

# Planning a Multilevel Intervention to Prevent Hearing Loss among Farmworkers and Managers: A Systematic Approach

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**ABSTRACT.** *Noise-induced hearing loss (NIHL) is the second most prevalent self-reported occupational illness or injury in the U.S., and agricultural workers experience high rates of hearing loss. This article uses Intervention Mapping (IM), a systematic approach to intervention development, to make recommendations for a program to improve hearing loss protection among farmworkers and managers. Final recommendations, based on previous work in the literature on hearing loss prevention, qualitative formative research, and theoretical considerations, include a specification of a multilevel theory- and evidence-based hearing protection program for farmworkers and farm managers. Twelve performance objectives (e.g., “monitor hearing and hearing loss with regular hearing testing”) are specified and crossed with six relevant determinants (knowledge and behavioral capability; perceived exposure and susceptibility and noise annoyance; outcome expectations; barriers; social influence; skills and self-efficacy) to create a highly detailed matrix of change objectives for farmworkers and for their managers. These change objectives are then grouped into five categories: two for both farmworkers and their managers (noticing exposures, taking action) and three only for the latter (surveying and planning, implementation and evaluation, and communication). Theoretical methods and practical strategies, including program materials and activities, are then delineated.*

**Keywords.** *Farmworkers, Health promotion, Hearing loss, Injury prevention, Intervention mapping, Noise, Occupational health, United States.*

Noise-induced hearing loss (NIHL) is the second most prevalent self-reported occupational illness or injury in the U.S., and agricultural workers experience high rates of hearing loss (Murray-Johnson et al., 2004; Plakke and Dare, 1992; Brackbill et al., 1994; Beckett et al., 2000). In a review of the literature on NIHL among individuals working on farms, we found that most studies focused on “farmers” and “farm operators.” For this article, we will refer to all individuals who have supervisory or management responsibilities on a farm (e.g., farm owner, farmer, farm operators, farm supervisors) as “farm managers.” These farm managers are responsible for activities such as the oversight of planting, harvesting, and disposition of crops; coordination of the care, feeding, and breeding of farm animals; preparation and

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Submitted for review in September 2007 as manuscript number JASH 7178; approved for publication by the Journal of Agricultural Safety and Health of ASABE in December 2008.

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maintenance of farm records; maintaining farm facilities, machinery, and equipment; and ensuring the safety and sanitary conditions of farm operations. Individuals who work on farms but do not have these supervisory roles will be referred to as “farmworkers.”

Frequent and continual exposure to noises greater than 85 decibels (dBA) is a leading cause of cumulative and irreversible hearing loss (NIDCD, 2007). Farmworkers and farm managers operate machinery and power tools that can subject them to excess noise exposure: farm tractor noise ranges between 90 and 100 dBA, chainsaws and snowmobiles emit sounds around 100 dBA, and activities involving animals, such as hog feeding, range from 95 to 110 dBA (McBride et al., 2003). In a population-based telephone interview study, the overall prevalence of hearing loss among farm managers was 34.3% and was surpassed only by musculoskeletal pain or discomfort, which was 56.4% (Alterman et al., 2008). Symptoms among farm managers were deafness in one or both ears; permanent, ongoing, or intermittent ringing in the ears (tinnitus); and trouble hearing. The weighted population prevalence of hearing loss among farm operators and managers from the National Health Interview Survey (NHIS) (1997-2003) was 22% (Tak and Calvert, 2008). In a study of 1,622 New York farmers interviewed for hearing loss and noise exposure, 22% self-reported hearing loss (Hwang et al., 2001), and those who were exposed to high noise levels from farm equipment and livestock and those who experienced high noise-level exposures from previous occupations were at higher risk for hearing loss. Age and gender were also significant predictors of hearing loss, with older and male farmers more likely to have experienced hearing loss. A recent study reported that among Hispanic migrant farmworkers more than 50% had some degree of hearing loss and more than 35% reported difficulty hearing or understanding speech, and the authors suggested that language barriers could worsen the impact of hearing loss (Rabinowitz et al., 2005).

Although NIHL represents a significant risk among farm managers and workers, use of hearing protection to reduce that risk is low. In a study assessing personal protective equipment use among Midwestern farmers, researchers found that although 61% reported that they worked in situations where there was so much noise they had to shout to be heard, the majority (72% to 78%) rarely or never used hearing protection (Carpenter et al., 2002). Another study with 167 Midwestern farmers noted that the majority of study participants (56%) did not use hearing protection devices (HPDs), and those who did used them only 17% of the time they were exposed to high levels of noise (McCullagh et al., 2002). A study of farmers in California found that among 1,401 farmers who spent at least 5% of their time around loud noise, only 22% said they used HPDs more than half the time when working under those conditions, and 56.3% said they rarely or never used hearing protection (Schenker et al., 2002). In a study of 761 farm operators and their spouses conducted in an eight-county area in northeastern Colorado, over 65% fell in the “high risk” category, defined as sometimes, rarely, or never using hearing protection when engaged in noisy farm operations (Stallones and Beseler, 2004). Rabinowitz et al. (2005) found that while exposure to noise was common among Hispanic farmworkers, reported use of hearing protection was rare; only 14% responded affirmatively to the question “Do you use hearing protection?”

There have been few studies that assess the effectiveness of interventions to increase safety behavior among farm managers and farmworkers (Vela Acosta et al., 2005; Reed et al., 2004), and only one focused specifically on hearing protection use:

Knobloch and Broste (1998) reported effects on hearing protection behaviors among students exposed to a hearing loss prevention curriculum in high school agriculture classes. A few theory- and evidence-informed interventions to reduce exposure to noise using individual hearing protection have been tested in other industries (Lusk et al., 1999; Lusk et al., 2003; Lusk et al., 2004; Stephenson et al., 2005) and may contribute to planning interventions for the farm.

The purpose of this article is to summarize previous work on interventions to prevent hearing loss and to extend the work with a systematic approach to intervention development to improve protection from hearing loss of farmworkers and farm managers. The approach includes a theoretical framework, which Kristensen (2005) has suggested is an important aspect of improving occupational intervention approaches and evaluation studies.

## **Methods**

### **Planning Framework**

We used the Intervention Mapping (IM) framework (Bartholomew et al., 2006; Bartholomew et al., 1998) to plan a multilevel hearing protection program for farmworkers and farm managers. This systematic process for health promotion program planning has been used to guide the development of many programs, including asthma management (Bartholomew et al., 2000a; Shegog et al., 2001; Bartholomew et al., 2000b), nutrition (Brug et al., 2005; Hoelscher et al., 2002; Perez-Rodrigo et al., 2005; Cullen et al., 1998; Cullen et al., 1997), sun protection (Tripp et al., 2000), adolescent risk-taking (Tortolero et al., 2005), violence (Murray et al., 1998; Murray et al., 1999; Stevens et al., 2002), and HIV prevention (van Empelen et al., 2003; van Kesteren et al., 2006). The process has also been used to develop and implement an intervention to increase breast and cervical cancer screening in Hispanic farmworker communities (Fernandez et al., 2005). Brosseau and colleagues (2007) describe the usefulness of the framework in developing a safety program in small fabrication plants that targeted the behaviors and determinants of both workers and managers.

### **Needs Assessment**

The first step of the IM process was a needs assessment that included a literature review and focus groups with the target population. In the literature review, we sought to know what tends to promote hearing-protective behaviors, what tends to hinder them (barriers), what factors are associated with the behaviors, and what is known about interventions designed to increase them. Because there is little available research specific to hearing loss among farmworkers and managers, we included studies of other safety behaviors in farmers and of hearing protection in non-farming industries. We then conducted focus groups with the target population. The results of the needs assessment were the basis of a risk model of factors associated with hearing loss among farmworkers and managers; this risk factor model then served as the foundation for the intervention recommendations.

### ***Priority Population for Intervention***

The priority population comprises both farm managers and farmworkers. According to the USDA (Allen and Ginger, 2005), the 3 million farm managers (operators) in the U.S. are largely older (average age 53 years) white males: only 3% are non-

Hispanic minorities and roughly 51,000 self-identify as Spanish, Hispanic, or Latino; 238,000 are female. On the other hand, findings from the National Agricultural Workers Survey (NAWS) 2005-2006 indicate that crop workers are largely foreign-born: 74% were born in Mexico and 4% elsewhere outside the U.S. (Overall, 84% of crop workers identify themselves as Hispanic or Latino). While 42% of all crop workers are migrants (who travel at least 75 miles during a 12-month period to obtain a farm job), they nonetheless seem to have stable work histories: 90% of all crop workers, including foreign-born newcomers, reported having worked for only one or two U.S. farm employers in the previous 12 months. This perhaps reflects the fact that 86% were employed directly by growers and packing firms; only 14% were employed by farm labor contractors. Farm work is their principal occupation: excluding foreign-born newcomers (who had less than a 12-month work history in the U.S.), workers averaged 38 weeks of farm work and 3 weeks of non-farm work in the previous year (U.S. Department of Labor, forthcoming). Overall, based on the physical demands of the work and their usual status as foreign-born immigrants, farmworkers are likely to be younger, unaware of U.S. laws intended to protect their health, and have low English-language literacy skills (U.S. Department of Labor, forthcoming).

### ***Factors Related to Farmworker and Farm Manager Behavior***

In a study among farmers in Missouri, Wadud et al. (1998) reported a perception of hearing problems as preventable, a concern about hearing problems, and that perceived barriers influenced the use of HPDs. Farmers in Midwestern states (Carpenter et al., 2002) indicated that the primary influences on a decision to use HPDs were a desire to avoid injury, exposure to noise, a current personal health problem, and barriers such as cost, inconvenience, and time constraints. Schenker et al. (2002) reported that over 56% of California farmers exposed to noise during their workday reported rarely or never using hearing protection; younger age and male sex were associated with better hearing protection behavior. Among those who did use hearing protection, concern about hearing loss was the strongest predictor.

External factors influencing hearing protection behavior among farmers included spousal influence, warning labels or stickers, government regulations, and concerns of family members, friends, and healthcare providers (Carpenter et al., 2002). Another study (McCullagh et al., 2002) found that interpersonal influences, barriers, and situational influences were associated with HPD use. While situational factors and barriers also influence HPD use among factory and construction workers (Lusk et al., 1997), interpersonal support was the factor most strongly related to HPD use among farmers. McCullagh et al. (2002) hypothesize that unlike construction workers, who are in proximity to others and may be influenced by modeling, farmers often work in relative isolation and are more heavily influenced by support of family or other farmers (outside of work). Kerr et al. (2002) also found that social norms, social models, and interpersonal support influence Mexican-American workers' expressed self-efficacy ("I can do it, and do it right") for protective behaviors. Another external factor that may be related to protection is noise exposure patterns, with intermittent exposure related to less protection. A study conducted among women working on family-operated farms found that those working 20 or fewer hours a week were significantly less likely to use HPDs than women who worked more than 20 hours per week (Meeker et al., 2002).

### ***Factors Related to Behavior of Non-Farmworkers***

Personal factors related to hearing protection among factory, construction, and manufacturing workers include perceived risk of hearing loss, perceived severity of loss, perceived effectiveness or value of protection (i.e., benefits), barriers to protection, self-efficacy, perceived health, and situational factors (Rabinowitz et al., 1996; Lusk, 1994; Lusk et al., 1997; Lusk et al., 1999; Hong et al., 2005; Kerr et al., 2002; Murray-Johnson et al., 2004). A study of metal shop workers conducted by Lusk and Kelemen (1993) found workers' use of HPDs was significantly associated with their perceptions of the value of keeping noises out including increased feelings of well being, and stress management. In another study, Lusk et al. (1997) reported that self-efficacy and barriers were predictors of HPD use in both men and women. Among men, the perceived value of use was also a significant predictor, while for women, being Hispanic or non-white was negatively associated with both self-efficacy and use. In a subsequent study, Lusk et al. (1999) identified as predictors of HPD use perceived noise exposure, self-efficacy, value of use, and barriers to use. Patel et al. (2001) identified barriers to use of HPDs among coal miners. The primary concern was that HPDs would make it harder to hear; miners would thereby feel isolated from their teams, unable to notice changes in machinery noise (often an early-warning sign of mechanical trouble), and, perhaps catastrophically, unable to hear "roof talk" (the sounds emanating from a mine under stress and possibly about to collapse). The researchers noted that these concerns of impaired hearing were never expressed by those who had actual experience with using hearing protection. Miners also cited low perceived social norms for HPD use. In another study of coal miners, Murray-Johnson et al. (2004) described such barriers as cost, hygiene of HPDs, comfort concerns, and the miners' pessimism about their own ability to change their behavior after years of not wearing HPDs.

External factors include no modeling by others of HPD use (Lusk et al., 1999) and noise exposure; workers who experience lower noise levels or intermittent noise are also less likely to use protection (Hong et al., 2005).

### ***Summary of Focus Group Findings***

Three focus groups were conducted with a total of 26 Hispanic farmworkers in Missouri, as part of a study on safety behavior conducted by the National Center for Farmworker Health. Farmworkers were recruited for the groups via flyers posted in communities where many farmworkers lived. To assess current behavior as well as factors influencing the use of HPDs during farm work, participants were asked questions about safety concerns, hearing loss, hearing-protection behavior, and barriers to using protection. When asked a general question about what they did to stay healthy, no one mentioned the use of hearing protection. Instead they mentioned walking or exercising, eating well (fruits and vegetables), taking vitamins, and sleeping enough. When further questioned about what they did to stay healthy while working, they noted drinking water, avoiding injury (particularly when working with machines), protecting themselves from the sun, being careful not to fall, and using safety measures such as wearing gloves, masks, protective devices, and glasses.

All participants in all three groups said they were concerned about their health at work and mentioned muscle or bone pain, arthritis, fractures, cough, cold/flu, and fatigue as health problems they believed could result from work or exposures while at work. When asked specifically about short-term problems, they mentioned allergies,

eye irritation, asthma, problems or infections of the skin, dehydration, snake bites, and exposure to pesticides or other chemicals. Long-term health problems of concern were cancer, lung disease, and back problems. Participants in one of the focus groups also mentioned cysts and “granules in the head from the chemicals.” In only one of the focus groups did participants mention concerns about their ears when asked generally about long-term health problems. However, when questioned specifically about hearing, participants said that they do worry about their hearing and protecting their ears. Most acknowledged that their work could cause hearing loss, but some differentiated risk by the type of work, with specific mention of ginning. While some participants said that they did not feel at risk for hearing loss because they were not exposed to loud noise, others said that they did feel at risk and that they or people they knew were beginning to experience hearing problems as a result of exposure to noise at work. Participants generally agreed that it is important to protect your hearing, “otherwise you will go deaf.”

On further questioning, some participants reported protecting their ears, and several reported using ear plugs. Participants raised the following issues related to HPD use:

- The notion that they were only at risk when exposed to loud continuous noise (susceptibility).
- The misconception that cleaning the ears well, using ear drops, and wearing earplugs and caps could protect their hearing.
- No requirement by the farm manager or owner to use HPDs.
- The perception that the manager or owner would not pay for HPDs.
- The perception that HPDs are uncomfortable, that they “cause fungus in the ears,” “make your ears sweat,” “make your ears swell,” and hurt or cause itching.
- The belief that HPDs interfere with hearing.
- The perception that other farmworkers do not use protection (social norms).
- The belief that protection is not perfect and that some noises are “too loud (or strong).”

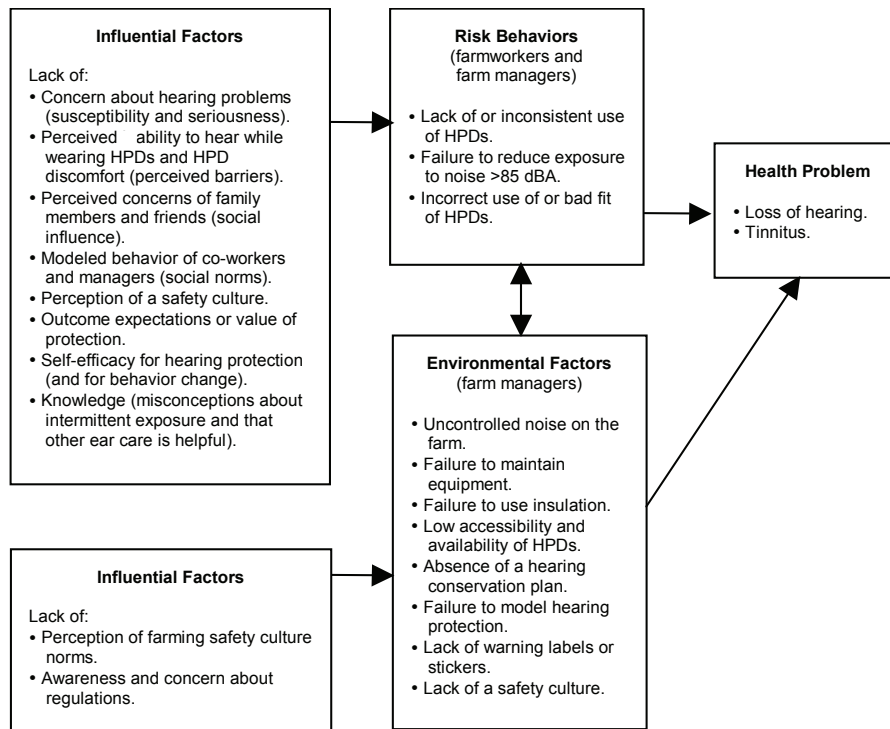
When asked what supervisors do to help them stay healthy, many participants said that they do little or nothing. Participants in one focus group, however, mentioned that supervisors give out pamphlets, including one with information on using ear plugs. Those same participants added that inspectors “check if you are using them,” and you “need to use them or you will be written up.” Most participants noted that information and equipment was provided only in the gin (not in the field or in other work areas).

### ***Risk Model***

The findings from the needs assessment were organized into a risk model (fig. 1) based on the approach of Green and Kreuter (2005) to health promotion planning, in which internal and external influences lead to risk behaviors and environmental factors. These, in turn, interact to create a health problem (in this case, NIHL or tinnitus).

### **Planning Matrix**

In the second step of Intervention Mapping, we worked from the risk model to develop a planning matrix (see table 1 in Appendix), making use of the results from the needs assessment. To summarize, the matrix crosses the behavioral performance objectives (left column) with their hypothesized determinants (top row) to generate spe-



**Figure 1. Risk model of factors related to hearing loss associated with farming.**

cific change objectives (cells), which are the immediate targets of the behavior change intervention. The matrix cells were constructed by asking, for each proposed determinant of each performance objective, “What would need to change [in the determinant (top row)] in order for a manager or worker to perform the behavior [in the left column]?”

### ***Performance Objectives***

We developed the performance objectives (what a participant should be expected to do after the intervention) by reviewing (1) the risk model, (2) suggested approaches in the literature to both personal protection and environmental change, and (3) the U.S. regulations and recommendations pertaining to hearing loss (OSHA, 1983; NIOSH, 1998). For those industries under OSHA regulations, when employees are exposed to excessive occupational sound levels, employers are required to implement reasonable administrative and engineering controls to reduce the sound levels. Should those controls fail, employers must provide hearing protection for each affected employee, exposed employees must be notified of the risk, and an effective hearing conservation program must be implemented. Employers are responsible for providing annual audiometric testing and for providing and monitoring HPDs. The employer must also implement a training program for all affected employees that gives the effects of noise on hearing; the purpose of HPDs; the advantages, disadvantages, and effectiveness of various types of HPDs; instructions on selection, fitting, use, and maintenance of

HPDs; and the purpose of audiometric testing and an explanation of the test procedures.

Leinster et al. (1994) suggested that management must be willing to take the lead in hearing protection efforts, assign clear roles, and become technically competent. They also note that it is important for leaders to provide workers with feedback and reinforcement for hearing protection because hearing loss is gradual and there are no immediate reinforcements for protection. Zohar and Luria (2003) also emphasize the importance of safety interactions between management and employees. These safety climate environmental aspects are reflected in the performance objectives (table 1 in Appendix).

The first section of the matrix (table 1 in Appendix) applies to personal hearing protection of both farmworkers and farm managers, and the second section depicts managerial activities related to planning and implementing hearing protection programs on the farm. Note that in the performance objectives there is an implied reciprocity between the hearing-protective behavior of people and the hearing safety environment created by their managers. The theoretical basis of the performance objectives is self-regulation, as used in health (Cameron et al., 2003; Clark et al., 1997; Clark and Zimmerman, 1990; Creer, 2000), psychology (Cleary and Zimmerman, 2004; Zimmerman, 2000), and education (Zimmerman, 1989; Schunk and Ertmer, 2000). “Self-regulation” here refers to an active, iterative process of setting a goal, choosing strategies, self-observation, making judgments based on those observations (rather than on habit, fear, or tradition), reacting appropriately in the light of one’s goal, and revising one’s strategy accordingly (Clark, 2003). Note also that some of the managerial performance and change objectives, particularly those pertaining to developing program materials and to audiometric testing, may be met by third parties in consultation with the farm manager. While the farm manager is not responsible for actually performing audiometry, he is responsible for seeing that it is done, and program planning must be done with her or his input and cooperation.

After developing the performance objectives (left column), we invited five farm managers and two agricultural extension agents to comment on their feasibility in telephone interviews. These individuals were referred to us by the NIOSH-funded Southwest Center for Agricultural Health, Injury Prevention, and Education at the University of Texas Health Science Center at Tyler. The interviews confirmed the performance objectives for both personal hearing protection (first section of the matrix) and for development and maintenance of protection plans by farm managers (second section). The participants noted that while most of the behaviors specified in section 2 were important and reasonable, they would only be feasible for farm managers after an educational session or other training.

The farm managers interviewed also noted that it was not realistic to expect a farm manager to “get off his tractor, get cleaned up, and go into town just for a hearing test.” They said it was feasible, however, to expect him or her to get tested at a local community center, at one of several meetings that are frequented by managers, or on the farm itself.

### ***Proposed Determinants of the Performance Objectives***

The column headings in the matrix (table 1 in Appendix) are factors that would likely influence the performance of the safety behaviors by workers and managers. These proposed determinants are from our literature review (which included workers



in other industries), behavioral science theory, and formative research (focus groups and interviews). We did not encounter evidence that determinants of personal hearing protection behavior were different for farm managers and farmworkers, except for the workers' perception of lack of support from farm managers for those behaviors. Using the theoretical constructs from the Health Belief Model (HBM) (Rosenstock, 1974) and Social Cognitive Theory (SCT) (Bandura, 1977), we organized the determinants into the following theoretical categories:

- Knowledge and behavioral capability (KBC) comes from SCT and refers to procedural knowledge of what to do and how to do it.
- Perceived susceptibility and severity (PSS) are from the HBM and describe an individual's perception of whether he/she is susceptible to a health problem and how severe the problem would be if it were experienced.
- Outcome expectations (including perceptions of benefits) (OE) is from SCT and is the expectations a person has regarding the results of performing the behavior. Positive outcome expectations depend, to some extent, on the expectations of response efficacy, i.e., that the health protection behavior will actually reduce the risk.
- Weighing perceived benefits against barriers (B) is dealt with most explicitly in the HBM.
- Social influence (SI) is from SCT and refers to the impact of the expectations of social rewards or approval. We also include here perceived support from the farm manager and significant others in the lives of both the workers and the managers, perceptions of the norms for safety and health on the farm, and perceptions of legal regulations.
- Skills and self-efficacy (SSE): Skill is from SCT, and is the capacity to perform a behavior. Self-efficacy is from both the HBM and SCT and is the confidence an individual has in performing a specific behavior.

Findings from the interviews with managers and experts corroborated the determinants of knowledge, outcome expectations, perceived risk, barriers, and skills and self-efficacy. For example, one participant said "the most important thing is to be aware of it and the damaging effects that loud noise can have." They underscored both the need for persuading farm managers of the importance of hearing protection for themselves and farmworkers and the need for support of the activities farm managers need to provide (such as hearing testing and education of farmworkers). One farm manager mentioned that even though he had 50% diminished hearing, "a lot of people would think I don't have a problem." Their comments confirmed that perceived susceptibility and severity were important determinants. Another barrier noted was that farm managers would need to see the benefit for themselves and for their employees before spending time and money on hearing protection. Interviewees mentioned that one possible barrier that managers may have is low expectations that their workers would actually use HPDs even if instructed to do so (perceived outcome expectations).

## **Program Recommendations**

### **Proposed Methods and Strategies**

We based our program recommendations on the planning matrices, a review of other safety programs (which is summarized briefly here), and recommendations for

an industrial hearing conservation program outlined by Royster and Royster (1990). Students participating in an agricultural safety curriculum in high school agriculture classes were more likely to report having adopted at least one safety behavior (Reed et al., 2004). An intervention involving a 60-minute educational program using flipcharts and group discussion about pesticide safety for Hispanic farmworkers was successful in increasing knowledge about pesticides, safety risk perception, and two of four behavioral outcomes (Vela Acosta et al., 2005). Interventions designed to influence external factors related to workers' safety behaviors by using modified supervisory safety practices have also been successful in increasing workers' safety behaviors (Zohar and Luria, 2003; Zohar, 2003).

Only a handful of interventions have been developed to increase HPD use among workers. Despite the use of a variety of potentially effective educational methods (e.g., simulation, group discussion, and tailored messages), these interventions have had limited success (Lusk et al., 1999; Lusk et al., 2003; Lusk et al., 2004). A study using postcard cues with positive or neutral persuasive messages effectively increased hearing protection behaviors among coal miners (Stephenson et al., 2005). The only study focused specifically on hearing protection among agricultural workers tested the effectiveness of a curriculum for high school students living or working on farms in Wisconsin (Knobloch and Broste, 1998). Results showed that the program, which included videotaped testimonials, reminder letters, and providing HPDs, increased HPD use, at least some of the time.

We recommend a program that focuses on creating hearing-safety interactions between farm managers and farmworkers. These interactions will provide the context for influencing the personal determinants of hearing-protection behavior for farmworkers as well as provide the external reinforcement and safety culture that seem to be necessary for lasting change of safety behavior. We propose theory-based methods and practical program strategies to influence change in hearing protection behavior. In table 2 (see Appendix), we list the determinants of hearing protection behavior from the planning matrix, the theoretical methods known to influence the determinants, and practical strategies to implement those methods.

### **Suggestions for Program Delivery**

The program would consist of two separate but interrelated modules: the farm manager module, and the farmworker module. The farm manager module could be delivered by an agricultural extension agent or trained community health worker (the "trainer") and could focus both on technical and logistic issues (how to monitor for noise on the farm, how to engineer noise reduction solutions, how to plan for periodic hearing testing for farmworkers, how to evaluate the hearing protection program) and communication issues (how to deliver education about hearing protection to farmworkers, how to engage with them in ongoing communication about hearing protection, reinforcing the need for adequate protection, taking corrective action when protection is lacking).

The training for the farm manager can be delivered via one-on-one or small-group education, aided by a short video, a self-tailored planning manual, and a communications toolkit. The planning manual should include guides to action (e.g., how to survey the farm for noise levels) and checklists for the manager. The toolkit contains training materials (e.g., a noise comparison chart), stickers and posters to cue safety behaviors, and reminders about ongoing manager communication. Following the training, the

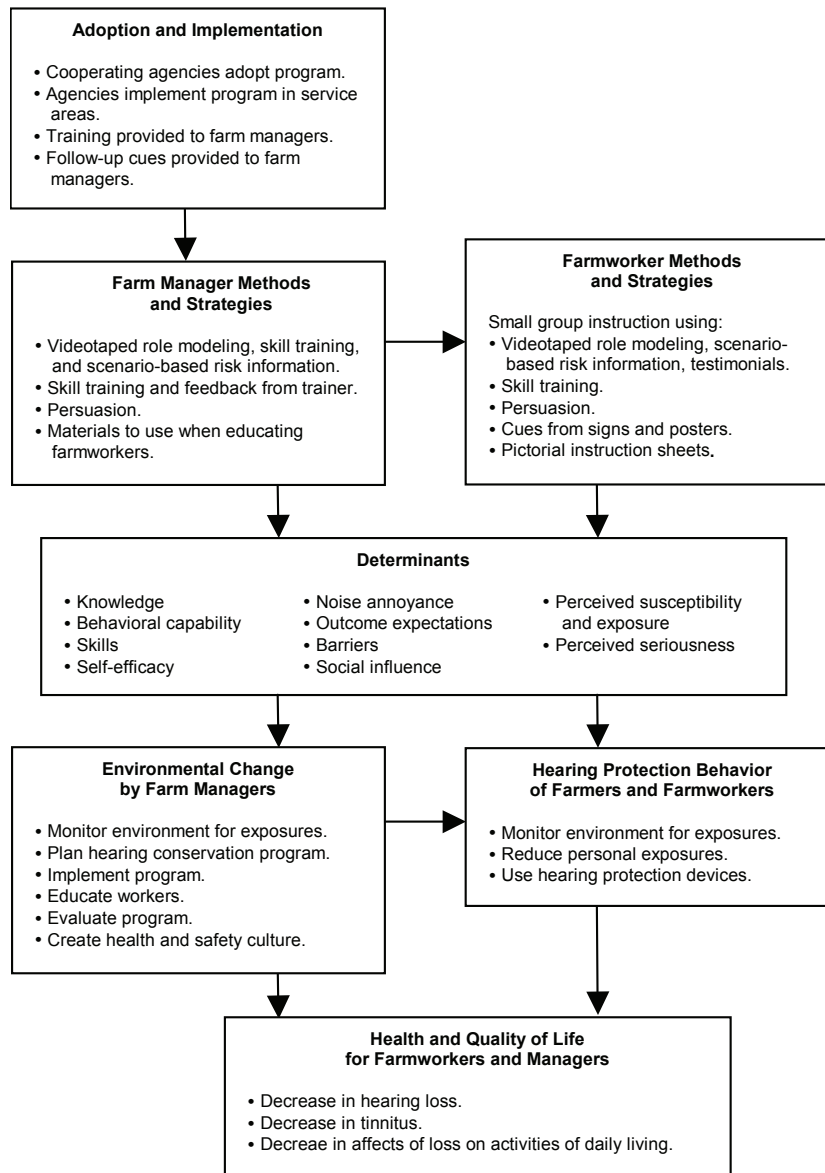
trainer would be available by phone for technical assistance and could deliver a booster training two months after the initial education to assess progress and provide feedback and reinforcement. The program should also include yearly reminder postcards with messages to encourage the manager to review and repeat the various elements of the hearing protection plan.

The farmworker module should be delivered by the farm manager and focus on susceptibility (e.g., it can happen to me), the seriousness of hearing loss (permanent and with familial/social consequences), monitoring their hearing, and choosing strategies to protect their hearing. Workers should receive HPDs and be instructed how to maintain the devices and how to ensure proper fit. The manager's communication toolkit will include a video and flipchart for use during group educational sessions, posters and flyers that serve as cues to action for farmworkers to have hearing tests and to protect their hearing, and HPDs for demonstrating proper use and fit. The education toolkit will also include a step-by-step guide (lesson plan) for the farm manager to follow as he/she delivers the training.

Based on our formative research, the program would be best disseminated through the cooperative extension service or local organizations that provide training, certification, or licensing classes to farm managers. The use of this existing infrastructure was recommended by Carpenter et al. (2002), who reported that farmers preferred education and training be delivered through their local agricultural extension offices, and was confirmed by our in-depth interviews with farm managers. The benefits of such an implementation and dissemination strategy include facilitation of both training and hearing testing and utilization of an existing network. When queried, both farm managers and extension agents thought that the extension service was a good dissemination mechanism for providing training and assistance to farm managers as they prepared and implemented hearing conservation programs on their farms. One farm manager said it was probably best to team up an extension agent with a nurse or health educator. She said that this was particularly critical when it came to explaining specifics about what noise can do to hearing and other medical aspects of the education. This participant also suggested that the trainer would have to be someone with farm experience. Again, participants underscored the importance of training and recommended that it be carried out in conjunction with some of the required training for managers and farmworkers (such as pesticide use training).

### **Evaluation Planning**

Figure 2 presents the logic model for the intervention recommendations. Research to evaluate a program based on the recommendations would optimally address both outcome and process questions. The program is intended to decrease noise-induced hearing loss (fig. 2, bottom). Because of the time horizon required to determine impact on health and function, the outcome evaluation would instead target effects on the behavior of both the farmworkers and managers, which can be measured by self-report and by observation on the farm (Lusk et al., 1997). The hypothesized determinants of the health-related behaviors and environmental changes are very important so that evaluators can understand the pathways of any program effect (fig. 2, middle). For example, did the program improve skills, knowledge, and perceived susceptibility? The next evaluation question is whether program developers included components that would deliver the proposed theoretical change methods. For example, did videotapes



**Figure 2. Logic model for intervention recommendations.**

include believable role models who delivered appropriately constructed messages to change the intended determinants?

Equally important to the outcome evaluation is the process of the program. The overall impact of a program depends both on its effectiveness and on its reach (Glasgow et al., 1999). These program recommendations can potentially have good reach if program developers partner with potential program implementers, in this case extension agents from the local agricultural extension service and staff from NIOSH

Agricultural Centers, at the beginning of program development so that the eventual program meets the requirements of the implementers and is easily adopted. Evaluation questions concerning adoption and implementation include questions about program reach (e.g., what is the proportion of intended population reached, including disparities in reach?), program fidelity (e.g., to what extent was the program implemented according to its original plan?), and dose (e.g., what was the amount of the program received by the priority population and their responses to it?) (Linnan and Steckler, 2002).

## **Discussion**

### **Contributions to the Literature**

This article presents an explicit depiction of how to use theoretical constructs to create a health and safety intervention for farmworkers. The health promotion field generally accepts the importance of applying theory, empirical evidence, and formative research to intervention development, and Kristensen (2005) recently urged the use of theory in intervention studies for occupational health. Health promotion researchers in areas other than occupational health have suggested that larger effect sizes are obtained from theory-informed interventions (Stone et al., 2002). However, no one theoretical model completely predicts or explains health behaviors, and health promotion researchers recommend using an overarching theoretical framework and selecting and integrating relevant constructs from other theories that have supportive empirical evidence (Rakowski and Breslau, 2004; Rimer, 2002; Institute of Medicine, 2002) or combining similar constructs from a number of different theories (Fishbein, 2000). Two particularly promising lines of theory-informed intervention research in occupational health are the Health Promotion Model by Lusk et al. (1999) and that proposed by Zohar and Luria (2003), a focus on worker and supervisor interaction to create a social safety environment. Brosseau et al. (2007) found that their use of a systematic planning process that considered the safety behavior of both supervisors and metal workers “led to important insights about program goals and intervention activities” and explicitly recommend such an approach to others (p. 344). We have combined insights from these studies along with others in the creation of an intervention plan that focuses on a range of important determinants for hearing protection, and we approach promoting change in the determinants by influencing supervisor-worker interaction. This multilevel or ecologic approach to change is an innovative aspect of the intervention recommendations.

### **Strengths and Weaknesses of the Recommendations**

The strengths of these recommendations include their development using a systematic process that incorporates theory and evidence and that has been effective for other health promotion programs (Bartholomew et al., 2006). The recommendations are based on formative research, including a review of studies of health and safety behaviors and interventions in farming and in other occupations.

A next step in developing the recommendations is further validation of the performance and change objectives with the priority population. We have already conducted a small number of interviews with farm managers and experts in agricultural safety and health; however, testing the appropriateness of the objectives would require a larger sample of farm managers and farmworkers. Of particular interest would be

their opinions on the feasibility of the suggested approaches to stimulate participation by farm managers in the recommended program. Another difficult issue to be addressed is the need for convenient audiometric services, as noted in the interviews conducted for this study.

We have also discussed possible networks for program dissemination and implementation (e.g., cooperative extension services). Other ways to enhance the recommendations would be to work with potential networks to ensure the feasibility of the program components and to recruit a program development team from among potential program implementers. This team could develop and pretest prototypes of the intervention and pilot test its implementation.

## Summary and Conclusions

The recommendations in this article present a reasonable foundation for the development and evaluation of a theory- and evidence-based intervention to promote the behaviors and environmental changes that could decrease noise-induced hearing loss among farmworkers. The intervention recommendations include both: (1) skill-building to implement self-protection, educate workers, and modify the environment; and (2) persuasion to enhance belief in the reality of noise exposures, the risk of hearing loss, and the importance and effectiveness of prevention.

### Acknowledgements

This work was funded by the National Institute for Occupational Safety and Health. The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health. The authors would like to thank Karyn Popham and Edward W. Fernandez, MS, for editorial assistance and Diana Ischiavici for assisting with the literature review.

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**Appendix follows.**

# Appendix

**Table 1. Intervention Mapping planning matrix of change objectives for farmworkers and farm managers, generated for each determinant of each performance objective.**

Section 1: Farmworkers	Determinants KBC, PSS, NA, and OE		
Performance Objectives	Knowledge and Behavioral Capability (KBC)	Perceived Exposure and Susceptibility / Severity (PSS) and Noise Annoyance (NA)	Outcome Expectations (OE)
<p>1. Monitor hearing and hearing loss with regular hearing testing:</p> <ul style="list-style-type: none"> <li>• Use results of hearing test to decide whether protective measures are effective (farm and leisure).</li> <li>• Use results of hearing test to consider improving protection (farm and leisure).</li> </ul>	<p>KBC.1.1. Describe what regular hearing testing is.</p> <p>KBC.1.2. Describe early symptoms of loss as difficulty carrying on conversation in noisy situations, ears ringing, or head noise after exposure.</p> <p>KBC.1.3. Discuss testing usefulness, as symptoms may not be detectable with early loss.</p> <p>KBC.1.4. Explain that if loss is detected, hearing protection needs improvement (farm and leisure time).</p>	<p>PSS.1.1. Describe the risk for hearing loss.</p> <p>PSS.1.2. Personalize the risk of hearing loss.</p> <p>PSS.1.3. Outline the impact of hearing loss on activities of daily living, communication, and work activities.</p> <p>PSS.1.4. Recognize hearing loss as permanent.</p> <p>PSS.1.5. Recognize hearing loss as serious even though it does not usually involve time off from work.</p> <p>PSS.1.6. Recognize that hearing loss is a real threat even though it occurs slowly.</p>	<p>OE.1.1. Expect that regular hearing testing will identify hearing loss while something can be done, i.e., before it becomes serious.</p> <p>OE.1.2. Express value on retaining hearing for work benefits, safety, and enjoyment of family, friends, and entertainment.</p> <p>OE.1.3. Consider immediate benefits of protection (even when there is already some hearing loss).</p>
<p>2. Monitor exposure to noise levels &gt;85 dBA:</p> <ul style="list-style-type: none"> <li>• Notice early signals of hearing loss (sounds are dull and hearing less sensitive) or threshold shifts.</li> </ul>	<p>KBC.2.1. Describe decibel as standard measure of sound intensity, 20 decibels a whisper, 60 normal speech, 70 noisy office.</p> <p>KBC.2.2. Describe types of noise &gt;85 dBA, e.g., inside acoustically insulated tractor cab in field, conversation can't be heard 3 ft. away, ears ring or buzz after exposure.</p>	<p>PSS.2.1. Personalize risk by listing personally valuable hearing-related losses.</p> <p>NA.2.2. Notice noise on farm as annoying and dangerous, leading to need to determine where and when exposures occur.</p> <p>NA.2.3. Describe that even intermittent exposures hurt hearing.</p>	<p>OE.2.1. Describe how monitoring exposure levels will help avoid exposure.</p> <p>OE.2.2. Describe that to plan effective protection, monitoring must include intermittent exposures.</p>
<p>3. Expand monitoring for health and safety:</p> <ul style="list-style-type: none"> <li>• Monitor noise exposure during non-working hours.</li> <li>• Monitor for exposures other than noise on the farm.</li> </ul>	<p>KBC.3.1. Describe other times during the day when he/she may be exposed to damaging noise levels.</p> <p>KBC.3.2. Describe types of recreational activities that expose to NIHL.</p> <p>KBC.3.3. Describe types of exposure risks on the farm.</p>	<p>PSS.3.1. Feel at risk for NIHL from exposure to noise outside of work.</p> <p>PSS.3.2. Feel personally susceptible to injury from other exposures or work conditions on the farm.</p> <p>NA.3.3. Notice noise exposure outside the farm as annoying and dangerous.</p>	<p>OE.3.1. Expect that by monitoring noise exposure outside the farm he/she will be able to better protect hearing.</p> <p>OE.3.2. Explain that monitoring for other risks can prevent injury during farm work.</p>
<p>4. Monitor the adequacy of current hearing protection behaviors.</p>	<p>KBC.4.1. Describe standards for hearing protection behaviors.</p> <p>KBC.4.2. Describe how personal behaviors compare with standards.</p> <p>KBC.4.3. Describe how to check the seals on earmuffs.</p> <p>KBC.4.4. Describe how well-fitting devices feel.</p>	<p>PSS.4. Describe risk for hearing loss if hearing protection is not being correctly used.</p>	<p>OE.4. Describe how monitoring and ensuring adequate hearing protection will reduce risk for hearing loss.</p>
<p>5. Choose and use strategies to protect hearing:</p> <ul style="list-style-type: none"> <li>• Request hearing protection devices (HPD) from farm managers.</li> <li>• Get device fit-tested.</li> <li>• Work with manager to take breaks from exposure.</li> <li>• Encourage younger workers to develop a habit of wearing HPDs.</li> <li>• Choose strategies to protect hearing during noise exposure outside of work.</li> <li>• Work with farm manager to choose strategies for other exposures.</li> </ul>	<p>KBC.5.1. Describe strategies such as avoiding exposure to noise on the farm, decreasing sources of noise &gt;85 dBA, keeping music volume in tractor cab at reasonable level, consistently using HPDs that fit and are designed well, and taking breaks between exposures.</p> <p>KBC.5.2. Describe how HPDs should fit and how to check fit.</p> <p>KBC.5.3. Describe strategies to protect against other exposures.</p>	<p>PSS.5.1. See self at risk for hearing loss if strategies not chosen.</p> <p>NA.5.2. Notice noise on farm as annoying and dangerous, leading to the need to be concerned about compliance with hearing protection.</p> <p>NA.5.3. See self at risk for other health problems if strategies not chosen.</p>	<p>OE.5.1. Explain that workers have ability to choose strategies that work to prevent hearing damage.</p> <p>OE.5.2. Explain that if protection fits well, it will not cause problems.</p>

**Table 1 (cont'd). Intervention Mapping planning matrix of change objectives for farmworkers and farm managers, generated for each determinant of each performance objective.**

Section 1: Farmworkers		Determinants B, SI, and SSE	
Performance Objectives	Barriers (B)	Social Influence (SI) (including social support and perceived norms and standards)	Skills and Self-Efficacy (SSE)
<p>1. Monitor hearing and hearing loss with regular hearing testing:</p> <ul style="list-style-type: none"> <li>• Use results of hearing test to decide whether protective measures are effective (farm and leisure).</li> <li>• Use results of hearing test to consider improving protection (farm and leisure).</li> </ul>	<p>B.1.1. Expect that managers support hearing testing and will provide access. B.1.2. Identify sources of testing. B.1.3. Describe tests as easy, not costly, and not time consuming.</p>	<p>SI.1.1. Discuss how co-workers are monitoring their hearing. SI.1.2. Describe that regular hearing tests are becoming standard on some farms. SI.1.3. Discuss that spouses and other friends and family really want hearing to be protected.</p>	<p>SSE.1. Describe confidence in ability to obtain hearing testing regularly.</p>
<p>2. Monitor exposure to noise levels &gt;85 dBA:</p> <ul style="list-style-type: none"> <li>• Notice early signals of hearing loss or "temporary threshold shifts" (sounds are dull and hearing less sensitive).</li> </ul>	<p>B.2.1. Describe monitoring as easy and not time consuming. B.2.2. Describe barriers to monitoring and how to overcome them. B.2.3. Describe farm managers and supervisors as supportive of monitoring exposures.</p>	<p>SI.2. Discuss how other workers are monitoring noise exposure.</p>	<p>SSE.2.1. Express confidence in monitoring noise exposure. SSE.2.2. Demonstrate observing farm environment for noise exposure.</p>
<p>3. Expand monitoring for health and safety:</p> <ul style="list-style-type: none"> <li>• Monitor noise exposure during non-working hours.</li> <li>• Monitor for exposures other than noise on the farm.</li> </ul>		<p>SI.3.1. Describe that others protect hearing during leisure activities (e.g., seen on TV shows, among valued professions). SI.3.2. Describe farm manager as working on health and safety on the farm.</p>	<p>SSE.3.1. Feel confident about monitoring noise exposure during non-working hours. SSE.3.2. Express confidence in monitoring other exposures on the farm.</p>
<p>4. Monitor the adequacy of current hearing protection behaviors.</p>	<p>B.4.1. Describe monitoring as easy and not time consuming. B.4.2. Describe barriers to monitoring and how to overcome them. B.4.3. Describe farm managers as supportive of monitoring exposures.</p>	<p>SI.4. Discuss how co-workers are monitoring their own hearing protection behaviors.</p>	<p>SSE.4. Express confidence in monitoring personal hearing protection behaviors.</p>
<p>5. Choose and use strategies to protect hearing:</p> <ul style="list-style-type: none"> <li>• Request hearing protection devices (HPD) from farm managers.</li> <li>• Get device fit-tested.</li> <li>• Work with manager to take breaks from exposure.</li> <li>• Encourage younger workers to develop a habit of wearing HPDs.</li> <li>• Choose strategies to protect hearing during noise exposure outside of work.</li> <li>• Work with farm manager to choose strategies for other exposures.</li> </ul>	<p>B.5.1. Describe choosing and using strategies as easy and not time consuming. B.5.2. Describe overcoming barriers by choosing and using strategies. B.5.3. Describe farm managers as supportive of choosing and using strategies. B.5.4. Describe how using HPDs and reducing exposure helps the farm manager. B.5.5. Believe if well fitted, HPDs can be comfortable.</p>	<p>SI.5.1. Discuss that protecting one's hearing through HPDs is becoming routine on some farms. SI.5.2. Describe how spouse and family would want action taken to protect hearing. SI.5.3. Describe personal responsibility as a model for other workers. SI.5.4. Describe manager as working to improve health of workers on the farm.</p>	<p>SSE.5.1. Express confidence in working with farm manager to lower exposure. SSE.5.2. Feel confident in ability to protect hearing during non-working hours. SSE.5.3. Describe confidence in implementing strategies to protect against other risks when helped by managers and supervisors.</p>

**Table 1 (cont'd). Intervention Mapping planning matrix of change objectives for farmworkers and farm managers, generated for each determinant of each performance objective.**

Section 2: Farm managers		Determinants KBC, PSS, NA, and OE	
Performance Objectives <sup>[a]</sup>	Knowledge and Behavioral Capability (KBC)	Perceived Exposure and Susceptibility / Severity (PSS) and Noise Annoyance (NA)	Outcome Expectations (OE)
<p>6. Using systematic methods, survey farm environment for noise exposure &gt;85 dBA and monitor for any excess noise exposure levels among workers:</p> <ul style="list-style-type: none"> <li>Describe exposures.</li> <li>Report potential noise exposure promptly to those exposed.</li> <li>Expand monitoring to note needs for other health and safety efforts.</li> </ul>	<p>KBC.6.1. Describe acceptable noise exposure levels. KBC.6.2. Describe how to use equipment to measure noise. KBC.6.3. Describe situations that indicate noise at unacceptable levels. KBC.6.4. Describe potential work exposures.</p>	<p>PSS.6.1. Describe that workers are susceptible even with intermittent exposure. NA.6. 2. Consider noise as annoying and negative (not just "part of job"). PSS.6.3. Describe how workers are susceptible to other types of exposures.</p>	<p>OE.6. State that once sources of exposure are found they can be dealt with.</p>
<p>7. Plan hearing protection program:</p> <ul style="list-style-type: none"> <li>Set priorities for noise control needs based on problem severity and cost-effectiveness of various options.</li> <li>Recruit one or more key individuals with responsibility for hearing protection.</li> <li>Develop and maintain written plans.</li> <li>Set goals for expanded health and safety planning.</li> </ul>	<p>KBC.7.1. Explain that hearing protection programs should include educational, engineering, and organizational solutions. KBC.7.2. Explain that programs should include HPDs and audiometric testing and feedback. KBC.7.3. Explain that programs should be based on assessment of noise exposure.</p>	<p>PSS.7.1. Describe hearing loss as a very serious health hazard. PSS.7.2. Consider noise as annoying and negative (not just "part of job").</p>	<p>OE.7.1. Expect that having a plan will improve control of exposures on the farm. OE.7.2. Expect that having key workers involved in the plan will improve implementation. OE.7.3. Expect that plans will be implemented more dependably when written. OE.7.4. Expect that the implementation of one plan will lead to others and improve personal and farmworker health.</p>
<p>8. Provide HPDs to farmworkers:</p> <ul style="list-style-type: none"> <li>Allow workers to select from a variety of HPDs.</li> <li>Ensure proper fit and care of HPDs.</li> <li>Respond to farmworker questions and complaints about HPDs or refer them to another resource person.</li> <li>Reissue and refit HPDs at the recommended times.</li> <li>Give farmworkers HPDs to take home for use during non-work activities.</li> </ul>	<p>KBC.8.1. Describe HPDs and the importance of comfort to the worker. KBC.8.2. Describe how to test for fit. KBC.8.3. Describe care of protectors. KBC.8.4. Identify vendors that sell HPDs. KBC.8.5. Describe how to check for fit and care. KBC.8.6. Identify common questions and complaints from farmworkers about HPD use and provide appropriate responses. KBC.8.7. List resources for questions and complaints about HPDs. KBC.8.8. State how often protectors should be reissued. KBC.8.9. Explain how off-the-job exposures compound hearing loss risk.</p>	<p>PSS.8.1. Describe the risk of not using an HPD to workers on his/her farm. PSS.8.2. Describe workers as exposed to harmful noise and in need of HPDs.</p>	<p>OE.8.1. Believe that if he/she provides HPDs, workers will accept and use them. OE.8.2. Believe that once provided, HPDs will prevent NIHL among workers. OE.8.3. Expect that compliance with OSHA regulation will eliminate the liability of a possible fine.</p>
<p>9. Engineer solutions to ameliorate noise at the source:</p> <ul style="list-style-type: none"> <li>Purchase the quietest suitable equipment.</li> <li>Make sure all equipment is insulated or maintained to be as quiet as possible.</li> <li>Transfer exhaust noise to remote locations.</li> <li>Use barrier vibration isolators and sound-absorbing materials.</li> <li>Conduct regular maintenance on all farm equipment.</li> </ul>	<p>KBC.9.1. Describe sources of noise that can be addressed through engineering solutions. KBC.9.2. Explain how to insulate cabs of equipment, minimize equipment vibration with rubber mounts, maintain exhaust systems, use mufflers, and eliminate metal-to-metal contact. KBC.9.3. Describe how to replace leaky mufflers, leaky seals, and loose brackets.</p>	<p>PSS.9. Describe noise levels on the farm as dangerous to self and workers. NA.9. Describe that environment will lead to reduced noise annoyance and better work environment for self and farmworkers.</p>	<p>OE.9.1. Expect that engineering solutions to reduce noise will significantly reduce exposure to noise for self and workers. OE.9.2. Expect that engineering solutions will lead to reduced hearing loss. OE.9.3. Expect that conducting regular maintenance on farm equipment will lead to decreased noise exposure.</p>

<sup>[a]</sup> Section 1 also applies to farm managers, as individuals working on a farm; therefore, numbering sequence is continuous.

**Table 1 (cont'd). Intervention Mapping planning matrix of change objectives for farmworkers and farm managers, generated for each determinant of each performance objective.**

Section 2: Farm managers			
Determinants KBC, PSS, NA, and OE (cont'd)			
Performance Objectives	Knowledge and Behavioral Capability (KBC)	Perceived Exposure and Susceptibility / Severity (PSS) Noise Annoyance (NA)	Outcome Expectations (OE)
<p>10. Evaluate whether the program is changing farm practices and level of injury:</p> <ul style="list-style-type: none"> <li>Assess changes in areas, equipment, or processes.</li> <li>Provide audiometric evaluation to assess effect on hearing loss.</li> <li>Use audiogram results to alert workers to changes indicative of hearing loss.</li> <li>Keep accurate and complete records.</li> <li>Compare annual test results to baseline to determine presence of standard threshold shift.</li> <li>If such a shift is present, pinpoint problem areas and remediate.</li> <li>Develop protocols and arrangements for referrals.</li> </ul>	<p>KBC.10.1. Describe the difference between initial exposure levels and new exposure levels (after implementation of the program).</p> <p>KBC.10.2. Describe how to measure change in environment and hearing protection behavior.</p> <p>KBC.10.3. Describe how to interpret audiogram results and the best way to notify workers.</p> <p>KBC.10.4. Describe how to identify a threshold shift and what recommendations should be made to the worker as a result.</p>	<p>NA.10. Describe changes in noise annoyance and recognize more comfortable working environment for self and workers.</p>	<p>OE.10.1. Expect that evaluation of the program will identify areas for improvement.</p> <p>OE.10.2. Expect that identifying threshold shifts will result in early detection of hearing loss and will help prevent further hearing loss among workers.</p>
<p>11. Educate farmworkers about hazards and protection:</p> <ul style="list-style-type: none"> <li>Work with key individuals to obtain farmworker input to and buy-in for plan components.</li> <li>Focus on young workers to establish early protection.</li> <li>Provide periodic refresher/booster training.</li> </ul>	<p>KBC.11.1. Describe educational elements that should be included in a program for farmworkers.</p> <p>KBC.11.2. Describe basic information about hearing hazards and protection and how it relates to the reality on their farms.</p> <p>KBC.11.3. Describe educational resources available to assist in their learning about hearing hazards and protection.</p> <p>KBC.11.4. Identify key individuals/natural leaders among farmworkers to help obtain buy-in.</p>	<p>PSS.11.1. Describe hearing risk of workers under his/her supervision.</p> <p>PSS.11.2. Describe severity of consequences for failing to educate farmworkers about noise exposure and hearing protection.</p> <p>PSS.11.3. Describe feelings of responsibility for reducing hearing loss risks on farm</p>	<p>OE.11.1. Expect benefits of educating farmworkers (safer, healthier environment; effective, productive workers; good morale; decreased liability) to outweigh barriers.</p> <p>OE.11.2. Expect educating workers to result in worker monitoring of noise exposure, hearing, and protection.</p> <p>OE.11.3. Expect obtaining input and buy-in to influence worker participation.</p> <p>OE.11.4. Expect providing refresher training to result in continued worker hearing protection.</p>
<p>12. Create a health and health and safety culture on the farm:</p> <ul style="list-style-type: none"> <li>Express culture via a variety of methods such as modeling, visual cues, training, and follow-up on violations.</li> <li>Counsel workers when they do not use hearing protection or show up for testing.</li> <li>Provide consequences for repeat offenses.</li> <li>Model the use of hearing protection.</li> <li>Interact with workers regarding hearing protection, including positive reinforcement for protection.</li> </ul>	<p>KBC.12.1 Describe the importance and benefits of the culture of a safe farm.</p> <p>KBC.12.2. Describe ways to promote health and safety including hearing protection.</p> <p>KBC.12.3. Describe when and how to interact with workers and provide reinforcement.</p>	<p>PSS.12.1. Describe the risk of not complying with farm rules.</p> <p>PE.12.2. Describe the importance of following farm rules regarding using hearing protection.</p> <p>PE.12.3. Describe the severity of consequences for repeated failures to comply with the rules.</p>	<p>OE.1.1. Expect that creating a health and safety culture on the farm will result in increased hearing protection and other health behaviors among workers.</p> <p>OE.12.2. Expect compliance to policy will lead to a safe farm.</p> <p>OE.12.3. Expect that severe consequences will help enforce compliance.</p>

**Table 1 (cont'd). Intervention Mapping planning matrix of change objectives for farmworkers and farm managers, generated for each determinant of each performance objective.**

Performance Objectives <sup>[a]</sup>	Barriers (B)	Determinants B, SI, and SSE	
		Social Influence (SI) (including social support and perceived norms and standards)	Skills and Self-Efficacy (SSE)
<p>6. Using systematic methods, survey farm environment for noise exposure &gt;85 dBA and monitor for any excess noise exposure levels among workers:</p> <ul style="list-style-type: none"> <li>Describe exposures.</li> <li>Report potential noise exposure promptly to those exposed.</li> <li>Expand monitoring to note needs for other health and safety efforts.</li> </ul>	<p>B.6. Describe how monitoring can be done as part of other farm activities.</p>	<p>SI.6.1. Expect that farm managers should be concerned about noise exposure and hearing protection.</p> <p>SI.6.2. Expect that farm managers should be surveying environment for noise exposures.</p> <p>SI.6.3. Expect that farm managers should be surveying for multiple exposures.</p>	<p>SSE.6.1. Demonstrate using sound level meter to measure noise in decibels.</p> <p>SSE.6.2. Express confidence in being able to locate, evaluate, and describe sources of noise that are over the safe threshold.</p> <p>SSE.6.3. Describe plan to look for other possible exposures.</p>
<p>7. Plan hearing protection program:</p> <ul style="list-style-type: none"> <li>Set priorities for noise control needs based on problem severity and cost-effectiveness of various options.</li> <li>Recruit one or more key individuals with responsibility for hearing protection.</li> <li>Develop and maintain written plans.</li> <li>Set goals for expanded health and safety planning.</li> </ul>	<p>B.7.1. Describe solutions as within the farm budget and normal safe farm operation.</p> <p>B.7.2. Describe solutions as within expectations of farm owners.</p>	<p>SI.7.1. Expect that some farm managers are planning cost-effective hearing programs.</p> <p>SI.7.2. Describe farm managers as engaged in a range of health and safety planning.</p>	<p>SSE.7. Express confidence in being able to plan effective programs that include both educational and engineering efforts.</p>
<p>8. Provide HPDs to farmworkers:</p> <ul style="list-style-type: none"> <li>Allow workers to select from a variety of HPDs.</li> <li>Ensure proper fit and care of HPDs.</li> <li>Respond to farmworker questions and complaints about HPDs or refer them to another resource person.</li> <li>Reissue and refit HPDs at the recommended times.</li> <li>Give farmworkers HPDs to take home for use during non-work activities.</li> </ul>	<p>B.8.1. Believe that HPDs can be easy to obtain.</p> <p>B.8.2. Believe workers will accept them if they are well fitted and comfortable.</p>	<p>SI.8.1. Expect that farm managers are providing HPDs.</p> <p>SI.8.2. Believe many farm managers are beginning to consider changes in hearing protection practices.</p>	<p>SSE.8. Express confidence in being able to locate, select, and provide appropriate HPDs.</p>
<p>9. Engineer solutions to ameliorate noise at the source:</p> <ul style="list-style-type: none"> <li>Purchase the quietest suitable equipment.</li> <li>Make sure all equipment is insulated or maintained to be as quiet as possible.</li> <li>Transfer exhaust noise to remote locations.</li> <li>Use barrier vibration isolators and sound-absorbing materials.</li> <li>Conduct regular maintenance on all farm equipment.</li> </ul>	<p>B.9.1. Describe resources (extension agents) to assist in implementing engineering solutions.</p> <p>B.9.2. Describe purchase of quieter equipment as within farm budget.</p>	<p>SI.9. Believe that many farm managers are carrying out solutions to ameliorate noise at the source.</p>	<p>SE.9. Feel confident in ability to engineer solutions to reduce noise on the farm.</p>

<sup>[a]</sup> Section 1 also applies to farm managers, as individuals working on a farm; therefore, numbering sequence is continuous.

**Table 1 (cont'd). Intervention Mapping planning matrix of change objectives for farmworkers and farm managers, generated for each determinant of each performance objective.**

Section 2: Farm managers			
Determinants B, SI, and SSE (cont'd)			
Performance Objectives	Barriers (B)	Social Influence (SI) (including social support and perceived norms and standards)	Skills and Self-Efficacy (SSE)
<p>10. Evaluate whether the program is changing farm practices and level of injury:</p> <ul style="list-style-type: none"> <li>Assess changes in areas, equipment, or processes.</li> <li>Conduct audiometric evaluation to assess effect on hearing loss.</li> <li>Use audiogram results to alert workers to changes indicative of hearing loss.</li> <li>Keep accurate and complete records.</li> <li>Compare annual test results to baseline to determine presence of standard threshold shift.</li> <li>If such a shift is present, pinpoint problem areas and remediate.</li> <li>Develop protocols and arrangements for referrals.</li> </ul>	<p>B.10. Describe resources available to minimize cost and effort in evaluating whether the program is effective.</p>	<p>SI.10.1. Believe that farm managers periodically assess program effectiveness and continue monitoring workers' hearing.</p> <p>SI.10.2. Believe that workers will appreciate being alerted to changes in hearing.</p>	<p>SE.10.1. Feel confident in ability to evaluate whether the program is changing farm practices and level of injury.</p> <p>SE.10.2. Feel confident in ability to arrange hearing tests and identify changes indicative of hearing loss.</p>
<p>11. Educate farmworkers about hazards and protection:</p> <ul style="list-style-type: none"> <li>Work with key individuals to obtain farmworker input to and buy-in for plan components.</li> <li>Focus on young workers to establish early protection.</li> <li>Provide periodic refresher/booster training.</li> </ul>	<p>B.11.1. Describe how education of farmworkers can be accomplished to minimize lost work time.</p> <p>B.11.2. Describe resources (extension agents, existing material) that can be used to facilitate training and overcome barriers such as language and other communication problems.</p>	<p>SI.11.1. Believe that the best farm managers educate farmworkers about NIHL and hearing protection.</p> <p>SI.11.2. Believe that other farm managers and employers will support their managers' plans for educating farmworkers.</p>	<p>SSE.11.1. Feel confident to educate farmworkers about hearing protection.</p> <p>SSE.11.2. Feel confident to identify key farmworkers and enlist their help in providing input and buy-in.</p> <p>SSE.11.3. Feel confident to provide refresher or booster education to farmworkers.</p>
<p>12. Create a health and safety culture on the farm:</p> <ul style="list-style-type: none"> <li>Express culture via a variety of methods such as modeling, visual cues, training, and follow-up on violations.</li> <li>Counsel workers when they do not use hearing protection or show up for testing.</li> <li>Provide consequences for repeat offenses.</li> <li>Model the use of hearing protection.</li> <li>Interact with workers regarding hearing protection, including positive reinforcement for protection.</li> </ul>	<p>B.12. Describe the creation of a health and safety culture as something that is feasible and fitting within the economic and personal resources of the farm.</p>	<p>SI.12. Believe that the best farm managers carry out activities such as training and good communication with workers in order to create a health and safety culture on the farm.</p>	<p>SSE.12.1. Feel confident in ability to create a health and safety farm culture.</p> <p>SSE.12.2. Demonstrate communication skills to use with workers.</p> <p>SSE.12.3. Feel confident to interact with workers to enforce health and safety on the farm.</p>



**Table 2. Methods and strategies for performance and change objectives in table 1.**

<b>Section 1. Farmworkers</b>		
Determinants (change objectives)	Methods	Examples of Possible Strategies and Program Materials
<b>Noticing Exposures: Performance Objectives 1-4: Monitoring hearing, exposure to noise, and hearing protection behaviors</b>		
Knowledge/behavioral capability (KBC.1.1-4; 2.1-2; 3.1-3; 4.1-4)	<ul style="list-style-type: none"> <li>Information</li> <li>Modeling</li> </ul>	<p>Materials: Farmworker videotape, posters, farmworker pictorial monitoring guide.</p> <p>Activities:</p> <ul style="list-style-type: none"> <li>Farm manager-led brief educational session.</li> <li>Explanation of noise exposure, hearing loss, testing, and protection.</li> <li>Video of workers monitoring exposure and protection at work and recreation.</li> <li>Video explaining signs of hearing loss, also reminding that signs are not always apparent.</li> <li>Farm manager talking about responding to hearing test results by improving protection.</li> <li>Farm manager talking about responding to noise on the farm by implementing engineering solutions.</li> </ul>
Perceived susceptibility/severity (PSS.1.1-3; 2.1-3; 4; NA.3); Skills/self-efficacy (SSE.1; 2.1-2; 4)	<ul style="list-style-type: none"> <li>Scenario-based risk information</li> <li>Management of anxiety related to hearing loss</li> <li>Verbal persuasion</li> <li>Modeling and reinforcement</li> </ul>	<p>Materials: Farmworker videotape.</p> <p>Activities:</p> <ul style="list-style-type: none"> <li>Farm manager leads brief educational session.</li> <li>Discussion of risks.</li> <li>Discussion of how risks can be managed and reduced.</li> <li>Video model of satisfaction from recognizing and managing risks.</li> <li>Video model of person in risk situation.</li> </ul>
Skills/self-efficacy (SSE.1; 2.1-2; 3; 4)	<ul style="list-style-type: none"> <li>Demonstration</li> <li>Verbal persuasion</li> <li>Modeling</li> </ul>	<p>Materials: Farmworker videotape, posters, pictorial monitoring guide.</p> <p>Activities:</p> <ul style="list-style-type: none"> <li>Farm manager shows workers how to look for exposures.</li> <li>Farm manager demonstrates sounds of varying decibels.</li> <li>Farm manager explains how to get hearing tested and respond to results.</li> <li>Worker in video obtains hearing test and results.</li> <li>In video, workers are tested, reinforced, and given conservation methods.</li> <li>Farmworker lists potential exposure and gets feedback on risk.</li> <li>Farmworkers discuss hearing protection behaviors and compare with standards.</li> </ul>
Outcome expectations (OE.1.1-3; 2.1-2; 3; 4)	<ul style="list-style-type: none"> <li>Modeling</li> <li>Vicarious reinforcement</li> </ul>	<p>Materials: Farmworker videotape.</p> <p>Activities:</p> <ul style="list-style-type: none"> <li>Manager explains hearing conservation (even if some loss has occurred).</li> <li>Manager explains that conservation requires recognition of exposures and hearing loss.</li> <li>Testimonials and role model stories in the video about benefits.</li> <li>Role model stories from farm manager about reasons for testing and benefits.</li> <li>Farmworkers share their own experiences.</li> </ul>
Social influence (SI.1.1-3; 2.1-2; 3; 4); Barriers/ manager support (B.1.1-2; 2.1-3; 4.1-3)	<ul style="list-style-type: none"> <li>Cues to action</li> <li>Message framing (positive)</li> <li>Social support</li> </ul>	<p>Materials: Posters.</p> <p>Activities:</p> <ul style="list-style-type: none"> <li>Manager schedules testing for workers and reminds workers to get tested.</li> <li>Posters with workers monitoring and testing; messages about saving hearing.</li> <li>Manager demonstrates support for monitoring for risks and testing hearing.</li> <li>Posters in high-noise work areas.</li> </ul>
<b>Taking Action: Performance Objective 5: Choose and use protective strategies</b>		
Knowledge/behavioral capability (KBC.5.1-3)	<ul style="list-style-type: none"> <li>Information</li> <li>Persuasive communication</li> <li>Cues</li> </ul>	<p>Materials: Farmworker videotape, signs, farmworker pictorial guide for HPDs.</p> <p>Activities:</p> <ul style="list-style-type: none"> <li>Farm manager describes strategies for hearing protection.</li> <li>Manager teaches with guide for HPDs for workers.</li> <li>Farm manager shares that he/she is working on a plan for the farm.</li> <li>Shows videotape with instructions for protection.</li> <li>Oral reminders to use hearing protection.</li> <li>Signs in areas where there is potential for noise exposure.</li> </ul>
Perceived susceptibility/severity (PSS.5; NA.5); Self-efficacy (SSE.5.1-3)	<ul style="list-style-type: none"> <li>Scenario-based risk information</li> <li>Modeling</li> <li>Anticipated regret</li> <li>Modeling and reinforcement</li> </ul>	<p>Materials: Videotape.</p> <p>Activities:</p> <ul style="list-style-type: none"> <li>Video with modeling of risk situations.</li> <li>Video with worker who regrets not having taken action to protect hearing.</li> <li>Video shows worker describing how well device works with good fit/interest from other workers.</li> </ul>
Outcome expectations (OE.5.1-2)	<ul style="list-style-type: none"> <li>Modeling</li> <li>Testimonials</li> </ul>	<p>Materials: Videotape.</p> <p>Activities:</p> <ul style="list-style-type: none"> <li>Personal experience messages from farm manager.</li> <li>Video with testimonials from farmworkers.</li> </ul>
Barriers (B.5.1-5); Social influence (SI.5.1-4)	<ul style="list-style-type: none"> <li>Modeling</li> <li>Vicarious reinforcement</li> </ul>	<p>Materials: Farmworker videotape.</p> <p>Activities:</p> <ul style="list-style-type: none"> <li>Video shows farmworker encouraged by manager to have a well fitting device.</li> <li>Video shows farmworker encouraging younger worker.</li> </ul>
Skills/self-efficacy (SSE.5.1-3)	<ul style="list-style-type: none"> <li>Skill training</li> </ul>	<p>Materials: Pictorial guide to HPDs.</p> <p>Activities:</p> <ul style="list-style-type: none"> <li>Manager provides guided practice for recognizing proper fit of equipment.</li> </ul>

**Table 2 (cont'd). Methods and strategies for performance and change objectives in table 1.**

<b>Section 2. Farm managers</b>		
Determinants (change objectives)	Methods	Examples of Possible Strategies and Program Materials
<b>Surveying and Planning: Performance Objectives 6 and 7</b>		
Survey farm environment for noise (and other) exposure, and plan hearing protection program		
Knowl- edge/behavioral capability (KBC.6.1- 4; 7.1-3); Skills/self- efficacy (SSE.6.1-3; 7)	<ul style="list-style-type: none"> <li>Information</li> <li>Skill training and guided practice</li> <li>Modeling</li> <li>Advance organiz- ers</li> </ul>	<p>Materials: Farm manager surveying and planning guide, manager videotape.</p> <p>Activities:</p> <ul style="list-style-type: none"> <li>Show videotape modeling monitoring and planning.</li> <li>One-on-one training.</li> <li>Trainer demonstrates monitoring and survey techniques.</li> <li>Trainer works with manager to identify barriers and plans to overcome them.</li> <li>Trainer demonstrates use of audiometer.</li> <li>Manager practices use of equipment and survey guides from manual.</li> </ul>
Perceived suscepti- bility/severity (PSS.6.1-3; 7.1-2; NA.6); Outcome expectations (OE.6; 7.1-4); Barriers (B.6; 7.1-2); Social influence (SI.6.1-3; 7.1-2)	<ul style="list-style-type: none"> <li>Verbal persua- sion</li> <li>Modeling</li> <li>Scenario-based risk information</li> </ul>	<p>Materials: Manager videotape and planning guide.</p> <p>Activities:</p> <ul style="list-style-type: none"> <li>Trainer shows videotape images of managers surveying and noting problems.</li> <li>Videotape testimonials of farmers who have conducted surveys and developed plans for their farms.</li> <li>Videotape scenarios of risks for inadequate plans.</li> </ul>
<b>Implementation and Evaluation: Performance Objectives 8-10</b>		
Provide hearing protection devices, implement engineering solutions, and evaluate program effectiveness		
Knowl- edge/behavioral capability (KBC.8.1- 9; 9.1-3; 10.1-4); Skills/self-efficacy (SSE.8; 9, 10.1-2)	<ul style="list-style-type: none"> <li>Advance organiz- ers</li> <li>Information</li> <li>Skill training</li> <li>Modeling</li> <li>Goal setting</li> </ul>	<p>Materials: Manager videotape, planning guide, pictorial guide for HPDs.</p> <p>Activities:</p> <ul style="list-style-type: none"> <li>Trainers assure that managers can demonstrate device use and arrange for fitting.</li> <li>Videotape shows how workers can assure fit.</li> <li>Trainers use planning guide to teach common engineering solutions.</li> <li>Trainers provide resources for technical assistance for engineering solutions.</li> <li>Trainers show guide's checklist for evaluation of program effectiveness.</li> <li>Trainers work with managers to set goals and compliance targets.</li> </ul>
Outcome expecta- tions (OE.8.1.- 3, 9.1-3; 10.1-2); Perceived sus- ceptibility/severity (PSS.8.1-2; 9.1- 2; NA.9.1-2; 10); Social influence (SI.8.1-2; 9; 10.1- 2); Barriers (8.1- 2; 9.1-2; 10)	<ul style="list-style-type: none"> <li>Verbal persua- sion</li> <li>Modeling with vicarious rein- forcement</li> <li>Scenario-based risk information</li> </ul>	<p>Materials: Manager videotape.</p> <p>Activities:</p> <ul style="list-style-type: none"> <li>Trainers discuss positive outcomes from better hearing protection.</li> <li>Farm managers on videotape give examples of successful programs.</li> <li>Farm managers on videotape talk about personal hearing loss.</li> </ul>
<b>Communication: Performance Objectives 11-12</b>		
Educate farmworkers about hazards and protection and create a health and safety culture		
Knowl- edge/behavioral capability (KBC.11.1-4; 11.1- 3; 12.1-3); Skills/self-efficacy (SSE.11.1-3; 12.1- 3)	<ul style="list-style-type: none"> <li>Information</li> <li>Modeling</li> <li>Skill training</li> <li>Commitment</li> </ul>	<p>Materials: Manager videotape, manager farmworker education guide, farmworker videotape, posters, farmworker pictorial monitoring guide, signs, farmworker pictorial guide for HPDs.</p> <p>Activities:</p> <ul style="list-style-type: none"> <li>Trainer models education session.</li> <li>Trainer reviews educational material with farm manager.</li> <li>Trainer discusses common questions, concerns, and barriers about HPD use and responses.</li> <li>Farm manager commits to a schedule for the education.</li> <li>Video with farm manager educating farmworkers and farmworkers complying with recommendations.</li> </ul>
Social influence (SI.11.1-2., 12); Outcome expecta- tions (OE.11.1-2; 12.1-3)	<ul style="list-style-type: none"> <li>Visible expecta- tions</li> <li>Modeling</li> <li>Reinforcement</li> </ul>	<p>Materials: Manager videotape.</p> <p>Activities:</p> <ul style="list-style-type: none"> <li>Videotape of manager interacting with workers regarding safety issues at times other than training.</li> <li>Trainer describes importance of hearing protection.</li> <li>Testimonials from farm managers about how a safe farm benefits both farmer and farmworkers.</li> <li>Trainer reinforces farmer's positive expectations of a safe farm.</li> </ul>