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Intervention Research in Agriculture: Examples From the Swine Confinement and Respiratory Health Project

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The "Measurement and Analysis in Agricultural Interventions" workshop session of the "Intervention Research in Occupational Health and Safety: Science, Skills, Strategies" conference considered a variety of approaches to safety and health interventions in agriculture. The "Respiratory Health in Swine Confinement Project" in Iowa, an educational intervention to improve respiratory health and safety in swine confinement workers, was presented as a case study for the discussion. Results from the project were used to illustrate the advantages and disadvantages of a variety of research techniques in interventions and program evaluation, including specific issues related to measurement and analysis. The discussion reflects comments from workshop participants along with summary observations reported to conference attendees. Themes of the session include the complementary nature of quantitative and qualitative techniques, and the importance of developing interventions that are community based. © *1996 Wiley-Liss, Inc.*

KEY WORDS: agricultural safety and health, farm safety training, health belief model, intervention methods, program evaluation, respiratory health, swine confinement

INTRODUCTION

The "Respiratory Health in Swine Confinement Project" addressed health-related knowledge, attitudes, and behavior among swine confinement workers [Ferguson et al., 1989]. The goals of the project were: (1) to increase knowledge about human respiratory conditions; (2) to enhance attitudes favoring the prevention of human respiratory conditions; and (3) to change behavior related to preventing such conditions. In planning the intervention, project staff developed a working theoretical model, based on the Health Belief Model [Janz and Becker, 1984], of how knowledge, attitudes, and behavior interrelate to influence respiratory health. Although not all goals of the project were achieved, the educational intervention had a significant effect in each of the three goal areas of the project [Gjerde et al., 1991].

The intervention included an educational program that had three components. First, those in the intervention group received six written units; pretests and post-tests were completed for each unit. Second, participants were invited to small group meetings at which project staff demonstrated dust mask use and indoor air measurement; participants also discussed barriers to following recommendations about preventing respiratory health hazards. Third, an industrial hygienist visited all of the farms in the intervention group, took indoor air measurements, and provided farmers with feedback on how their farms compared with recommended maximum safety levels and with other farms in the project in terms of ammonia, hydrogen sulfide, carbon dioxide, carbon monoxide, and dust.

This paper uses the "Respiratory Health in Swine Confinement Project" as a case study for some of the critical issues in intervention research in agriculture. The first por-

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tion of the paper considers a variety of methodological issues relevant to the swine confinement intervention: (1) the identification of an appropriate sample; (2) the development of an educational intervention that was appropriate to the farming community; (3) the evaluative steps taken to monitor and modify the intervention; (4) designing community-based interventions; (5) the use of expert observers and other methods; and (6) the complex problems involved in assessing exposure to agricultural hazards.

The concluding portions of the paper review the complementary relationship between qualitative and quantitative methods and the kinds of results that the two methods produce, a theme that was identified throughout the conference. Intervention research in agricultural communities requires sensitivity to local concerns and salient issues. Focus groups and other qualitative techniques identify these concerns for the researcher. Then an iterative evaluation program can be initiated to examine the entire intervention process, make modifications as necessary, and assess the outcomes of the intervention.

METHODS

Sample Selection

Intervention and control counties

The research design was that of a between-subjects, treatment vs. control group study in which participants were randomized by county of residence. The county structure in Iowa is quite regular: rows or "tiers" of similar-sized counties line up east to west across the state. Two tiers of counties that are geographically separated by a middle tier of counties were selected. Farms in the selected counties were enrolled in the project and one tier of counties was randomly assigned to the intervention group and the other tier to the control group. This method of separating the counties was adopted to minimize comparison or contamination between treatment and control groups [Cook and Campbell, 1979]. Knowledge, attitudes, and behavior of the participants in both groups were assessed through a swine producer survey. In addition, those in the intervention group completed pretests and post-tests for each of the educational units. Finally, the industrial hygienist also assessed indoor air quality in confinement buildings.

Intervention

Educational units

Before the written educational units were finalized, information from the swine producer survey was used to guide the content of the units. This procedure helped to assure that the units addressed information the swine farmers did not already know. Conducting this kind of needs assessment reduces the likelihood of a ceiling effect on the pretest measures. A ceiling effect can occur when scores are very high prior to an intervention and leave little room for improvement [Nunnally, 1978]. For example, many farmers reported on the swine producer survey that they were interested in wearing dust masks and stated that they were able to obtain them. For these farmers, an educational unit directed toward obtaining and wearing any kind of dust mask likely would have produced a celing effect on the pretest. Many respondents did not know, however, that the one-strap masks that were readily available were not adequate to protect them from most of the respiratory hazards associated with swine confinement buildings. The survey also found that keeping the masks clean and figuring out how to store the masks away from dusty areas were problems that needed to be addressed.

Evaluation

Process evaluation

Project staff conducted a process evaluation [Rossi and Freeman, 1993] for each component of the educational intervention. Completion rates were recorded for pretests and post-tests, as was the timing for the return of each test unit, the number of reminders sent, attendance at group meetings, and the amount of time spent by the industrial hygienist at each site. In addition, participants provided comments about each of the educational units, the group meetings, and the overall project.

Formative evaluation

Educational materials were revised based on comments received, a process called formative evaluation, i.e., evaluation whose purpose is to improve the product or process being evaluated [Rossi and Freeman, 1993]. For example, surveys identified content areas that respondents found difficult to understand or that they did not find pertinent to their own farms.

Part of the formative evaluation concerned asking farmers to identify individuals or groups that they would go to for information about agricultural health and safety. This project began at the height of the farm crisis of the mid-1980s. Many farmers were concerned about their economic survival and the project staff wanted to make the most efficient use of existing communication channels. For example, county agricultural extension agents were expected to play a major role in the dissemination of project information. However, extension agents were found to be not as highly valued as other sources of information, perhaps because some farmers associated them with government policies that contributed to the farm crisis. The most trusted sources of information identified were veterinarians, farm

magazines, and other farmers. Thus, the project strategies for disseminating information were changed to utilize these sources. In addition to demonstrating the importance of checking assumptions about an intervention with those who will participate, this example highlights the importance of historical effects in intervention research.

Summative evaluation

Outcome assessment, sometimes called summative evaluation, examined changes in knowledge, attitudes, and behavior in the intervention group as compared to the control group at the conclusion of the project.

Designing Community-Based Interventions

Advisory committee

The project was based on principles of community organization, for example using natural (i.e., existing) helping networks within communities to achieve desired change. One method for enhancing the networks was through the formation of an Advisory Committee whose members provided valuable insight and assistance throughout all phases of the project. Advisory Committee members helped decide when to conduct various phases of the intervention. When working in agricultural settings, the timing of interventions is critical since respondents' participation in project activities must not conflict with such events as planting and harvesting. Ideally, advisory group members are owners and partners in the intervention process. While they are volunteers, they are also "experts" on most of the matters on which they are consulted. Advisory group members should be involved throughout the project and have some say over the outcome of the project.

In addition, all participants have ownership in the project, i.e., they should feel that they are an important part of project success. In addition to getting feedback from participants throughout the project and updating them through a participant newsletter, the Respiratory Health in Swine Confinement Project provided each farm with a fence sign stating that the farm was participating in the project. Although the responses to the fence signs were not systematically evaluated, several members of the Advisory Board noted that the signs generated discussion of the Project among their friends. Further, although this was a 5 year project, participation remained high throughout.

Additional Data Collection and Evaluation Methods

Direct observation

Direct observation, such as an on-farm safety and health review, can be very useful in agricultural intervention research. In the swine project, an industrial hygienist visited each farm. The hygienist used a checklist for on-site evaluation of agricultural hazards and took measurements of indoor air quality. An advantage of direct observation is that it allows for in-depth assessment of a number of variables by an independent evaluator using a standardized protocol. Once the data collection protocol has been developed, the observers/judges should undertake a series of pretests with the instrument. The reliability of these observations can be calculated and the protocol modified until an acceptable level of inter-rater reliability is achieved [Nunnally, 1978]. The main disadvantages of these assessments are: (1) direct observation can be very expensive; (2) there can be bias if respondents make changes in preparation for the observer's visit; (3) such assessments are restricted to a limited time frame; and (4) multiple observers must evaluate a common sample or subsample of sites so that a measure of the reliability of the observations can be calculated.

Secondary sources

A final research method for interventions is to use secondary sources of information. The main problem with secondary sources is to make certain that the information obtained is interpretable and relevant to the current research or intervention hypotheses, and that this information does not introduce additional skew in the results. For example, while workers' compensation claims might detect the most serious back injuries, they would be unlikely to identify problems that do not result in hospitalization or visits to health professionals. In this example, the number of back injury claims filed would provide a minimum estimate for the actual number of back injuries experienced on the job; and, as with other written material, transcription errors and omissions must be anticipated.

Secondary source information can be useful as long as one understands the limitations of the data. For example, in patient compliance research, secondary sources such as blood tests are considered by some researchers to be more reliable indicators than self-report. This is not to say that blood tests are perfect indicators of compliance in all cases. Blood or urine tests are subject to bias due to biologic variability in metabolizing drugs and may therefore overrepresent or underrepresent compliance. On the other hand, patients will generally answer truthfully if the questions are asked sensitively and appropriately and if there is no penalty for noncompliance. Problems arise when patients are concerned that their medical care will be jeopardized if they have violated a protocol. Overall, secondary sources provide an opportunity for a multimethod validation of a given exposure or observation [Campbell and Fiske, 1959].

EXPOSURE ASSESSMENT

Although this case study focused on respiratory health in swine confinement workers, it served as one example of

the many hazardous exposures to be found throughout agriculture [e.g., Myers et al., 1992]. The workshop participants recognized the variety of potential hazards found in farming. One major focus of the discussion concerned the need for improved assessment of farm hazards, including better measurement methods of these hazards.

Problems Unique to Agriculture

The measurement of exposure to hazards on farms presents unique problems. For example, there are no easy-to-use chemical exposure tools available to farmers as there are to workers in some other industries. Further, direct sampling methods designed for conventional industry are applicable to some agricultural chemicals, but are either unknown to the general agricultural population (e.g., hydrogen sulfide tests) or are not available through conventional agricultural supply sources, such as feed/supply outlets (Pedersen, personal communication). This problem has been recognized in the current effort to develop exposure assessment kits for selected farm chemicals (e.g., NIOSH Agricultural Initiative, Hull et al., in preparation). However, farm owner/operators and farm workers handle a large number of different pesticides and chemicals in the course of a season. Developing rapid assessment tools for all of these potential exposures is a major undertaking. Similarly, equipment and animal hazards present a number of unique exposures not found in other industries. The problem is not that the nature of the various hazards is completely unknown. Rather the problem is in the large number of separate potential exposures to agricultural hazards. It is important to distinguish between the health effects to farmers resulting from exposures to agricultural hazards and the exposures themselves. In many respects the health effects are methodologically easier to assess than the actual exposures. While single point measures can reliably evaluate farmers' overall health or injury status, valid and replicable assessment of the exposure process is methodologically quite challenging.

Worker observations vs. outside observers

Reliability and validity of measures [Cook and Campbell, 1979] are a major concern to any scientific endeavor. In the workshop discussion, it became clear that there are advantages and disadvantages to measurements by subject/participants and by outside observers. For assessments of the farm work environment by farmers, the goal is to solicit independently verifiable judgments [Nunnally, 1978]. The underlying hypothesis is that the experienced farm worker is in the best position to evaluate the features of his/her work environment. The main problem with this approach is to develop measures that reliably assess the environment, independent of the worker's emotional state or personal preferences. However, when such measures can be developed, the researcher has the advantage of a much longer period of evaluation (e.g., months or years) of the work environment from the point of view of the worker/evaluator.

Outside observers and monitoring equipment have the advantage of relatively high reliability and easy replication. As noted above, protocols can be developed and modified to a pre-determined level of reliability. Monitoring equipment of various types can supplement the assessments of outside observers. The main drawback to this approach is that it is very difficult and expensive to assess extended periods of exposure to the farm work environment. The discussion by the workshop participants confirmed that both worker/participants and independent observers can make unique and valuable contributions to a research program.

Of concern is the problem of developing reliable measures of period prevalence for exposures, particularly for chemicals and pesticides. Point prevalence measures can be addressed through visits like those of the industrial hygienist in the Respiratory Health Project in Iowa. It is substantially more difficult to develop reliable measurements of exposure over a period of several months or years. Since farmers' work varies by day, by season, and by activity, assessing the many exposures is particularly problematic.

Another intervention that can serve as a model for identifying exposures in agriculture is the Cooperative Agricultural Surveillance Training (CAST) Program at NIOSH [Pedersen, 1994]. This program combines safety awareness and hazard surveillance into a comprehensive series of taped lectures on a variety of farm topics. Included in this series are components entitled "Standardized Observation Walkthrough Protocols" and "Field Observation and Coding." These components provide training in the skills and methodologies necessary to identify and inventory occupational hazards in an agricultural setting, and to associate these hazards with specific agricultural activities and operational areas.

Nevertheless, even when exact exposures are known, the informational demands necessary to cope with the physical and chemical exposures are daunting. The National Ag Safety Disc currently under development will be able to collect much of this information in a form that is available to farmers [Jones et al., 1994].

Qualitative and Quantitative Methods

The underlying current of discussion in the "Measurement and Analysis in Agricultural Interventions" workshop reflects the main themes of debate throughout the entire "Intervention Research" meeting. Foremost among these themes is the complementary relationship and apparent trade-off between qualitative and quantitative research methods. The workshop participants recognized that it is misleading to pose these different methods in an "either–or" fashion. Rather, qualitative and quantitative techniques

should be viewed as complementary and sometimes overlapping. The task of the researcher is to use each technique to gain the maximum amount of information from each method. Each stage in the research process may present different informational demands and may require different methods to respond to the demands.

If a given research area is new, qualitative methods are appropriate to help define the relevant domain of analysis. Then once the boundaries and elements of the domain have been defined, quantitative approaches can be implemented to systematically assess the responses of the population working in this domain. In this way the results of a qualitative analysis can be translated into a structured instrument for a quantitative analysis. Similarly, one of the main goals of studies using quantitative methods is to generalize from sample to population. For example, in surveillance epidemiology, an important goal is to estimate the prevalence of a phenomenon in a population. Estimating prevalence in a population necessarily must follow a precise definition of the phenomenon to be estimated, and requires a sample that has been properly selected, perhaps stratified by farm size, commodity, geographical location, seasonal variations in the activity, or by other criteria (Pedersen, personal communication).

Focus groups

A well known example of qualitative research techniques is a focus group. This technique provides an excellent illustration of some of the differences in approach between qualitative and quantitative research methods. By any comparison to quantitative techniques, focus group participants represent only a very small percentage of a population. More important, the main purpose of a focus group is not to develop information that can be generalized to a population but to explore the program, process, or environment that is the topic of investigation. Each focus group participant may describe particular features of the environment in different terms than those used by other members of the group. The qualitative methodologist is forced to check and recheck the meaning of each comment in the context of the other comments from the group. It is through this type of analysis that common themes are identified and evaluated. By contrast, quantitative methods typically use standardized prompts regarding the environment under investigation, and it is the responses to these prompts that are varied. In short, qualitative methods seek variability in the environment; quantitative methods seek variability in the population [Kidd et al., submitted].

Through focus groups, researchers are able to collect a wide range of information that is not often available through other methods. Focus groups are useful for generating new ideas and for midcourse calibration. They permit the group leader/moderator to follow up in content areas that appear to be contradictory or require clarification. Focus groups use the respondents' language to describe salient issues (e.g., farmers' own descriptions and experiences) and allow the moderator to address sensitive issues that may be unsuitable in a questionnaire format or too personal for a phone interview. In addition, focus groups can help researchers identify "hot" issues, new ideas, or emerging problems that would not be detected through other types of measures. Focus groups may also be an initial step in developing structured, quantitative measures [e.g., Heaney, 1994], in establishing content and construct validity [Cook and Campbell, 1979], and in defining the domain or context of relevant issues [a complex problem in quantitative research, e.g., Stokols, 1987].

EVALUATION OF AN INTERVENTION AS RESEARCH: AN ITERATIVE PROCESS

Perhaps one of the most important features of the Respiratory Health Project, from a research perspective, is the use of a continuous process of evaluation during the 5 year intervention. By using the results from each round of evaluation in the preparation of the next phase of the intervention, the project was able to maintain a dynamic, relevant, and up-to-date program. This process also forced the intervention to remain close to the community of farmers participating in the project, and to agricultural safety and health in general. This approach to intervention research is consistent with current program evaluation methodology and technique [Campbell, 1984; Cronbach et al., 1980].

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