs. 5 years ago		
Less often	54	3.7
About the same	807	56.0
More often	581	40.3

cause the seal around a chemical facemask to leak. Chewing and smoking tobacco while working make the use of even dust masks bothersome. Table IV presents the responses to health and grooming questions. One quarter of the farmers wore a mustache and 10% wore full beards. Tobacco usage was relatively low: 14% smoked, 10% chewed. Half wore glasses all the time. Only 3% wore contact lenses. Four percent use hearing aids, yet 29% reported definite hearing loss and an additional 15% suspected that they might have some loss of hearing.

Sun exposure can be a serious problem for farmers. Nearly 6% reported having had skin cancer, and 18% said that they have skin that burns easily. Seventeen percent reported problems with hips and knees, and almost 10% had difficulty walking. Breathing problems were reported by 8% of farmers and chronic health conditions by 10%. When asked whether their skin was sensitive to contact with chemicals and other materials, 11% reported definite sensitivity and another 11% suspected such sensitivity.

Sun Exposure

Participants were questioned on their usage of sunblock/sunscreen, wide-brimmed hat or cap with a wide bill and back flap, long-sleeved shirt, gloves, and sunglasses (Fig. 2). Regular sunscreen usage was very low, while the use of wide-brimmed hats and sunglasses was more prevalent. More responded that they use long-sleeved shirts and gloves. Many rarely or never used any of these protective measures to sun exposure.

Noise

When asked if they work in situations where there is so much noise that they need to shout in order to be heard, 61% of the farmers said yes: 21% did so once a day, 33% did once a week, 22% once a month, and 24% less than once a month. Even so, usage of earmuffs or earplugs was very low (Fig. 3). Those reporting never or rarely using ear protection in the form of earmuffs were 78% and in the form of earplugs were 72%.

Chain Saws

Chain saw usage was common on farms. Eighty-five percent used them: 92% once a month or less; 8% once a week or more. Those who used chain saws were asked if and how often they used goggles or safety glasses, shin/leg protectors, heavy gloves, hard hats, steel-toed footwear, and chaps. Of these, the most frequently used were goggles, heavy gloves, and steel-toed boots. But many never or rarely used these or any of the other protective equipment (Fig. 4).

TABLE IV. Farmer (n = 150) Health and Hygiene

	Not sure	No	Yes	Percent yes
Wear beard		1,283	148	10.3
Wear mustache		1,068	367	25.6
Use hearing aid		1,370	63	4.4
Wear glasses		724	720	49.9
Wear contact lenses		1,391	44	3.1
Wear prosthetic hand/arm		1,430	4	0.3
Wear prosthetic foot/leg		1,431	5	0.3
Chew tobacco		1,300	136	9.5
Smoke		1,235	202	14.0
Hearing loss	220	806	419	29.0
Breathing problems	52	1,267	117	8.1
Vision impairment	41	925	470	32.7
Difficulty walking		1,281	135	9.4
Previous skin cancer	22	1,331	82	5.7
Skin that sunburns easily	32	1,154	255	17.7
Sensitive skin (to chemicals, etc.)	163	1,119	153	10.7
Chronic health condition	39	1,262	139	9.7
Problems with hips/knees	41	1,152	250	17.3

Welding

Use of welding equipment was very widespread. Seventy percent welded: 2% daily, 32% weekly, 38% monthly, and 29% less than monthly. Face shields/welding masks were almost universally used. Protective gloves and safety glasses/goggles were frequently used. Steel-toed footwear and a welder’s apron were rarely used.

Metal Work

Eighty percent of the farmers regularly performed metal work (cutting, grinding, and/or pounding) with a frequency almost identical to that of welding. Many wore safety glasses/goggles and/or face shields along with heavy gloves while metal working. Again, the use of steel-toed footwear was rare.

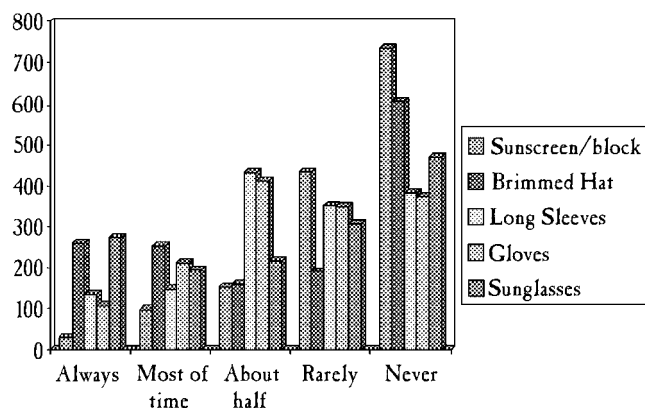


FIGURE 2. PPE usage related to sun exposure.

Handling Large Farm Animals

Sixty-eight percent of farm workers handled large farm animals (e.g., cattle, horses, swine, etc.) in barns and yards, a vast majority of them on a daily basis. Use of dust/mist masks and safety glasses and goggles was rare. Use of steel-toed footwear and heavy gloves was only slightly more common. Most farm workers never utilized any PPE while handling their livestock.

Handling Animals in Confinement Housing

About 32% of farm workers worked in animal confinement housing, most (75%) on a daily basis. Again, usage of

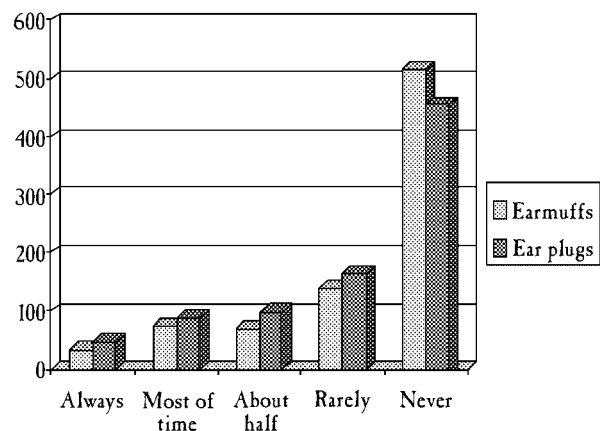


FIGURE 3. PPE usage in noisy situations.

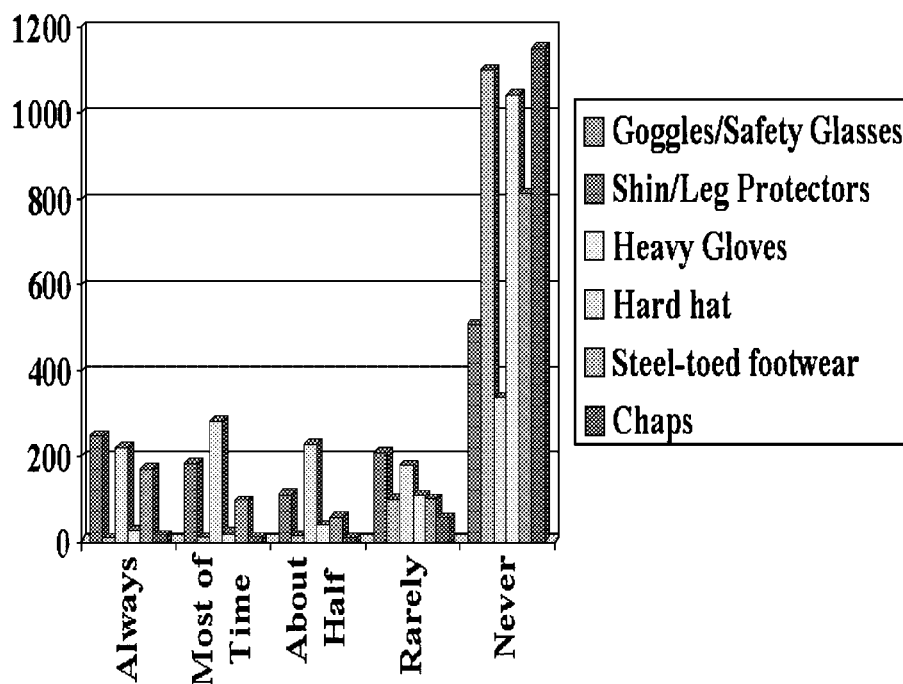


FIGURE 4. PPE usage while operating a chain saw.

any PPE during this work was very uncommon, with occasional use of heavy gloves being the most likely. Fewer than 3% of those working in these situations reported wearing any respiratory protection most or all of the time.

Handling Feed

Most farmers (83%) handled grain, hay, and feed, or emptied silos: 48% daily, 21% weekly, 15% monthly, and 16% less than monthly. Usage of PPE during these activities was low, with the usage of heavy gloves and nuisance dust masks the most frequent.

Working in Manure Storage Facilities

Only 2.6% of farm workers ever entered or repaired enclosed manure storage facilities (e.g., below ground pits or “slurry stores”), and those who did, did so infrequently. Of these, 15% used the recommended self-contained breathing apparatus half or most of the time, while the remainder rarely or never did so.

Mixing or Applying Agricultural Chemicals

Just over half of the farmers (53%) mixed or applied agricultural chemicals themselves. Most did not do this very often though: 67% less than monthly, 22% monthly, 10% weekly, 2% daily. Most reported the availability of fresh water for washing and eyewash, but few had decontamination

kits in the work area. Use of chemical resistant gloves was fairly regular. The use of other types of PPE was rare (i.e., nuisance dust masks, dust/mist masks, dust/mist/fume masks, face shields, chemical coveralls or aprons, and chemical protective footwear).

In summary, the percentage of farm workers participating in the queried activities in rank order is as follows: chain saw use (85%); hay, grain, feed, and silage handling (83%); metal work (80%); welding (70%); large animal handling (68%); working in noisy situations (61%); mixing and applying agricultural chemicals (53%); working in animal confinement housing (32%); and entering or repairing enclosed manure storage pits (2.6%).

The next part of the survey addressed general issues regarding PPE usage, storage, purchase, and instruction.

Factors Influencing Personal Decisions to Use PPE

Two factors stood out as being major influences in a farmer’s decision whether or not to use PPE: a personal desire to avoid injury and exposure, and current personal health problems (Fig. 5). In these cases, a strong influence was given as a response more often than some or no influence. Factors of ‘ease and comfort of use,’ as well as ‘spousal influence,’ approached ‘current health problems’ as having ‘strong influence’ responses, but were more often cited as having ‘some influence.’ Other factors reported to have some influence included time required, cost, convenience of storage location, warning stickers/labels, government

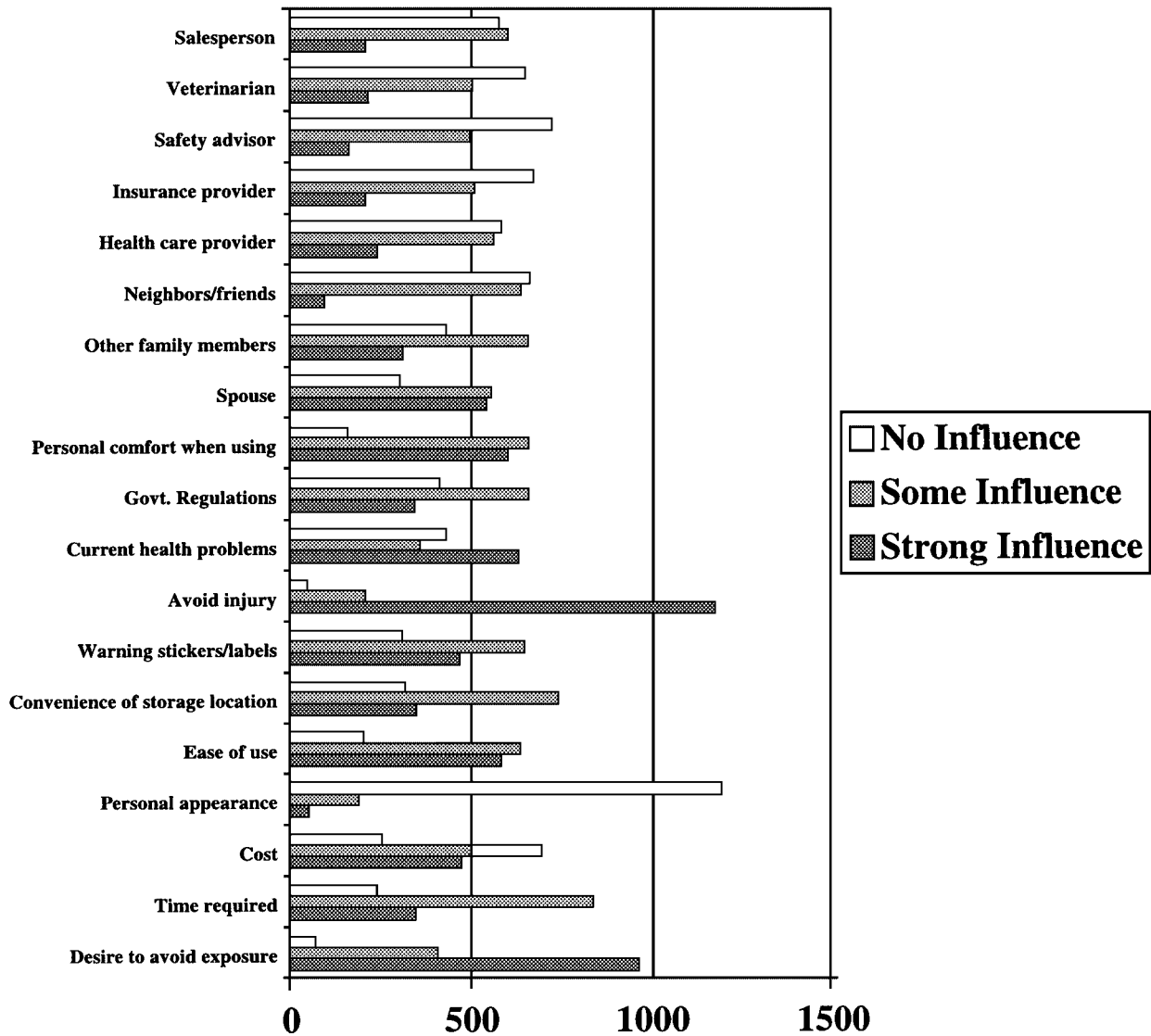


FIGURE 5. Factors influencing the decision whether or not to use PPE.

regulations, and the concerns of other family members. Neighbors/friends, health care providers, insurance providers, safety advisors, veterinarians, and salespersons exerted less influence. Many (~75%) stated that concerns about their personal appearance while wearing PPE had no influence at all on their decision.

PPE Acquisition

Farm workers were asked where they had purchased their PPE within the past year, and where they would prefer to buy it. The top three actual sources matched the top three preferences: local hardware or building supply stores, farm cooperative stores, and chemical suppliers. Mail order catalogs, grain elevators, and implement dealers were likely alternative choices. Less important were supply/

equipment route dealers, auto parts supply stores, medical clinics, pharmacies, farm fuel suppliers, local safety councils, public health agencies, agricultural trade association meetings, and agricultural extension offices or meetings. In general, preferences paralleled current purchasing patterns.

PPE Storage

When asked where specific items of PPE were stored on their farms, the workshop, home, garage, and farm vehicle were most commonly cited. The one exception to this was dust/mist masks and dust/mist/fume masks that were stored in chemical storage areas. Some stored sunblock, chemical handling gloves, safety goggles, and ear protection in storage containers on equipment.

PPE Training

Only 27% of the respondents had received formal training in the use of PPE. Of these, most had received instruction through their agricultural extension office or chemical supplier. By far, most would prefer to get their training from the extension office, followed by their chemical supplier and farm cooperative store. If offered a choice, the mode of instruction preferred would be (1) educational videotape, (2) one-on-one personal demonstration, (3) printed instruction, or (4) classroom lecture/demonstration, all being almost equally viable alternatives. The one method offered as a choice that was not popular was training via farm data networks over the internet via personal computer.

DISCUSSION

The sample surveyed is a good representation of Midwestern farms. Ninety percent were small farms employing three or fewer laborers. Thus, while WPS and OSHA agricultural work standards are associated primarily with large agricultural operations, there remains a great need to assure that those working on small farms are adequately protected as well.

Despite the ready availability of sunscreens and widespread warnings, skin cancers are on the rise in the US. According to the American Cancer Society, approximately 1.3 million new cases of highly curable basal cell or squamous cell skin cancers arise every year [American Cancer Society, 2000]. Since the early 1970s, the incidence rate of melanoma has increased significantly on average of 4% per year, with projections of about 47,700 persons to be diagnosed in 2000 resulting in 7,700 deaths. Agricultural workers are prime candidates for skin cancer because they are outdoors and exposed to the sun on a daily basis. While 6% of the respondents reported already having had skin cancer, and 18% reported having skin that burns easily, the use of protective measures on a regular basis was low.

A study of Midwestern farmers found that, in general, farmers are knowledgeable about skin cancer, feel they are susceptible, realize it is a serious disease and that protective actions are beneficial, but they still do not practice sun protection [Marlenga, 1995]. Nonetheless, efforts to provide screening and educational programs in hopes of improving farm family skin cancer protection continue [Rosenman et al., 1995; Marlenga and Lee, 1996; Mullan et al., 1996].

Noise-related hearing loss ranks among the top occupational hazards listed by NIOSH [1998]. Agricultural workers experience one of the highest rates of hearing loss [Plakke and Dare, 1992; Brackbill et al., 1994; Knobloch and Broste, 1998]. Tractors, combines, choppers, grain dryers, and chain saws all produce excessive noise. Studies have shown that farmers and other agricultural workers may experience substantial hearing loss as early as in high school [Broste et al., 1989] or by the age of 30 [Lupescu et al., 1999; Oskam

and Mitchell, Oklahoma Cooperative Extension Service Bulletin F-1722]. A tractor under load generates about 100 dB of sound. By comparison, a jackhammer generates 120 dB. The upper limit to exposure to 100 dB recommended by the Ontario Industrial Safety Act 1971 is a 2-hr exposure period over any 24-hr interval [Farm Safety Association, 1985]. Earmuffs or earplugs are recommended in any noisy work environment. Very few respondents in this survey regularly used either.

Chain saws were used on nearly every farm. In Tennessee, chain saws and falling trees cause about 20% of the agricultural deaths. About eight people are killed every year, and hundreds of others suffer severe injuries [Lown and Prather, 1993]. The U.S. Consumer Products Safety Commission reported 37,000 chain saw related accidents in 1989 [Elvex, 1999]. The body areas injured were: head (3,091), upper body (1,735), hand (14,381), leg area (15,253), and foot (2,817). According to one insurance underwriter, the average chain saw injury requires 110 stitches. Vibration syndromes associated with chain saw use include "vibration-induced white finger" and is associated with peripheral nerve damage and circulatory disturbances [Futatsuka and Sakurai, 1986; Hirata et al., 1999]. All chain saw manufacturers recommend the use of goggles, safety glasses or face shields, shin/leg protectors or chaps, hard hats, steel-toed footwear, and heavy gloves while using chain saws. In our survey, goggles, steel-toed boots, and heavy gloves were the most commonly used, but a majority rarely, if ever, used any PPE.

Welding and metal work in the repair and maintenance of farm implements was used by 70–80% of farmers. The PPE recommended for welding includes fire-resistant gauntlet gloves, aprons, overalls, leggings and boots, welding helmets, respirators, ultraviolet radiation filter plates for arc welding, and goggles with filter lenses. Welding generates noxious fumes and gases depending on the welding process, base material, and filler material [Cyr and Johnson, 1995]. This is particularly true when welding galvanized metal. Metal particulates of small diameter can penetrate deep into the lung, and fumes can cause eye irritation, dizziness, nausea, and "metal fume fever" [Legault and Ayers, 1993; Kuschner et al., 1998; Fuortes and Schenck, 2000; Kelleher et al., 2000]. In our survey, the use of face shields or welding masks was almost universal. Protective gloves and goggles were commonly used, but the use of steel-toed footwear or welder's aprons was rare.

Injuries are often caused in the handling of large farm animals. Conditions both outside and inside are often dusty and warrant the use of goggles and dust/mist masks. Use of steel-toed boots and heavy gloves can help avoid traumatic injuries and rope burns. In our survey, 68% of the farmers handled large farm animals in barns and yards on a daily basis. Use of any PPE in these activities was rare.

Animal confinement housing presents additional risks. Indoor atmospheres in swine or poultry confinement

buildings and horse stalls contain gases, dusts, and endotoxin in concentrations significantly in excess of those in outdoor environments [Pickrell, 1991; Pickrell et al., 1993; Zejda et al., 1994; McGorum et al., 1998]. Workers in these areas are potentially exposed to large amounts of gram-negative bacterial endotoxins [Thedell et al., 1980; Simpson et al., 1999]. Airborne endotoxin concentrations in dairy, swine, and poultry units have been measured in the range where clinical effects occur [Clark et al., 1983; Pickrell et al., 1995; Kullman et al., 1998; Simpson et al., 1999]. In our survey, 32% of the farm workers worked in animal confinement housing. Use of nuisance dust masks, dust/mist masks, powered air purifying respirators, safety goggles, heavy gloves, and steel-toed footwear was rare.

Handling hay, grain, and silage is a major cause of chronic illness in agricultural workers [Penn State, 1992; Bharadwaj et al., 1999; Kirkhorn and Garry, 2000]. Entering confined areas such as silos, grain bins, or any inadequately ventilated building can put a farmer at risk of being overcome by silo gases or dusts which can cause permanent lung damage or death [Douglas et al., 1989; Zwemer et al., 1992; Pavelchak et al., 1999]. Shoveling or grinding grain, or cleaning out grain storage structures can also expose farmers to bacterial and fungal spores and byproducts. Respiratory reactions include hypersensitivity pneumonitis ("farmer's lung"), toxic organic dust syndrome (TODS) similar to that caused by inhalation of grain dusts ("grain fever"), and confinement house dusts, chronic bronchitis, acute bronchitis, asthma, and irritation of the nose and sinuses [Manfreda et al., 1986; Cormier et al., 1993; Lacasse et al., 1997; Simpson et al., 1998; Bharadwaj et al., 1999; Melenka et al., 1999; von Essen et al., 1999; Kirkhorn and Garry, 2000; Schuyler et al., 2000]. Use of nuisance dust masks, dust/mist masks, powered air-purifying respirators, safety goggles, steel-toed footwear, and heavy gloves are all recommended for this work. In our survey, none of these items were regularly used by a majority of farmers during this type of work.

Only 2.6% of the farmers ever entered or repaired underground manure storage facilities. Yet this activity is so dangerous that it warrants special consideration. Manure pit systems are used primarily in livestock barns (especially dairy and swine operations). The oxygen-deficient, toxic, and/or explosive atmosphere, which can develop in a manure pit, has claimed many lives. Frequently, manure pit incidents result in multiple fatalities, as persons attempting to rescue others become victims themselves. Only 15% of those working in manure pits reported using the mandatory self-contained breathing apparatus half or most of the time, while the remainder rarely or never did so.

The use of PPE is most commonly associated with the tasks of mixing and applying agricultural chemicals with requirements described in the WPS [Runyan, 1994]. Even so, usage of any of the recommended devices other than chemical resistant gloves was rare.

Motivations behind decisions of whether or not to follow safety behaviors have been the subject of numerous studies [von Essen and McCurdy, 1998; Hodne et al., 1999]. It has been suggested that farmers are almost always aware of the risks they take. They do not consider themselves careless. Rather, they believe that they take calculated risks [Green, 1999]. While many farmers work alone, they often work in a more safety-conscious manner when in the presence of children or spouses, wishing to protect them and set a good example [Lee et al., 1997; Green, 1999]. This intuitive decision-making process is complex and influenced by diverse factors, such as knowledge, convenience, habit, availability, monetary costs, perceived ability to control situations, perceived consequences, social factors, norms, intentions, facilitating conditions, etc. [Brown et al., 1983; Zindler-Wernet and Weiss, 1987; Kist-Kline and Lipnickey, 1989; Rosenstock, 1990; Triandis, 1991; Anspaugh et al., 1994; DeJoy, 1996; Geller, 1996; Herrick et al., 1997; Petrea, 2001].

CONCLUSIONS

This survey revealed that PPE usage on Midwestern farms is woefully inadequate and requires further attention. Survey questions indicated that farmers were satisfied with their current sources of PPE, and that most prefer to be informed and trained about PPE through their local agricultural extension offices.

Most importantly, however, was the fact that the primary motivating factor behind a personal decision to utilize PPE was a personal desire to avoid injury and exposure, or to allay current personal health problems. Outside influences played some, but not overriding roles. While recent surveys indicate that agricultural injury rates have been declining on larger farms [McCurdy and Carroll, 2000; National Safety Council, 2000], no national data exist on rates of chronic health problems that could be curtailed with PPE, such as hearing loss or pulmonary disease among farmers. Education, training, and PPE availability have dramatically improved over the generations, yet safety behavior lags behind. It remains a challenge to determine a way to motivate farmers and workers to improve their usage of PPE.

Limitations

The aim of this survey was descriptive with a view to an assessment of PPE usage practices at the time. In that the numbers of variables addressed in this survey are large, multivariate analyses and attempts to associate types of behavior with one another on an individual basis were not performed. No attempt was made to correlate PPE usage with injury or disease outcomes.

Our survey was performed in 1995–1996, and is a snapshot of practices at that time as influenced by existing economic factors, farm price support structures, standards of

practice of the day, levels of consumer information of the day, etc. As economic pressures, regulatory practices, and information levels change over time, it is possible that safety practices may be affected. However, except for the expanded implementation of the WPS for agricultural pesticides required since April 1994 [Runyan, 1994], no major regulatory changes have occurred since the time of data collection that would have had a powerful influence on behavior modification related to use of PPE.

The modified Dillman mail survey technique, combined with telephone surveys, resulted in a 60.1% response rate, which is considered good for survey research [Babbie, 1990]. However, the possibility remains that non-respondents may have exhibited different attitudes and practices than respondents.

As a self-report, there may be some inaccurate data submitted, such as people wanting to report socially desirable behaviors [Brink and Wood, 1990]. The survey is based solely on information from farmers; no unbiased outside observers were employed to monitor or verify usage practices.

Generalizability of the findings should be tempered by the fact that the sample is non-random. Rather, it is a convenience sample as fully described above. However, we feel that the large sample size allows an accurate reflection of most small to mid-size Midwest farm practices, and this sampling system is comparable to that used by the U.S. Department of Agriculture for various studies. Another limitation is that the survey did not solicit information on ethnicity or racial status, which may have allowed for more explicit detail in analyses. Yet, the vast majority of the total Midwest farm population is Caucasian.

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